Platinum Level

- An educational grant in support of the NER Foundation Symposium 2010: Cancer Imaging for the Neuroradiologist: Fundamentals to Functional and Molecular Imaging
- Annual Bayer HealthCare Pharmaceuticals Outstanding Presentation Award in General Neuroradiology
- Annual educational grant in support of the Maintenance of Certification (MOC) and Self Assessment Modules (SAM)* programming live and on the ASNR website
- Performance and Quality Improvement (PQI) Initiative

Gold Level

TOSHIBA
Leading Innovation

Silver Level

SIEMENS
imagination at work

Contributor

VITAL

*Session Programming is under review as of 4/6/10 by the American Board of Radiology to meet the criteria for self-assessment toward the purpose of fulfilling requirements in the ABR Maintenance of Certification. To obtain current SAM credit information, visit www.asnr.org.
Dear Colleagues,

Welcome to the ASNR 48th Annual Meeting and NER Foundation Symposium 2010. Dr. Carolyn Meltzer from Emory University, President-Elect of the ASNR and this year’s Program Committee Chair, has worked with members of her committee to present topical and significant educational and scientific material for this year’s programming. A special feature on Saturday morning “Technical Advances in Brain Tumor MR Imaging,” ASNR in collaboration with the International Society for Magnetic Resonance in Medicine (ISMRM).

The NER Foundation Symposium 2010 “Cancer Imaging for the Neuroradiologist. Fundamentals to Functional and Molecular Imaging” will be educationally beneficial for all attendees, both specialists and generalists.

The Annual Meeting features Self Assessment Module (SAM) sessions in each of the subspecialty areas of neuroradiology, a general content SAM session MOC sessions in brain, spine, head and neck, and advanced imaging, and new this year, Synaptic Function programming. Focus Sessions developed in cooperation with the American Society of Functional Neuroradiology (ASFR), American Society of Head and Neck Radiology (ASHNR), American Society of Pediatric Neuroradiology (ASPR), American Society of Spine Radiology (ASSR), and the Society of NeuroInterventional Surgery (SNIS) cover a wide range of topics of interest for both the sub-specialist and general neuroradiologist. Once again, attendees may the American Board of Radiology (ABR) neuroradiology MOC recertification examination on site at the meeting.

I wish to extend a special thanks to the following Co-Chairs for their efforts in organizing the programming for the following subspecialty areas:

American Society of Functional Neuroradiology (ASFR) ..........................Scott H. Faro, MD
American Society of Head and Neck Radiology (ASHNR) ........................Lawrence E. Ginsberg, MD
American Society of Pediatric Neuroradiology (ASPR) .........................L. Santiago Medina, MD, MPH
American Society of Spine Radiology (ASSR) .......................................Jeffrey A. Stone, MD
Society of NeuroInterventional Surgery (SNIS) .................................Cameron G. McDougall, MD

The annual meeting provides a unique opportunity to gain a better understanding of how the ASNR functions to assist the practice of neuroradiology during a time of rapid change. The meeting also provides excellent opportunities to renew old friendships and make new ones, as well as exchange ideas and share conversation with world-renowned researchers and clinicians.

I congratulate Carolyn Meltzer and her committee for constructing an outstanding program. I welcome all attendees to one of the best products of the ASNR — our annual meeting. I hope to be able to greet you personally during the meeting.

Sincerely,

John R. Hesslink, MD, FACR
ASNR President
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Sudipta Roychowdhury, MD
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Robert J. Young, MD
The ASNR 48th Annual Meeting and NER Foundation Symposium 2010 host venue is the Hynes Convention Center in Boston. Boston, first incorporated as a town in 1630 and as a city in 1822, is one of America’s oldest cities, with a rich economic and social history. What began as a homesteading community eventually evolved into a center for social and political change. Boston has since become the economic and cultural hub of New England.

Walking Map of Boston
General Information

Meeting Registration
Registration will take place in the Hall C Foyer, Hynes Convention Center. The registration desk will be open during the following hours:
Friday, May 14 ....................................................... 5:00 pm - 8:00 pm
Saturday, May 15 ....................................................... 6:30 am - 6:00 pm
Sunday, May 16 ....................................................... 6:30 am - 6:00 pm
Monday, May 17 ....................................................... 6:30 am - 6:00 pm
Tuesday, May 18 ....................................................... 6:30 am - 6:00 pm
Wednesday, May 19 ....................................................... 6:30 am - 6:00 pm
Thursday, May 20 ....................................................... 6:30 am - 6:00 pm

Speaker Ready Room Location & Hours
Hynes Convention Center - Room 313
Friday, May 14 ....................................................... 5:00 pm - 8:00 pm
Saturday, May 15 through Thursday, May 20 ....................................................... 6:00 am - 6:00 pm

Name Badges
Please wear name badges at all times while you are attending the scientific sessions, social programs, and technical exhibits. Badge colors are identified as follows:
ASNR, ASFNR, ASHNR, ASPNR, ASSR, or SNIS Member ....................................................... Blue
Non-Member ....................................................... Green
Fellow/Trainee ....................................................... Tan
Other Professional ....................................................... Yellow
Guest ....................................................... Peach
Exhibitor ....................................................... Gold
Staff ....................................................... Purple

Committee/Specialty/Regional Society Meetings
Please refer to the Daily Postings on the Meetings & Announcements Board located in the Hall C Foyer of the convention center.

Meetings & Announcements Board
The Meetings & Announcements Board is located in the Hall C Foyer of the convention center. Please refer to the Daily Postings on the Meetings & Announcements Board for information on committee meetings.

CME Pavilion
Located in Room 309 of the Hynes Convention Center, the CME Pavilion computer terminals will be available to registered attendees that can be used to evaluate attended sessions and print CME certificates.
Hynes Convention Center - Room 309
Saturday, May 15 ....................................................... 7:00 am - 9:00 pm
Sunday, May 16 through Thursday, May 20 ....................................................... 6:30 am - 9:00 pm

E-Access/Messaging Center
The E-Access Message terminals are located in Room 310 of the Hynes Convention Center. The terminals can access/send external email and leave internal messages for other attendees.
Hynes Convention Center - Room 310
Hynes Convention Center
Saturday, May 15 ....................................................... 7:00 am - 9:00 pm
Sunday, May 16 through Thursday, May 20 ....................................................... 6:30 am - 9:00 pm

Hynes Convention Center
900 Boylston Street
Boston, MA 02115-3101
(617) 954-2000

Coat Check
Hynes Convention Center - Auditorium Foyer
Hours of Operation:
Saturday, May 15 ....................................................... 6:30 am - 6:00 pm
Sunday, May 16 ....................................................... 6:00 am - 6:00 pm
Monday, May 17 ....................................................... 6:00 am - 8:00 pm
Tuesday, May 18 through Thursday, May 20 ....................................................... 6:00 am - 7:00 pm

Concierge Desk
Hynes Convention Center - Hall C Foyer
Saturday, May 15 ....................................................... 9:30am - 5:00pm
Sunday, May 16 ....................................................... 9:30am - 5:00pm
Monday, May 17 ....................................................... 9:30am - 5:30pm
Tuesday, May 18 ....................................................... 9:30am - 5:30pm
Wednesday, May 19 ....................................................... 9:30am - 5:30pm

24-Hour Medical Clinic/Hospital
Beth Israel Deaconess Medical Center
Emergency Department-24 Hours
330 Brookline Avenue, Boston, MA 02215
(617) 667-7000

On-site First-Aid/Emergency
• The nurse’s office is on Level 1 (Plaza Level) in the Main Lobby.
• In case of emergency, please dial 2111 from any house phone.
• Emergency efforts will be coordinated by the Hynes Convention Center.
• From a cell phone, please dial 617-954-2111.
General Information (continued)

Food Service
ASNRC Food Service will be served in Exhibition Hall D during technical exhibition hours. Continental Breakfasts, Morning and Afternoon Coffee Service and Box Lunches are provided complimentary throughout the annual meeting. Please refer to the schedule below.

Continental Breakfast
Monday, May 17 through
   Thursday, May 20 ........................... Ballroom ABC Foyer

Morning Breaks
Monday, May 17 .............................. Ballroom ABC Foyer
Tuesday, May 18 through
   Thursday, May 20 ........................... Exhibition Hall D

Box Lunches
Monday, May 17 .............................. Ballroom ABC Foyer
Tuesday, May 18 through
   Thursday, May 20 ........................... Exhibition Hall D

Afternoon Breaks
Monday, May 17 .............................. Ballroom ABC Foyer
Tuesday, May 18 through
   Thursday, May 20 ........................... Exhibition Hall D

AJNR - Hall C Foyer
All attendees are invited to stop by the booth any time to tour the AJNR Website and Blog and take advantage of the meeting discount on subscriptions.

Meet AJNR’s Editor-in-Chief
Dr. Mauricio Castillo, AJNR’s Editor-in-Chief, will be present at the Journal’s booth Monday-Wednesday from 11:00 am to 12:00 pm to answer questions regarding the Website and Blog, listen to suggestions, talk about projects with prospective authors, and advise fellows regarding their future contributions to the Journal.

AJNR Booth
Hynes Convention Center - Hall C Foyer
Schedule
Saturday, May 15 ............................. 12:00 pm - 5:00 pm
Sunday, May 16 through
   Thursday, May 20 ........................... 8:30 am - 5:00 pm

Meeting Location: Hynes Convention Center
NOTE: All scientific sessions and exhibits are located at the Hynes Convention Center

Registration
Hall C Foyer - Level 2
CME Pavilion
Room 309 - Level 3

E-Access/Messaging Center
Room 310 - Level 3

How-To Morning and Noon Sessions
Ballroom ABC - Level 3

Focus/Scientific Paper Sessions
Ballroom ABC, Room 302-304-306, Room 311, Room 312 - Level 3
Room 210 - Level 2

Synaptic Junction Workshops
Room 207 - Level 2

Synaptic Junction Lectures
Room 208 - Level 2

EXHIBITS

Scientific Exhibits, Electronic Scientific Exhibits (eSE), Scientific Posters
Exhibition Hall C - Level 2

Technical Exhibits
Exhibition Hall D - Level 2

MISCELLANEOUS

American Board of Radiology (ABR)
Information Desk
Hall C Foyer - Level 2

ABR Exam Room
Room 207 (Thursday, May 20 only) - Level 2

American Journal of Neuroradiology (AJNR) Desk
Hall C Foyer - Level 2

Ballroom ABC Overflow Seating
Room 103 - Plaza Level 1

Coat Check
Auditorium Foyer - Level 2

Fellows Lounge
Room 200 - Level 2

Headquarters Office
Room 300 - Level 3

Meetings & Announcements Board and Job Postings Board
Hall C Foyer - Level 2

Restaurant Reservations
Hall C Foyer - Level 2

Speaker Ready Room
Room 313 - Level 3

VIP/NER Foundation Lounge
Room 308 - Level 3
Important Information for Fellows/Trainees

New this year for Fellows/Trainees!
A room has been dedicated for trainees/fellows and recent graduates throughout the 48th Annual Meeting and NER Foundation Symposium 2010. This will provide a “home base” for fellows/trainees and colleagues to catch up with each other during the meeting.

Fellows/Trainees Lounge, Hynes Convention Center - Room 200
Visit the Fellows/Trainees Lounge, opened daily Saturday, May 15 - Thursday, May 20 from 6:30am - 6:30pm to meet ASNR leaders who will be available for networking and sharing of knowledge and experiences throughout the meeting.

Auditorium Level 2 is the Primary Location for Daily Breakfast and Programming
Continental breakfast provided between 7:25am-7:55am (Monday - Thursday)

Take this opportunity to get involved and meet ASNR leaders!

Sunday, May 16
Greetings & Welcome to the ASNR Annual Meeting
John R. Hesselink, MD, FACR
President
Carolyn C. Meltzer, MD, FACR
President-Elect

Monday, May 17
AJNR... It's More Than Just a Journal
Mauricio Castillo, MD, FACR
AJNR Editor-In-Chief

Tuesday, May 18
Why ASNR Membership is Important to You
David M. Yousem, MD, MBA
ASNR Past President

Wednesday, May 19
NER Foundation and its Opportunities
Eric J. Russell, MD, FACR
NER Foundation Chair

Thursday, May 20
Become Involved in ASNR Committees
Patrick A. Turski, MD, FACR
Clinical Practice Committee Chair
Colin P. Derdeyn, MD
Research Committee Chair
Pina C. Sanelli, MD, MPH
Fellowship Directors Committee Chair

Remember to attend the Fellows Luncheon in the Auditorium
Tuesday May 18,
12:30pm - 1:30pm

For continuous updates on fellows/trainees mentoring programming please visit www.asnr.org/2010.
Guest Hospitality and Social Program

Guest Hospitality
Sheraton Boston Hotel
Hampton Room/Gardner Room
Saturday, May 15 - Thursday May 20, 2010
8:00 am - 10:00 am
Sheraton Boston Hotel - Hampton Room

The Guest Hospitality is available to those who have registered for the program. The program is a central gathering place for guests to meet with friends old and new. As a part of Guest Hospitality you will receive complimentary continental breakfast and beverages and free admission to the Monday evening “Best of Boston Bistro” Reception with Technical Exhibitors and entertainment.

There is on-site concierge service that provides information about Boston attractions, tours and dining. The city of Boston offers visitors an endless choice of activities that range from fine dining to lively family fun, many within walking distance of the Sheraton Boston Hotel, ASNR Headquarters Hotel.

Guest Hospitality Suite
Sheraton Boston Hotel, Hampton Room
Saturday, May 15 – Thursday, May 20, 2010
8:00 am – 10:00 am

Presentations: Gardner Room
Topics:

Saturday, May 15 – 9:00am
Greater Boston Convention & Visitors Bureau
“Things to See and Do in Boston”

Monday, May 17 – 9:00am
Freedom Trail Foundation:
“Historic Reenactment by Paul Revere”

Tuesday, May 18 – 9:00am
Boston By Foot:
“The ‘Re-shaping’ of Boston’s Architecture:
The Contemporary City, A Narrated Slide Show”

Wednesday, May 19 – 9:00am
Greater Boston Convention & Visitors Bureau
“Things to See and Do in Boston”

Social Program
“When of Boston Bistro”
Welcome Reception
Monday, May 17, 2010
6:30 pm - 7:30 pm
Hynes Convention Center - Exhibit Hall D

We look forward to welcoming attendees to the Technical Exhibition Hall for a pre-dinner reception of local Boston culinary favorites. The reception offers attendees the perfect opportunity to see this year’s Technical Exhibition, the ASNR’s annual showcase for the newest products and services for the field of Neuroradiology. Enjoy complimentary pre-dinner hors d’oeuvres and beverages while you learn about the newest technologies. Connect with old friends, make new ones and meet representatives from companies participating in this year’s technical exhibition.

This casual social setting also allows plenty of informal discussion with the company representatives, so bring your product and service challenges and come in search of solutions to the place where advanced technology and diagnostic and interventional neuroradiological excellence come together.

The Scientific Exhibition (posters, scientific and electronic exhibits) will also be available for viewing throughout the reception.

You won’t want to miss this “Best of Boston” Experience!
Past Annual Meetings

Organizational Meeting
May 19, 1962
Keene’s English Chophouse
New York

Second Business Meeting
October 5, 1962
Shoreham Hotel
Washington, DC

First Annual Meeting
October 7, 1963
Queen Elizabeth Hotel
Montreal

Second Annual Meeting
September 23, 1964
Waldorf Astoria
New York

Third Annual Meeting
June 11, 1965
Dennis Hotel
Atlantic City

Fourth Annual Meeting
June 15-16, 1966
Sheraton-Park Hotel
Washington, DC

Fifth Annual Meeting
May 15, 1967
Columbia University
New York

Sixth Annual Meeting
September 27-28, 1968
Jung Hotel
New Orleans

Seventh Annual Meeting
May 13-19, 1969
Joint Meeting with American
Association of Neurological
Surgeons
Sheraton-Cleveland Hotel
Cleveland

Eighth Annual Meeting
February 12-13, 1970
Washington Hilton
Washington, DC

Ninth Annual Meeting
May 27-29, 1971
Fairmont Hotel
San Francisco

Tenth Annual Meeting
February 21-24, 1972
Maria-lsabel Sheraton
Mexico City

Eleventh Annual Meeting
May 26-28, 1973
Statler Hilton
Boston

Twelfth Annual Meeting
March 14, 1974
(In conjunction with X Symposium
Neuroradiologicum)
Convention Center
Punta del Este, Uruguay

Thirteenth Annual Meeting
June 3-7, 1975
Bayshore Inn
Vancouver

Fourteenth Annual Meeting
May 18-22, 1976
Peachtree Plaza
Atlanta

Fifteenth Annual Meeting
March 27-31, 1977
Hamilton Princess Hotel
Bermuda

Sixteenth Annual Meeting
February 26-March 2, 1978
Hyatt Regency
New Orleans

Seventeenth Annual Meeting
May 20-24, 1979
Hotel Toronto
Toronto

Eighteenth Annual Meeting
March 16-21, 1980
Century Plaza
Los Angeles

Nineteenth Annual Meeting
May 5-9, 1981
Marriott Hotel
Chicago

Twentieth Annual Meeting
October 10-16, 1982
(In conjunction with XII
Symposium Neuroradiologicum)
Washington Hilton
Washington, DC

Twenty-First Annual Meeting
June 5-9, 1983
St. Francis Hotel
San Francisco

Twenty-Second Annual Meeting
June 2-7, 1984
Westin Copley Place Hotel
Boston

Twenty-Third Annual Meeting
February 18-23, 1985
Marriott Hotel
New Orleans

Twenty-Fourth Annual Meeting
January 19-23, 1986
Sheraton Harbor Island Hotel
San Diego

Twenty-Fifth Annual Meeting
May 20, 1987
New York Hilton
New York

Twenty-Sixth Annual Meeting
May 15-20, 1988
Chicago Hilton & Towers
Chicago

Twenty-Seventh Annual Meeting
March 19-24, 1989
The Peabody Orlando
Orlando

Twenty-Eighth Annual Meeting
May 19-23, 1990
Century Plaza Hotel & Tower
Los Angeles

Twenty-Ninth Annual Meeting
June 9-14, 1991
The Washington Hilton and
Towers
Washington, DC

Thirtieth Annual Meeting
May 31-June 5, 1992
Adam’s Mark
St. Louis

Thirty-First Annual Meeting
May 17-20, 1993
Vancouver Trade and
Convention Center
Vancouver

Thirty-Second Annual Meeting
May 3-7, 1994
Opryland Hotel and
Conference Center
Nashville

Thirty-Third Annual Meeting
May 23-27, 1995
Sheraton Chicago Hotel and
Towers
Chicago

Thirty-Fourth Annual Meeting
June 23-27, 1996
Washington State Convention
and Trade Center
Seattle

Thirty-Fifth Annual Meeting
May 18-22, 1997
Metro Toronto Convention
Center
Toronto

Thirty-Sixth Annual Meeting
May 17-21, 1998
(In conjunction with XVI
Symposium Neuroradiologicum)
Pennsylvania Convention Center
Philadelphia

Thirty-Seventh Annual Meeting
May 23-28, 1999
San Diego Convention Center
San Diego

Thirty-Eighth Annual Meeting
April 4-8, 2000
Hyatt Regency Atlanta
Atlanta

Thirty-Ninth Annual Meeting
April 23-27, 2001
Hynes Convention Center
Boston

Fortieth Annual Meeting
May 13-17, 2002
Vancouver Convention
& Exhibition Center
Vancouver

Forty-First Annual Meeting
April 28 - May 2, 2003
Marriott Wardman Park Hotel
Washington, DC

Forty-Second Annual Meeting
June 7-11, 2004
Washington State Convention
and Trade Center
Seattle

Forty-Third Annual Meeting
May 21-27, 2005
Metro Toronto Convention
Center
Toronto

Forty-Fourth Annual Meeting
April 29-May 5, 2006
San Diego Convention Center
San Diego

Forty-Fifth Annual Meeting
June 9-14, 2007
Hyatt Regency Chicago
Chicago

Forty-Sixth Annual Meeting
May 30-June 5, 2008
Ernest N. Morial Convention
Center
New Orleans

Forty-Seventh Annual Meeting
May 16-21, 2009
Vancouver Convention and
Exhibition Centre
Vancouver
ASNR Past Presidents and Founders

1962-64 Juan M. Taveras, MD*
1964-65 Mannie M. Schechter, MD*
1965-66 Donald L. McRae, MD*
1966-67 Ernest H. Wood, MD*
1967-68 Harold O. Peterson, MD*
1968-69 Colin B. Holman, MD*
1969-70 Giovanni Di Chiro, MD*
1970-71 D. Gordon Potts, MD
1971-72 Norman E. Chase, MD
1972-73 Fred J. Hodges, III, MD*
1973-74 T. Hans Newton, MD
1974-75 Hillier L. Baker, Jr., MD*
1975-76 Irvin I. Krizheff, MD
1976-77 Norman E. Leeds, MD
1977-78 Sadek K. Hilal, MD*
1978-79 Stephen A. Kieffer, MD
1979-80 David O. Davis, MD
1980-81 George Wortzman, MD
1981-82 Gabriel H. Wilson, MD
1982-83 Arthur E. Rosenbaum, MD
1983-84 O. Wayne Houser, MD
1984-85 Samuel M. Wolpert, MD
1985-86 R. Thomas Bergeron, MD
1986-87 Derek C. Harwood-Nash, MD*
1987-88 Michael S. Huckman, MD
1988-89 Anne G. Osborn, MD
1989-90 Joseph F. Sackett, MD
1990-91 Anton N. Hasso, MD, FACS
1991-92 R. Nick Bryan, MD, PhD, FACS
1992-93 David Norman, MD
1993-94 Glenn S. Forbes, MD
1994-95 Robert M. Quencer, MD
1995-96 Robert R. Lukin, MD
1996-97 Burton P. Drayer, MD
1997-98 Richard E. Latchaw, MD
1998-99 A. James Barkovich, MD
1999-00 Eric J. Russell, MD, FACS
2000-01 William S. Ball, Jr., MD
2001-02 William P. Dillon, MD
2002-03 Patrick A. Turski, MD
2003-04 Charles M. Strother, MD
2004-05 Victor M. Haughton, MD
2005-06 Patricia A. Hugdins, MD
2006-07 Robert I. Grossman, MD
2007-08 David M. Yousem, MD, MBA
2008-09 Robert D. Zimmerman, MD, FACR

Founding Members

Norman E. Chase, MD
Giovanni Di Chiro, MD*
William N. Hanafee, MD
Fred J. Hodges, III, MD*
Colin B. Holman, MD*
Norman E. Leeds, MD
Eugene V. Leslie, MD*
Donald L. McRae, MD*
Thomas H. Newton, MD
Harold O. Peterson, MD*
D. Gordon Potts, MD
Mannie M. Schechter, MD*
Juan M. Taveras, MD*
Ernest H. Wood, MD*
Awards and Honors

2009 - 2010 ASNR Gold Medal Award

The Gold Medal fosters the highest standards of the American Society of Neuroradiology, based on exceptional quality, service, and excellence, and not necessarily on fame. It emphasizes both professional and personal attributes... individuals who are superb neuroradiologists, clinicians, or scientists, and truly outstanding. The recipients are individuals who have extended themselves beyond furthering their own careers through contributions at all levels of professional strata, with an accent on consistency and duration of these outstanding contributions.

2009 Gold Medal Recipient
Anton N. Hasso, MD, FACR

Anton N. Hasso MD, FACR currently serves as Professor of Radiological Sciences and Director of Neuroimaging Research and Development at the University of California Irvine (UCI). He also holds a joint appointment as Professor of Otolaryngology, Head and Neck Surgery. He served as department chair at UCI in 1996-2001, prior to which he headed the Section of Neuroradiology at Loma Linda University Medical Center (LLUMC) for many years.

His graduate medical education and training includes fellowships in diagnostic and cardiovascular radiology at LLUMC, in neuroradiology at the University of California Los Angeles (UCLA) and a post-doctoral fellowship in orbital and otolaryngologic radiology at the Foundation A. de Rothschild, Paris, France under the guidance of Jacqueline Vignaud MD. As a result of Dr. Vignaud’s influence, and during his service at UCLA under the tutelage of Professor William Hanafee, Dr. Hasso developed much of his future career path in the newly developing subspecialty of Head and Neck Radiology.

Professor Hasso is a nationally and internationally recognized expert in diagnostic neuroimaging. He is much in demand as an invited lecturer, nationally and internationally. He has authored more than 118 peer-reviewed articles, as well as 78 books, book chapters, and monographs. His research interests include emerging clinical applications of advanced protocols in CT and MRI in diagnostic imaging of the brain, spine, head and neck. His list of exhibits and invited lectures is extensive, and he has served on eight editorial boards, and has had numerous positions as reviewer, all for journals covering a wide spectrum of imaging areas. He has had grants to evaluate various contrast materials including the earliest iodine containing non-ionic contrast agents and paramagnetic contrast materials. He is currently researching applications of diffusion weighted MR imaging in evaluating spinal disorders, and is a co-investigator in NIH-funded projects on developmental neurological disorders in children and adult brain neoplasms.

Dr. Hasso is a tireless worker on behalf of organized radiology. He has served as President of the ASNR, the California Radiological Society, the Inland Radiological Society, the Western Neuroradiological Society, the American Society of Head and Neck Radiology, and the American Roentgen Ray Society (ARRS). He has held numerous important commission chairs, council memberships, and directed categorical courses for the American College of Radiology (ACR), the ARRS, the Radiological Society of North America, and is a Founding Member of the World Federation of Neuroradiological Societies. He currently serves in the House of Delegates of the American Medical Association representing the ACR and, as a member of the council of the ACR representing the ARRS. He has been a member of the Diagnostic Radiology Resident Review Committee, and now serves on the Board of Directors of the Accreditation Council of Graduate Medical Education and the Council of Medical Specialty Societies.

Awards and Honors

Past ASNR Gold Medal Award Recipients

1995
Juan M. Taveras, MD*
T. Hans Newton, MD

1996
Sadek K. Hilal, MD*
Giovanni Di Chiro, MD*

1997
Derek C. Harwood-Nash, MB, ChB, DSc, FRCP, FACR, RCRAD(SA)*

1998
Irvin I. Kricheff, MD
D. Gordon Potts, MD

1999
Grant B. Hieshima, MD
Michael S. Huckman, MD

2000
Hillier L. “Bud” Baker, Jr., MD*

2001
O. Wayne Houser, MD
J. Arliss Pollock, MD*

2002
R. Thomas Bergeron, MD
David O. Davis, MD

2003
Norman E. Leeds, MD, FACR
Anne G. Osborn, MD, FACR

2004
Ralph Heinz, MD, FACR
Stephen A. Kieffer, MD, FACR

2005
Samuel M. Wolpert, MD

2006
R. Nick Bryan, MD, PhD, FACR
Charles W. Kerber, MD

2007
Robert M. Quencer, MD

2008
Robert R. Lukin, MD

2009
Glenn S. Forbes, MD, FACR
E. Turgut Tali, MD

Dr. E. Turgut Tali graduated and completed his radiology residency at Hacettepe University Faculty of Medicine (1979-1984). He served as a research fellow in the Neuroradiology Division and MRI Center of the Department of Radiology at The University of Iowa under William T. C. Yuh, MD, MSEEE (1990-1992). Within one year, Dr. Tali was appointed to the position of Head of the MRI Research Team in 1991. After completion of his fellowship, Dr. Tali returned to Gazi University Faculty of Medicine, Department of Radiology, Ankara, Turkey, where he established the MRI Center. In 1995, Dr. Tali launched a research collaboration agreement with General Electric and the Johns Hopkins University Department of Radiology, making his center among the few in Europe with international collaboration. Under his directorship, the MRI center became one of the pioneers and leading centers for clinical MRI and MR research in Turkey. Dr. Tali addressed the evolution of magnetic resonance imaging in Turkey as a trainer of several residents, fellows, and faculty. He was the technical and clinical MR adviser at several university hospitals, hospitals, and centers. In 2004, he was appointed as the director of Neuroradiology; in 2008, as the Associate Dean of the Faculty of Medicine; and in 2009, as the Chairman of Medical Informatics.

Dr. Tali has focused his research on CNS infections and spinal imaging. He is an internationally known researcher and an author, who published a book, 12 book chapters, wrote more than 80 international publications, and supervised 17 doctoral theses. His manuscript of “Spinal Infections” published in the European Journal of Radiology was one of the 10 most downloaded articles in 2005. He is currently the Co-editor-in-chief of The Neuroradiology Journal, was the guest editor of Neuroimaging Clinics of North America in 2008, Rivista Di Neuroradiologia in 2003 and 2001, and he has also been serving as a member of the editorial board of several other journals. In addition, he is one of the internationally known educators who has delivered more than 60 lectures and 140 presentations in different major international meetings.

Dr. Tali has served and contributed to many societies. He has currently been serving as an Executive Committee member of European Society of Neuroradiology (ESNR) since 2006, and Chairman of The Council for National Delegates since 2008. He has also been serving as the Chairman of an Ad Hoc Committee, and a member of different committees and subcommittees of ESNR, the World Federation of Neuroradiological Societies, and the European Society of Radiology (ESR), including the ASNR-ESNR Liaison Committee in order to develop more collaboration and cooperation between the two major societies of Neuroradiology. Also, he has been an active member of the American Society of Neuroradiology since 1992, and he was one of the founders of the American Society of Spine Radiology in 1992. Furthermore, he is actively participating and representing ESNR at the European School of Radiology (ESOR), and the European School of Neuroradiology (ESONR) at the European Society of Radiology. He is currently an Executive Committee member of the Turkish Society of Neuroradiology. He served as an Executive Committee member of the Turkish Society of Radiology and the National Delegate (1995-1997) at ESR, ISMRM (1996-1999, 2001-2004) and ESNR (1996-present). He served as the President of the Turkish Society of Magnetic Resonance, and initiated and organized the Eastern Mediterranean Congresses of MRI together with Greece and Israel, and in collaboration with the ISMRM. He directed and/or served as an organizing committee member of several domestic and international courses, congresses, and symposiums in radiology and neuroradiology, including the European Course in Neuroradiology in 2001, and ESNR XXVIII Annual Congress and 12th Advanced Course in 2003.

He was elected as the President of XX Symposium Neuroradiologicum and the European Society of Neuroradiology XXXIX Annual Congress and 23rd Advanced Course, which will be held in Istanbul in 2014. With Dr. Gouliamos, he will also organize the European Course of Neuroradiology between 2012-2014 in Turkey and Greece.

Dr. Tali is married and has two daughters.
Awards and Honors

The Neuroradiology Education and Research (NER) Foundation
Award for Outstanding Contributions in Research

This award, created in 2004 in recognition of consistent excellence and lifelong accomplishment in basic or clinical neuroscience research, is given to an ASNR senior member over the age of 50 recognized in the neuroradiology field for distinguished long term achievement in basic or clinical research.

2010 NER Foundation Award for Outstanding Contributions in Research

Victor M. Haughton, MD
University of Wisconsin Hospitals and Clinics, Madison

Dr. Victor Haughton graduated with honors from Harvard College in Cambridge, Massachusetts and from Yale University School of Medicine. He trained in medicine at Tufts New England Medical Center and in radiology residency at the Peter Bent Brigham Hospital in Boston. He has had Radiology staff positions at Harvard University, Medical College of Wisconsin and at the University of Wisconsin School of Medicine and Public Health in Madison. He has served previously as Chief of Neuroradiology, Director of Magnetic Resonance Imaging, Professor of Biophysics and Chief of Neuroradiology research at the Medical College of Wisconsin. He has a part-time position with the Center for Biomedical Computation in Norway.

His primary research interests involve functional imaging of the brain and spine, spine anatomy, and intervertebral disk degeneration. He has performed research with support from an Individual National Research Service for study in Europe and awards from NIH for R01 research projects. He participated in FDA phase II and III trials of new contrast media. Dr. Haughton has published over 80 chapters and over 400 peer-reviewed manuscripts and has 9 patents.

2010 ASNR Cornelius G. Dyke Memorial Award

This award was established to honor Cornelius G. Dyke, one of the pioneers in neuroradiology, and is given to a trainee or junior faculty member in neuroradiology for excellence as demonstrated in a paper, which represents original, unpublished research in some aspect of neuroradiology.

Elysa Widjaja, MD
Hospital for Sick Children, Toronto Canada

"Alteration of Human Fetal Subplate Layer and Intermediate Zone During Normal Development on MR and Diffusion Tensor Imaging"

Dr Elysa Widjaja is a staff pediatric neuroradiologist at the Hospital for Sick Children in Toronto and also holds an appointment at the division of Neurology at the Hospital for Sick Children. She received the Equity and Merit Scholarship during medical school at the University of Melbourne, Australia, and graduated in 1995. Subsequently, she moved to United Kingdom and undertook her internship, internal medicine training and then radiology residency training. She completed the neuroradiology training at Sheffield Teaching Hospital in United Kingdom in 2005, followed by the pediatric neuroradiology fellowship at the Hospital for Sick Children in Toronto in 2007. She was the recipient of the Berlex/NER Foundation Fellowship in Basic Science Research Award from ASNR in 2007-08.

Her clinical and research interest is centered on pediatric epilepsy and brain malformations, using advanced imaging not only to improve detection of brain malformations, but also to understand the effects of epilepsy on the developing brain.
### Past ASNR Cornelius G. Dyke Memorial Award Recipients

<table>
<thead>
<tr>
<th>Year</th>
<th>Name</th>
<th>Contribution</th>
</tr>
</thead>
<tbody>
<tr>
<td>1972</td>
<td>George M. McCord, MD</td>
<td>&quot;The Venous Drainage to The Inferior Sagittal Sinus&quot;</td>
</tr>
<tr>
<td>1973</td>
<td>Barton Lane, MD</td>
<td>&quot;Cerebrospinal Fluid Pulsations at Myelography: A Video-Densitometric Study&quot;</td>
</tr>
<tr>
<td>1974</td>
<td>Jacques Theron, MD</td>
<td>&quot;Anatomical-Radiological Correlates of the Anterior Choroidal Artery&quot;</td>
</tr>
<tr>
<td>1975</td>
<td>Thomas P. Naidich, MD</td>
<td>&quot;The Normal Anterior Inferior Cerebellar Artery&quot;</td>
</tr>
<tr>
<td>1976</td>
<td>- No Award</td>
<td></td>
</tr>
<tr>
<td>1977</td>
<td>Burton P. Drayer, MD</td>
<td>&quot;The Capacity for CT Diagnosis of Cerebral Infarction. An Experimental Study in the Non-Human Primate&quot;</td>
</tr>
<tr>
<td>1978</td>
<td>Joseph A. Horton, MD</td>
<td>&quot;The Grain in the Stone: A Computer Search for Hidden CT Patterns&quot;</td>
</tr>
<tr>
<td>1979</td>
<td>Dieter R. Enzmann, MD</td>
<td>&quot;Experimental Brain Abscess Evolution Studied with the CT Scan and Neuropathological Correlation&quot;</td>
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<tr>
<td>1980</td>
<td>- No Award</td>
<td></td>
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<tr>
<td>1981</td>
<td>A. Ronald Cowley, MD</td>
<td>&quot;The Influence of Fiber Tracts on the CT Appearance of Cerebral Edema: An Anatomical Pathological Correlation&quot;</td>
</tr>
<tr>
<td>1982</td>
<td>B. Ludwig, MD</td>
<td>&quot;Postmortem CT and Autopsy in Perinatal Intracranial Hemorrhage&quot;</td>
</tr>
<tr>
<td>1983</td>
<td>- No Award</td>
<td></td>
</tr>
<tr>
<td>1984</td>
<td>Val M. Runge, MD</td>
<td>&quot;Contrast Enhanced Magnetic Resonance Evaluation of a Brain Abscess Model&quot;</td>
</tr>
<tr>
<td>1985</td>
<td>- No Award</td>
<td></td>
</tr>
<tr>
<td>1986</td>
<td>Jeremy B. Rubin, MD</td>
<td>&quot;Part 1 Imaging Spinal CSF Pulsation by 2DFT Magnetic Resonance: Significance During Clinical Imaging&quot;</td>
</tr>
</tbody>
</table>

### Other Award Recipients

- **1979**
  - John L. Ulmer, MD
  - "Magnetization Transfer or Spin-Lock? An Investigation of Off-Resonance Saturation Pulse Imaging Using Varying Frequency Offsets"

- **1983**
  - John C. Strainer, MD
  - "MRI of Primary Auditory Cortex: An Analysis of Pure Tone Activation and Tone Discrimination"

- **1987**
  - Stephen G. Imbesi, MD
  - "Why Do Ulcerated Atherosclerotic Carotid Artery Plaques Embolize? A Flow Dynamics Study"
Awards and Honors

ASNR 2009 Outstanding Presentation Awards

ASNR is pleased to announce the winners of the Outstanding Presentation Awards. The overall quality of the paper and poster presentations at the Vancouver meeting was excellent, and the winners should be commended for their outstanding work. A $1,000 award will be given to the primary author of each winning presentation.

Seven awards were presented in Six categories: in Adult Brain/General Neuroradiology (two awards, one awarded by the ASNR, and another awarded by Bayer Healthcare Pharmaceuticals), Functional Neuroradiology, Head and Neck, Interventional (The Michael Brothers Memorial Award), Pediatrics (The Derek Harwood-Nash Award), and Spine. Both awards in Adult Brain/General Neuroradiology were selected by a panel of ASNR members under the direction of the Education Committee. The five subspecialty awards were judged by panels selected from each of the specialty societies, including ASFNR, ASHNR, ASPNR, ASSR, and SNIS. We would like to thank all of the judges for their tremendous effort in evaluating the presentations. Congratulations to the winners!

General Neuroradiology

PAPER 95: Systematic Characterization of the Spot Sign in CT Angiography Improves Its Predictive Value for Hemotoma Expansion and Hospital Mortality: All Spot Signs Are Not Created Equal
Delgado Almandoz, J.B. • Yoo, A.J. • Stone, M.J. Schaefer, P.W. • Goldstein, J.N. • Rosand, J. • Oleinik, A. Lev, M.H. • Gonzalez, R.G. • Romero, J.M. (Massachusetts General Hospital, Boston, MA)

Bayer Best Paper Award in General Neuroradiology

PAPER 159: Comparison of High-Resolution Magic Angle Spinning, MR Spectroscopy and MIB-1 Labeling of Nonenhancing Astrocytoma
Smith, K.J. • Berger, M.S. • Lu, Y. • McKnight, T.R. (University of California San Francisco, San Francisco, CA)

Functional Neuroradiology

PAPER 134: Effect of Prescan Patient-Radiologist Encounter Functional MR Image Quality
Mahmoud, S.Y. • Ahmed, M. • Emch, T. • Jones, S.E. Lockwood, D. • Masood, F. • Moon, D. • Phillips, M.D. Ruggieri, P. • Smith, A. • Stultz, T. • Tievsky, A. (Cleveland Clinic Foundation, Cleveland, OH)

Head and Neck Radiology

PAPER 446: Direct Visualization of Endolymphatic Hydrops in Patients with Endolymphatic Sac Tumors
Butman, J.A.1 • Kim, H.J.2 • Lonser, R.R.3 (1 The Clinical Center of the National Institutes of Health, Bethesda, MD, 2 National Institutes of Deafness and other Communication Disorders, NIH, Bethesda, 3 MD, National Institute of Neurological Disorders and Stroke, NIH, Bethesda, MD)

Interventional Neuroradiology

PAPER 172: Intraarterial Chemotherapy (Chemosurgery) in Children with Advanced Intraocular Retinoblastoma: A New Treatment Paradigm
Patsalides, A.1 • Abramson, D.2 • Dunkel, I.2 • Mar, B.2 Brodie, S.3 • Gobin, Y.3 (1 Weill Cornell Medical College, New York, NY, 2 Memorial Sloan Kettering Cancer Center, New York, NY)

Pediatric Neuroradiology

PAPER 336: Radiation Dose Reduction and Protocol Optimization for Pediatric Head and Sinus CT Using a Novel Low-Dose Simulation Tool
Morris, J.M. • DeLone, D.R. • Yu, L. • Leng, S. Kofler, J.M. • McCollough, C.H. (Mayo Clinic, Rochester, MN)

Spine

PAPER 339: TRICKS of the Trade: Role of Time Resolved Contrast Enhanced MR Angiography in Evaluation of Spinal Vascular Malformations
Siddiqui, A. • Hampton, T. • Deasy, N. (Kings College Hospital, London, United Kingdom)

2009/2010 Specialty/Regional Society Awards

The American Society of Neuroradiology is pleased to announce the recipients of the 2008/2009 Special/Regional Society Awards. These individuals were selected by the respective societies as having the best presentation at each society’s most recent Annual Meeting.

American Society of Spine Radiology (ASSR) Mentor Award
“Performing Thoracic Transforminal Injections: A New Technique” Humberto G. Rosas, MD Mallinckrodt Institute of Radiology/Washington University, St. Louis, MO

Eastern Neuroradiological Society (ENRS) (The Norman E. Leeds Award)
“Imaging the Temporal Mandibular Joint” Bidyut K. Pramanik, MD New York University School of Medicine, New York

Southeastern Neuroradiological Society (SENRS) “Longitudinal Diffusion Tensor Findings in Children with Diffuse Brainstem Glioma Treated with Radiation and Antiangiogenic Therapy” Kathleen J. Helton, MD St. Jude’s Children Research Hospital in Memphis, TN

Western Neuroradiological Society (WNRS) (The Gabriel H. Wilson Award)
“Radiographic and Anatomic Evaluation of Eagle’s Syndrome Using 3-D Computed Axial Tomography for Evaluation of the Elongated Styloid Process and Stylohyoid Ligament in Neutral and Head Turned Positions” Daniel J. Lattin, BS David Geffen School of Medicine, UCLA, Los Angeles, CA
Awards and Honors

**2010-2011 NER Foundation Fellowship in Basic Science Research Award**

This fellowship, first awarded in 1986, was created by the ASNR with the support of Bayer Healthcare Pharmaceuticals, Inc. to stimulate the scientific development of promising young men and women, and to aid them in embarking on a career in academic radiology. It is specifically designed to provide educational opportunities for young radiologists who are not yet professionally established in the radiologic sciences to gain further insight into scientific investigation, and to develop competence in research. This fellowship is supported by the Neuroradiology Education and Research (NER) Foundation of the American Society of Neuroradiology.

The recipient of the 2010-2011 fellowship is:

**Stephen E. Jones, MD, PhD**
**Cleveland Clinic**

“Validation of Probabilistic DTI Algorhythms Using Direct Stimulation Data from Stereotactic EEG Electrodes in Humans”

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Past Bayer Healthcare Pharmaceuticals, Inc./NER Foundation Fellowship in Basic Science Research Award Recipients

**1986-87**
Jeremy B. Rubin, MD  
Stanford University Medical Center  
“New Methods Using MRI to Assess Ventricular Shunt Function and Measure Intravenous Pressure Non-invasively in Patients with Ventricular Shunt Catheters”

**1987-88**
No Award

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**1988-89**
Apichai Jarenwattananon, MD  
University of Wisconsin Medical Center  
“In-Vivo Sodium MRI (Na-MRI) in Canine Model of Status Epilepticus”

Warren A. Stringer, MD  
Loma Linda University Medical Center  
“Evaluation of the Relationships Between Cerebral Perfusion, Ventilation, and Intracranial Pressure by Xenon-enhanced Computed Tomography in Children with Cerebral Edema”

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**1989-90**
Todd Lempert, MD  
University of California at San Francisco  
“Evaluation of the Healing Response to Thrombogenic Coil Occlusion of Experimental Aneurysms”

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**1990-91**
Lori L. Baker, MD  
Stanford University Medical Center  
“Evaluation of MR Diffusion Imaging Versus Magnetic Susceptibility Enhanced Mapping of Perfusion Pool in Regional Cerebral Ischemia”

Lee H. Monsein, MD  
The Johns Hopkins University School of Medicine  
“Primate Model of Reversible Regional Cerebral Ischemia”

---

**1991-92**
Steven N. Breiter, MD  
The Johns Hopkins Hospital  
“Proton MRS in the Determination of Lactic Acid Concentration in Seizures, Both Human and Animal”

Frank J. Lexa, VII, MD  
University of Pennsylvania  
“MRI Demonstration of Axonal Transport in the Mammalian CNS”

---

**1992-93**
Michael A. Kraut, MD, PhD  
The Johns Hopkins Hospital  
“Lactate Production and Metabolism in Cerebral Activation”

Brian W. Chong, MD  
University of California at San Diego  
“A Search for Hidden MRI Flow Patterns in Human Cranial Vessels”

---

**1993-94**
Thomas E. Conturo, MD, PhD  
The Johns Hopkins Hospital and Johns Hopkins University  
“Mechanisms of the Phase Enhancement Effects of Bolus-Injected Paramagnetic Contrast Agents and Applications in Quantitative Cerebral Blood Volume and Flow Imaging”

John P. Karis, MD  
Barrow Neurological Institute  
“Epilepsy Localization: Advanced High Resolution MRI-PET FDG Correlation”

---

**1994-95**
Jerry Burke, MD  
Bowman Gray School of Medicine  
“Serial Positron Emission Tomography and Functional MR Imaging of Stroke”

Robert Fulbright, MD  
Yale University School of Medicine  
“Functional MR Imaging of the Spine”

---

**1995-96**
Norman J. Beauchamp, MD  
The Johns Hopkins Hospital  
“The Natural History of ‘Areas of Risk of Infarction’ as Defined by Perfusion MRI and MR Spectroscopy”

Anthony Masaryk, MD  
University of Wisconsin-Madison  
“Analysis of Aneurysm Hemodynamics Using MRI/MRA Morphology and Flow Measurements Correlated with Hemodynamic Numerical Analysis and Simulation”

---

**1996-97**
Joseph T. Lurito, MD, PhD  
The Johns Hopkins Hospital  
“Functional MRI and Electrophysiologic Correlates of Sub-modality Specific Somatosensory Activation”

Jeffrey L. Sunshine, MD  
University Hospitals of Cleveland  
“Early Identification of Ischemic Penumbra by Diffusion and Perfusion MR in Acute Stroke”

---

**1997-98**
Huy M. Do, MD  
University of Virginia Health Sciences Center  
“The Neuroprotective Effect of Intraarterial Nerve Growth Factor (HGF) in a Rabbit Embolic Stroke Model”

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**1998-99**
William F. Marx, MD  
University of Virginia  
“Endovascular Treatment of Experimental Aneurysms Using Biologically Modified Embolic Coils: Promotion of Permanent Occlusion via Intra-aneurysmal Fibroblast Delivery”
Awards and Honors

Past Bayer Healthcare Pharmaceuticals, Inc./NER Foundation Fellowship in Basic Science Research Award Recipients (continued)

1999-00
Kevin R. Moore, MD
University of Utah Center for Advanced Medical Technology
"Meg-Constrained High-Resolution Surface-Coil MR Imaging and MR Spectroscopy for Evaluating Medically Refractory Epilepsy"

John G. Short, MD
University of Virginia
"Induction of Spinal Interbody Fusion Using Gene Therapy Tissue Engineering Techniques"

2000-01
John Port, MD, PhD
The Johns Hopkins Medical Institution
"Imaging Selective Attention Mechanisms"

Eric Schwartz, MD,
Hospital of the University of Pennsylvania
"Diffusion-based MR Imaging in a Rat Spinal Cord Following Injury and Transplantation" 

2001-02
Pratik Mukherjee, MD, PhD
Mallinckrodt Institute of Radiology, Washington University School of Medicine
"Comparison of Magnetic Resonance Imaging and Positron Emission Tomography in the Study of Cerebral Hemodynamics"

2002-03
John G. Dalle, DO
University of Utah School of Medicine
"Polymer-Chelate Conjugates for Diagnostic Cancer Imaging"

Christopher Lascola, MD, PhD
Duke University Medical Center
"Magnetic Resonance Imaging of Spreading Depression-Induced Reactive Gliosis in Mice"

2003-04
Dheeraj Gandhi, MD
University of Michigan Health System
"Can the Choline/Creatine Ratio Predict Early Treatment Response of Head and Neck Squamous Cell Carcinoma Treated with Radiation Therapy in an Animal Model: A Prospective Study"

Susan M. Kealey, MD
Duke University Medical Center
"Correlation of MR Permeability Measurements with Histologic Markers of Angiogenesis in Rodent High-Grade Brain Tumors Before and After Treatment with Antiangiogenisis Agent PTK 787"

2004-05
Tuong Huu Le, MD, PhD
University of California, San Francisco
"Structural and Functional Correlates of Axonal Shearing in Traumatic Brain Injury: A Combined DTI, fMRI and MSI Study"

Whitney B. Pope, MD, PhD
David Geffen School of Medicine at University of California, Los Angeles
"Identification of Unstable Atherosclerotic Plaque at the Carotid Bifurcation Using High-Resolution CT/PET Imaging: Correlation to Histopathology and Patient Symptoms"

2005-06
Srinivasan Mukundan, Jr., PhD, MD
Duke University Medical Center
"Toward the Development of a Nanoscale, Target-Specific Liposomal Platform Technology for Computed Tomography Based Molecular Imaging"

Max Wintemark, MD
University of California, San Francisco
"Morphometric and Functional Characterization of Atherosclerotic Carotid Disease by Multidetector-Row CT-Angiography: A Comparative Study with Ex Vivo Histology and Imaging"

2006-07
Michelle S. Bradbury, MD, PhD
Memorial Sloan Kettering Cancer Center
"In Vivo Monitoring of Human Embryonic Stem Cell-derived Grafts in the Central Nervous System of Living Animals Using Optical Imaging Technologies"

Edwin Wang, MD
New York University School of Medicine
"In Vivo Imaging of the Epidermal Growth Factor Receptor with a Bimodal MRI/Optical Contrast Agent"

2007-08
Myria Petrou, MA, MBChB
University of Michigan, Ann Arbor, MI
"Investigation of Axonal Loss, Demyelination and Response to Treatment in a Mouse Model of Multiple Sclerosis Using Diffusion Tensor Imaging"

Elysa Widjaja, MD
Hospital for Sick Children, Toronto, Canada
"Determining the Extent of Diffusion Tensor Abnormalities in Focal Cortical Dysplasia"

2008-09
Bradley Foerster, MD
Johns Hopkins Hospital, Baltimore, Maryland
"MR Molecular Imaging of Glutamate Carboxypeptidase II (GCP II) Modulation in an Experimental Model of Stroke"

Noriko Salamon, MD
David Geffen School of Medicine at the University of California at Los Angeles, Los Angeles, California
"Diffusion Tensor Imaging in the Identification of the Extra-Hippocampal Abnormality in the Patients with Mesial Temporal Lobe Epilepsy with Hippocampal Sclerosis"

2009-10
Christopher T. Whitlow, MD, PhD
Wake Forest University School of Medicine, Chapel Hill, NC
"Evolving Patterns of Functional Connectivity in the Developing Brain: An Arterial Spin Labeling Perfusion MRI and Computational Network Analytical Investigation"
Awards and Honors

Neuroradiology Education and Research (NER) Foundation Scholar Award in Neuroradiology Research

Since 1995, the NER Foundation has been in the process of raising funds to support neuroradiology research. This is one of the most important goals of the NER Foundation, and of the ASNR as the premier organization for neuroradiology. This award was created for young investigators in the early stages of their careers, to enhance their competency in areas important to the future of neuroradiology, including health services research, physiological imaging and interventional neuroradiology. It also affords the Foundation the opportunity to begin to develop leadership in these areas.

Past NER Foundation Scholar Award in Neuroradiology Research Recipients

1999
L. Santiago Medina, MD, MPH
Children’s Hospital Medical Center, Cincinnati, OH
“The Role and Cost-Effectiveness of Imaging in Newborns with Suspected Occult Spinal Dysraphism”

2000
Melanie B. Fukui, MD
University of Pittsburgh Medical Center, Pittsburgh, PA
“Carotid Stenosis Evaluation: Cost-Effectiveness of Computed Tomographic Angiography vs. Magnetic Resonance Angiography”

2001
Soonmee Cha, MD
New York University Medical Center, New York, NY
“Dynamic Contrast Enhanced T2*-weighted MRI and Histopathological Assessment of Experimental Glioma”

2002
James D. Eastwood, MD
Duke University Medical Center, Durham, NC
“CT Perfusion Imaging in Subarachnoid Hemorrhage Related Vasospasm”

2003
Steven G. Imbesi, MD
University of California, San Diego Medical Center, San Diego, CA
“Alteration of Intracranial Aneurysm Flow Dynamics: Development and Evaluation of Potential Neurointerventional Endovascular Treatment Regimens for Wide Necked Aneurysms”

2004
Pratik Mukherjee, MD, PhD
University of California San Francisco, San Francisco, CA
“Diffusion Tensor MR Imaging and Quantitative Tractography of Brain Development in Premature Newborns”

2005
Donna R. Roberts, MD
University of California, San Francisco, CA
“The Assessment of Image-guided Transcranial Magnetic Stimulation as an Adjuvant to Extracranial Cortical Stimulation for the Treatment of Chronic Facial Pain”

2006
Steven G. Imbesi, MD
University of California Medical Center, San Diego, CA
“Alteration of Intracranial Aneurysm Flow Dynamics: Development and Evaluation of Potential Neurointerventional Endovascular Treatment Regimens for Wide Necked Aneurysms”

2007
Pina C. Sanelli, MD
Weill Medical College of Cornell University, New York, NY
“Assessing the Value of CT Perfusion in Improving Clinical Outcomes in Aneurysmal Subarachnoid Hemorrhage Using a Decision Analytic Model”

2008
Tammie L. S. Benzinger, MD, PhD
Washington University School of Medicine, St. Louis, MO
“Childhood Leukodystrophy with Neuromuscular Disability: Translational Use of MRI Directional Diffusivity as a Tool for Prognosis and Response to Therapy”

2009
Vivek Prabhakaran, MD, PhD
Johns Hopkins Hospital, Baltimore, MD
“Characterizing the Neural Substrates of Stroke Recovery Utilizing fMRI and Perfusion Imaging”

2009
Greg Zaharchuk, M.D., PhD
Stanford University Medical Center, Stanford, CA
“Optimizing Arterial Spin Label MRI for the Visualization of Collateral Flow in Moyamoya Disease”

The recipients of the 2010 award are:

Steven W. Hetts, MD
University of California, San Francisco
“Endovascular Catheter for Magnetic Navigation under MRI Guidance: Evaluation of Healing In Vivo at 1.5T”

Danel Mandell, MD
Hospital for Sick Children
“Evolution of Individual White Matter Lesions in Leukaoaraisis: A Serial MRI Study”

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Awards and Honors

Neuroradiology Education and Research (NER) Foundation Outcomes Research Grant Related to CT and MR Perfusion

This grant is targeted to the characterization of brain tumors and specifically, the differentiation of neoplastic from nonneoplastic condition, effect of MRS on need for biopsy or the election of a biopsy site, and evaluation of MRS in radiation necrosis.

No award in 2010.

Past Neuroradiology Education and Research (NER) Foundation Outcomes Research Grant Recipients

2005
William Hollingsworth, PhD
University of Washington
“Systematic Literature Review of Magnetic Resonance Spectroscopy (MRS) of the Characterization of Brain Tumors”

2006
James M. Provenzale, MD
Duke University School of Medicine
“Systematic Review of CT and MR Perfusion Imaging for Brain Tumor and Stroke”

2009-2010 NER Foundation Fellowship in Cerebrovascular Disease Research

Established in 2002, this fellowship expanded eligibility to allow both neuroradiology fellows and all faculty at the Assistant Professor level to apply. It was created to provide an opportunity for a young neuroradiologist to pursue research in a topic that will advance the diagnosis and treatment of cerebrovascular disease.

No award in 2010.

Past NER Foundation/Boston Scientific Fellowship in Cerebrovascular Disease Research Award Recipients

2003-04
Joshua Shimony, MD, PhD
Washington University School of Medicine, St. Louis, MO
“Improved MR Methods for Evaluation of Brain Perfusion in Patients with Carotid Stenosis”

2004-05
Timothy J. Kaufmann, MD
Mayo Clinic and Foundation, Rochester, MN
“A Prospective Clinical Trial of 3.0T MR Angiography in the Follow-up of Intracranial Aneurysms Treated with Endovascular Coils”

2005-06
Donna Hoghooghi, MD
University of California, San Francisco, CA
“Extent and Effectiveness of Embolization and Determination of Vascular Supply in Meningiomas Using a Combined Interventional X-ray/MR Fluoroscopy Suite”

2006-07
Albert Yoo, MD
Massachusetts General Hospital, Boston, MA
“Predicting Clinical Outcomes of Intra-arterial Thrombolysis in Acute Stroke Using Diffusion/Perfusion MRI”

2007-08
Todd Abruzzo, MD
University of Cincinnati Medical Center, Cincinnati, OH
“Modeling Modes of Intracranial Aneurysm Recurrence After Coil Embolization: Mechanisms of Coil Compaction and Aneurysm Re-Growth”

2008-09
Humberto Morales, MD
University of Cincinnati, Cincinnati, OH
“Safety of Iodinated Contrast Material in a Middle Cerebral Artery Occlusion/Reperfusion Model”
An enhancement of the Continuing Medical Education online evaluation system allows for attendees to print out their official CME certificate for the number of hours claimed during the NER Foundation Symposium 2010 and ASNR 48th Annual Meeting and take it with them when they leave. Go to any terminal in the CME Pavilion and follow the simple directions for printing out an official NER Foundation Symposium 2010 and ASNR 48th Annual Meeting CME Certificate.

Following the meeting, the ASNR 2010 CME certificate site will be available online by mid-July for 90 days for attendees to print out their CME certificates.

Please Note: Due to the availability of CME certificates online, certificates will not be mailed to attendees.

Letter of Attendance
If you wish to obtain a Letter of Attendance, please request one at the Registration Desk located in the Hall C Foyer of the Hynes Convention Center.

CME Pavilion
To access the CME evaluation program, run the “ExpoCard” through the card reader at one of the terminals and follow the simple directions for selecting and evaluating the sessions you have attended. The CME credit hours awarded to a session will automatically be recorded in your record when the evaluation for a session is completed. Evaluations can be completed at the end of a session, during breaks, at the end of the day or the end of the week. You will be able to view a record of the sessions you have evaluated and the number of CME credit hours earned throughout the program. It will also be possible to print your certificate and transcript to take home with you.

Please Note: To receive CME credit for sessions attended at the NER Foundation Symposium 2010 and ASNR 48th Annual Meeting, all evaluations must be entered by the end of the meeting.

Scientific Program and Meeting Evaluation
The 2010 Continuing Medical Education (CME) Pavilion allows online recording of CME credits via the Internet. The improvements have created a faster and more user-friendly system for evaluating sessions and speakers and recording CME hours electronically. The CME Pavilion is easily accessible in Room 309 at the Hynes Convention Center. Please complete the evaluations for each session to assist in planning future meetings and to help us maintain accreditation of future programs.

Accreditation Statement
The American Society of Neuroradiology is accredited by the Accreditation Council for Continuing Medical Education (ACCME) to provide continuing medical education for physicians. The American Society of Neuroradiology takes responsibility for the content, quality, and scientific integrity of the CME activity. The American Society of Neuroradiology designates this educational activity for a maximum of 32.50 AMA PRA Category 1 Credit(s)™. Physicians should claim credit commensurate with the extent of their participation in the activity.

Target Audience
The ASNR 48th Annual Meeting is designed for the practicing general radiologist who reads neuroradiology studies, the dedicated neuroradiologist who strives to better integrate advanced imaging and image-guided diagnostic and therapeutic strategies into his/her daily practice, or the imaging scientist who wishes to gain a better understanding of the current state of these technologies and how they are applied to evaluate disorders of the brain, spine, and head and neck.

Programming will include discussion of imaging methods and techniques such as MR diffusion and perfusion, magnetic resonance spectroscopy, functional magnetic resonance imaging, MR angiography, CT perfusion, CT angiography, catheter-based angiography and associated therapies, and image-guided spine interventions.

Sessions dealing with pediatric neuroradiology, head and neck imaging, diagnostic imaging of the spine and spinal therapeutic interventions, vascular imaging and interventions, functional and molecular imaging, and adult neuroradiology will be offered.
ASNR 48th Overall Annual Meeting Educational Objectives

After attending the 48th Annual Meeting, you will be able to:

• Analyze the clinical spectrum and imaging findings associated with back pain, sickle cell disease, and seizure disorders in children

• Participate and review in Maintenance of Certification (MOC) and Self-Assessment Module (SAM) Programming with sessions highlighting Head & Neck, Brain, Spine, Pediatrics, and Vascular and Interventional focus

• Identify major health policy and socioeconomic factors likely to affect the future of Neuroradiology, including prospects of and aspects of Health Care Reform legislation, Comparative Effectiveness Research, and Informatics drivers of healthcare decisions

• Analyze the indications for, imaging findings, and outcomes related to intracranial stents and aneurysm treatment and outline goals for endovascular therapy

• Discuss the constellation of imaging findings in head and neck neoplasms, their pattern of nodal spread and post-operative appearance

• Comprehend and analyze new developments in MR spectroscopy, diffusion imaging, brain perfusion imaging, and molecular imaging.

• Analyze current best practices and strategies for imaging evaluation and intervention of spine trauma, the facet joint, and vertebroplasty

• Evaluate leadership and management approaches to optimizing performance of your radiology practice
Synaptic Junction Programming
Formerly known as Electronic Learning Center (ELC)

The ASNR Synaptic Junction provides the opportunity for connecting your practice to the future through offerings focused on enhancing workflow, efficiency, standardization of interpretation and reporting, and improvements in revenue cycle, particularly those that involve software, hardware and informatics-based solutions. Lectures and Workshops are FREE

**Monday, May 17**

10:45 am - 12:30 pm
Lecture: The Business of Neuroradiology
- 10:45 am - 11:15 am Informatics Solutions to Business Pressures in Radiology
  - Alan Pitt, MD
- 11:15 am - 12:30 pm Future Directions in the Business of Neuroradiology
  - Alan Pitt, MD, Frank J. Lexa VII, MD, MBA

1:30 pm - 3:00 pm
Lecture: Do We Really Need Standardized Reporting? “Point-Counterpoint”
- 1:30 pm - 2:00 pm The Advantages of Structured Reporting
  - C. Douglas Phillips, MD, FACR
- 2:00 pm - 2:30 pm The Myth of Structured Reporting in Neuroradiology
  - Barton F. Branstetter IV, MD
- 2:30 pm - 3:00 pm Debate

3:30 pm - 5:00 pm
Workshop: Post Processing*
- Introduction & Overview
  - John L. Go, MD

**Tuesday, May 18**

1:30 pm - 3:00 pm
Lecture: Making The Reading Room More Pleasant
- 1:30 pm - 2:15 pm How to Get a Speech Recognition that Actually Works
  - Barton F. Branstetter IV, MD
- 2:15 pm - 3:00 pm Make Yourself Comfortable!
  - The Importance of Ergonomics
  - Eliot L. Siegel, MD

3:30 pm - 5:00 pm
Workshop: Post Processing*
- Introduction & Overview
  - John L. Go, MD

**Wednesday, May 19**

3:15 pm - 4:45 pm
Lecture: Leadership Skills and Challenges
- 3:15 pm - 3:45 pm Leadership in Difficult Economic Times
  - Carolyn C. Meltzer, MD, FACR
- 3:45 pm - 4:15 pm Group Identification, Framing Effects, and Organizational Leadership
  - Andrew F. Simon, PhD, PsyD
- 4:15 pm - 4:45 pm Differentiating Key Leadership Concepts: Authority/Power and Cooperation/Collaboration
  - Andrew F. Simon, PhD, PsyD

*Please Note: Due to the direct financial support from companies to conduct these sessions, CME credit hours will not be granted for any Synaptic Junction Workshops.
In addition to the Technical Exhibition, the leadership of the ASNR is pleased to announce the thirteenth annual slate of instructional How-To forums. These sessions, presented in conjunction with major corporate contributors, deal with advances in imaging and procedures as well as principles in neuroradiology and image information management. How-To Morning and Noon Sessions are scheduled throughout the week.

The How-To Sessions offer a unique opportunity for neuroradiologists to discuss techniques, procedures, and products with their colleagues as well as with technical specialists from the imaging industry. Comments and suggestions from meeting registrants were integrated into this year’s format. The sessions vary and include both didactic presentations and demonstrations, all with a strong practical emphasis. A significant portion of each session is devoted to questions and answers.

**How-To Session Programming in Ballroom ABC**

**Monday, May 17 - Morning Session**
6:30 am - 7:30 am

[Bracco](#) Life From Inside

**Monday, May 17 - Noon Session**
12:30 pm - 1:30 pm

[Toshiba](#) Leading Innovation

**Tuesday, May 19 - Noon Session**
12:30 pm - 1:30 pm

[GE](#) Imagination at Work

**Wednesday, May 19 - Noon Session**
12:30 pm - 1:30 pm

[Siemens](#)

Please Note: Due to the direct financial support from companies to conduct these sessions, CME credit hours will not be granted for any How-To Sessions.
Printed and Electronic Scientific Exhibits (ESEs)
Exhibit Hall C

Scientific Exhibits

Adult Brain .......... 1-38
Anatomy ............ 39-40
Head and Neck ... 41-55
Interventional ... 56-57
Pediatrics ........ 58-67
Spine .............. 68-73

Electronic Scientific Exhibits (ESEs)

Shared
Adult Brain ......................... 1-61
Anatomy ................................ 60-70
Head and Neck ....................... 71-87
Interventional ...................... 88-89
Pediatrics ......................... 90-100
Socioeconomics ................. 101
Spine ............................... 102-119
Scientific Posters - Exhibit Hall C

Scientific Posters

Scientific Posters

Adult Brain ........................................ 1-114
Anatomy ........................................... 115-118
Head and Neck ..................................... 119-131
Interventional ..................................... 132-164
Pediatrics .......................................... 165-179
Spine .................................................. 180-195
General Information

Welcome Reception
Monday, May 17 6:30pm – 7:30pm

Exhibit Hours
Tuesday, May 18 through Thursday, May 20 10:15am – 4:00pm

“Best of Boston” Bistro Reception
Monday, May 17, 2010  6:30pm - 7:30pm
Hynes Convention Center - Exhibit Hall D

We look forward to welcoming our Technical Exhibitors to a pre-dinner reception of local Boston culinary favorites. The reception, located in Exhibit Hall D, offers attendees the perfect opportunity to see this year’s Technical Exhibition, the ASNR’s annual showcase for the newest products and services for the field of Neuroradiology. Enjoy complimentary pre-dinner hors d’oeuvres and beverages while you interact with ASNR exhibitors and fellow attendees. This casual social setting is an ideal time to showcase your product and company. The ASNR Technical Exhibition is the place where advanced technology, diagnostic and interventional Neuroradiological excellence come together.
## Technical Exhibits Roster (as of 04/06/10)

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Ashley H. Aiken, MD  
Emory University School of Medicine  
Felipe C. Albuquerque, MD  
Barrow Neurological Institute, Neurosurgical Associates  
Nolan R. Altman, MD  
Miami Children’s Hospital  
Gerard Anderson, PhD  
John Hopkins Bloomberg School of Public Health  
Yoshimi Anzai, MD, MPH  
University of Washington Medical Center  
Daniel P. Barboriak, MD  
Duke University Medical Center  
A. James Barkovich, MD  
University of California, San Francisco Medical Center  
Walter S. Bartynski, MD  
Presbyterian University Hospital  
Jacqueline A. Bello, MD, FACR  
Montefiore Medical Center  
Phillip M. Boiselle, MD  
Beth Israel Deaconess Medical Center  
Barton F. Branstetter IV, MD  
University of Pittsburgh Medical Center  
Allan L. Brook, MD  
Montefiore Medical Center  
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Mayo Clinic Florida  
R. Nick Bryan, MD, PhD  
University of Pennsylvania Health System  
Randy L. Buckner, PhD  
Harvard University  
Mauricio Castillo, MD, FACR  
University of North Carolina at Chapel Hill School of Medicine  
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Mayo Clinic Florida  
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Washington University  
Mallinckrodt Institute of Radiology  
W. Dalton Dietrich, PhD  
The Miami Project of Cure Paralysis  
University of Miami  
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Duke University Medical Center  
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The Johns Hopkins University School of Medicine  
David J. Fiorella, MD, PhD  
Stony Brook University Medical Center  
Nancy J. Fischbein, MD  
Stanford University  
Christine M. Glastonbury, MBBS  
University of California, San Francisco  
John L. Go, MD  
Los Angeles County  
University of Southern California Medical Center  
R. Gilberto Gonzalez, MD, PhD  
Massachusetts General Hospital  
P. Ellen Grant, MD  
Children’s Hospital Boston  
Gary L. Hedlund, DO  
Primary Children’s Medical Center. Salt Lake City  
Joseph A. Helpern, PhD  
New York University School of Medicine  
Joshua A. Hirsch, MD  
Massachusetts General Hospital  
Patricia A. Hudgins, MD  
Emory University School of Medicine  
Mohannad Ibrahim, MD  
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Mayo Clinic  
Emanuel Kanal, MD, FACR,  
FISMRRM, AANG  
University of Pittsburgh Medical Center  
Darrell G. Kirch, MD  
Association of American Medical Colleges (AAMC)  
Richard P. Klucznik, MD  
The Methodist Hospital  
Bernadette Koch, MD  
Cincinnati Children’s Hospital  
Jaroslaw Krejza, MD, PhD  
University of Pennsylvania  
David Lasakovits  
American Board of Radiology  
Meng Law, MD, MBBS, FRACR  
Los Angeles County  
University of Southern California Medical Center  
Frank J. Lexa VII, MD, MBA  
Drexel University  
Global Consulting Practicum  
Wharton Graduate School of Business  
Instituto de Empresa, Madrid  
Michael L. Loftus, MD  
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Robert A. Zimmerman, MD  
Children's Hospital of Philadelphia
ASNR 48th Annual Meeting
Scientific Program Overview (as of 04/06/10)

Meals and Breaks: Breakfasts, Morning and Afternoon Coffee Service and Box Lunches will be provided throughout the week.

PLEASE NOTE: Annual Meeting food service locations vary throughout week based on Technical Exhibit hours and programming.

NOTE: Page numbers referenced throughout the program correspond to the page number within the Proceeding Book.

MONDAY MAY 17

6:30 am – 7:55 am
BREAKFAST

7:40 am – 7:45 am
(1) Opening Remarks
p. 1

7:45 am – 8:45 am
(2) Maintenance of Certification (MOC) – Review Session
(A+R) Adult Pediatric Brain
p. 1

8:45 am - 10:15 am
(3) General Session: Pitfalls in Practice: Sharpening Your Skills
p. 2

10:15 am - 10:45 am
MORNING BREAK

10:45 am - 12:30 pm
(4) Parallel Scientific Paper Sessions
(a) Adult Brain: New Techniques/Post Processing
p. 3
(b) Adult Brain: Cerebrovascular Occlusive Disease I
p. 10
(c) Trauma: Adult Brain and Spine
p. 19
(d) Pediatric: Neoplasms and Cerebrovascular
p. 28
(e) Excerpta Extraordinaire: Head and Neck
p. 36

10:45 am - 12:30 pm
(5) Synaptic Junction Programming - Lecture
The Business of Neuroradiology
p. 49

12:30 pm - 1:30 pm
LUNCH

1:30 pm - 3:00 pm
(6) ASPNR Programming: Back Pain in Children:
Optimizing Imaging in Non Traumatic and Traumatic Etiologies
p. 49

1:30 pm - 3:00 pm
(7) ASFNR Programming: Pediatric
p. 51

1:30 pm - 3:00 pm
(8) Socioeconomic Programming: Comparative Effective Research (AR+) (SAM)**
p. 52

1:30 pm - 3:00 pm
(9) General Session: Head And Neck: Sinus
p. 53

1:30 pm - 3:00 pm
(10) Synaptic Junction Programming - Lecture
Do We Really Need Standardized Reporting?
"Point-Counter Point"
p. 55

3:00 pm - 3:30 pm
AFTERNOON BREAK

3:30 pm - 5:00 pm
(11) Parallel Scientific Paper Sessions
(a) Adult Brain: Neoplasms
p. 55
(b) Adult Brain: Epilepsy & Other
p. 62
(c) Pediatric: Functional Imaging
p. 68
(d) Head and Neck: New Techniques
p. 74

3:30 pm - 5:00 pm
(12) ASFNR Programming: Multi-Modality/Functional Neuroimaging
p. 80

5:00 pm - 6:30 pm
(13) ASPNR Programming: Seizure Disorder in Children:
The Role of Histopathologic and Functional Imaging in Medical Versus Surgical Treatment (AR+)* (SAM)**
p. 82

5:00 pm - 6:30 pm
(14) General Session: Spine Imaging
p. 84

5:00 pm - 6:30 pm
(15) PQI: Getting Started With Baby Steps
p. 85

5:00 pm - 6:30 pm
(16) Advanced Imaging Seminar: MR Spectroscopy
for the Neuroradiologist
p. 86

*AR+ = Audience Response Plus+ Session

**Session is under review as of 4/6/10 by the American Board of Radiology to meet the criteria for self-assessment toward the purpose of fulfilling requirements in the ABR Maintenance of Certification. To obtain current SAM credit information, visit www.asnr.org.
TUESDAY, MAY 18

6:30 am - 7:55 am
BREAKFAST

7:45 am - 8:45 am
(17) Maintenance of Certification (MOC) - Review Session
AR+ Vascular
p. 89

8:45 am - 10:15 am
(18) Socioeconomic Programming: Overview of Healthcare Reform Legislation
p. 90

10:15 am - 10:45 am
MORNING BREAK

10:45 am - 12:30 pm
(19) Parallel Scientific Paper Sessions
(a) Adult Brain: Functional Imaging
p. 91
(b) Interventional: New Devices and Techniques
p. 100
(c) Pediatric: Developmental/Congenital Malformations and Demyelinating/Degenerative and Neonatal
p. 107
(d) Head and Neck: Pharynx, Larynx, Soft Tissue Neck, Sinonasal and Temporal Bone
p. 115

12:30 pm - 1:30 pm
LUNCH

1:30 pm - 3:00 pm
p. 121

1:30 pm - 3:00 pm
(21) ASFNR Programming: Adult (AR+)* (SAM)**
p. 123

1:30 pm - 3:00 pm
(22) ASHNR Programming: Head and Neck Cancer I: Imaging of Sinonasal and Skull Base Cancer
p. 124

1:30 pm - 3:00 pm
(23) Synaptic Junction Programming - Lecture: Making The Reading Room More Pleasant
p. 125

3:00 pm - 3:30 pm
AFTERNOON BREAK

3:30 pm - 5:00 pm
(24) Parallel Scientific Paper Sessions
(a) Adult Brain: Alzheimer/Demyelinating
p. 126
(b) Adult Brain: Cerebrovascular Occlusive Disease
p. 132
(c) Head and Neck: Anatomy, Face, Orbit and Congenital
p. 140
(d) Pediatric: New Techniques and Other
p. 146
(e) Excerpta Extraordinaire: Adult Brain
p. 151

3:30 pm - 5:00 pm
(25) Synaptic Junction Programming Post Processing Workshop
p. 162

5:00 pm - 6:30 pm
(26) ASHNR Programming: Head and Neck Cancer II: Imaging of Mucosal Malignancies of the Upper Aerodigestive Tract, Including PET/CT (AR+)* (SAM)**
p. 163

5:00 pm - 6:30 pm
(27) General Session: Imaging Biomarkers in Dementia
p. 164

5:00 pm - 6:30 pm
(28) General Session: Radiation Dose Reduction for the Neuroradiologist: What You Need to Know!
p. 165

5:00 pm - 6:30 pm
(29) Advanced Imaging Seminar: New Developments in Diffusion MRI
p. 166

*AR+ = Audience Response Plus+ Session
**Session is under review as of 4/6/10 by the American Board of Radiology to meet the criteria for self-assessment toward the purpose of fulfilling requirements in the ABR Maintenance of Certification. To obtain current SAM credit information, visit www.asnr.org.
Scientific Program Overview (as of 04/06/10)

WEDNESDAY, MAY 19

6:00 am - 7:30 am
BREAKFAST

7:30 am - 8:30 am
(30) Maintenance Of Certification (MOC) - Review Session
(AR+) Head and Neck
p. 169

8:30 am - 10:00 am
(31) General Session: Future Perspectives
p. 169

10:00 am - 10:30 am
MORNING BREAK

10:30 am - 10:45 am
(32) ASNR Presidential Address
p. 170

10:45 am - 10:55 am
(33) ASNR Award Announcements
p. 170
- Gold Medal Award
- Honorary Member Award
- Cornelius G. Dyke Memorial Award
- 2009 Outstanding Presentation Awards
- NER Foundation Scholar Award in Neuroradiology Research
- NER Foundation Award for Outstanding Contributions in Research
- NER Foundation Award in Basic Science Research

10:55 am - 11:45 am
(34) Keynote Speaker: The Politics and Ethics of Healthcare Reform
p. 171

11:45 am - 12:10 pm
(35) American Society of Neuroradiology (ASNR) Annual Business Meeting (Members Only)
p. 171

11:45 am - 1:15 pm
LUNCH

1:15 pm - 2:45 pm
(36) ASHNR Programming: Head And Neck Cancer III: Thyroid, Neck And Pediatrics
p. 171

1:15 pm - 2:45 pm
(38) ASSR Programming: The Facet Joint
p. 174

1:15 pm - 2:45 pm
(39) ASPNR Programming: 2010 ASPNR Interesting Case Team Competition: Blue Stars Versus Red Stars Versus Audience
p. 176

1:15 pm - 2:45 pm
(39a) Research in Progress: An Interactive Forum
p. 177

3:15 pm - 4:45 pm
(40) Parallel Scientific Paper Sessions
(a) Adult Brain: Neoplasms II
p. 178
(b) Interventional: Aneurysms I
p. 185
(c) Spine: New Techniques and Degenerative
p. 191
(d) Adult Brain: New Techniques
p. 198
(e) Quality/Socioeconomic
p. 204

3:15 pm - 4:45 pm
(41) Synaptic Junction Programming - Lecture: Leadership Skills And Challenges
p. 211

4:45 pm - 6:15 pm
(42) ASSR Programming: Spine Trauma (AR+)* (SAM)"
p. 212

4:45 pm - 6:15 pm
(43) Socioeconomics Programming Informatics Of Healthcare Reform
p. 213

4:45 pm - 6:15 pm
(44) SNIS Programming: Trial Updates: Progress Report From Trials That Will Change Your Practice
p. 214

4:45 pm - 6:15 pm
(45) Advanced Imaging Seminar: New Developments in Brain Perfusion Imaging
p. 215

*AR+ = Audience Response Plus+ Session
**Session is under review as of 4/6/10 by the American Board of Radiology to meet the criteria for self-assessment toward the purpose of fulfilling requirements in the ABR Maintenance of Certification. To obtain current SAM credit information, visit www.asnr.org.
THURSDAY, MAY 20

6:30 am - 7:55 am
BREAKFAST

7:45 am - 8:45 am
(46) Maintenance Of Certification (MOC) - Review Session (AR+)
Spine
p. 219

8:45 am - 10:15 am
(47) General Session: Tackling The Many Faces Of The AJNR
p. 220

10:15 am - 10:45 am
MORNING BREAK

10:45 am - 12:30 pm
(48) Parallel Scientific Paper Sessions
(a) Interventional: Thrombolysis/Stroke
p. 220
(b) Interventional: Aneurysms II
p. 227
(c) Adult Brain: Vascular, Intracranial
p. 236
(d) Adult Brain: Inflammatory/Infectious Diseases
p. 244
(e) Spine: Intervention: Vertebroplasty, Biopsy, Pain Management
p. 251

12:30 pm - 1:30 pm
LUNCH

1:30 pm - 3:00 pm
(49) Parallel Scientific Paper Sessions
(a) Adult Brain: Functional Imaging
p. 258
(b) Interventional: Arteriovenous Malformations/Fistulae
p. 265
(c) Spine: Other
p. 271
(d) Adult Brain: Anatomy of Brain and Other
p. 278
(e) Excerpta Extraordinaire: Interventional and Spine
p. 284

3:00 pm - 3:30 pm
AFTERNOON BREAK

3:30 pm - 5:00 pm
(50) ASSR Programming: Vertebroplasty and the INVEST Trial
p. 295

3:30 pm - 5:00 pm
(51) SNIS Programming: Aneurysm Treatment: On the Edge (AR+)* (SAM)**
p. 296

3:30 pm - 5:00 pm
(52) General Session: Time Is Brain
p. 298

3:30 pm - 5:00 pm
(53) Advanced Imaging Seminar: New Developments in Molecular Imaging
p. 299

5:00 pm - 5:15 pm
(54) Closing Remarks

*AR+ = Audience Response Plus+ Session
**Session is under review as of 4/6/10 by the American Board of Radiology to meet the criteria for self-assessment toward the purpose of fulfilling requirements in the ABR Maintenance of Certification. To obtain current SAM credit information, visit www.asnr.org.
ASNR 49th Annual Meeting
Seattle, Washington
June 4 - 9, 2011
Washington State Convention & Trade Center
Seattle, Washington

2012
50th Annual Meeting
April 21 - 26
New York Hilton
New York, New York

2013
51st Annual Meeting
May 18 - 23
San Diego Convention Center
San Diego, California

2014
52nd Annual Meeting
May 17 - 22
Palais des Congrès de Montreal
Montreal, Quebec, Canada
NOTE ABOUT SCANNED IMAGES: Scanned images are included in the proceedings book. Some submitted images were reduced during the printing process, thereby decreasing clarity. The images as originally submitted can be viewed within the abstract on the ASNR website at www.asnr.org/2010.

Monday Morning
7:40 AM – 7:45 AM
Ballroom ABC
(1) Opening Remarks
— John R. Hesselink, MD, F ACR, ASNR President

Monday Morning
7:45 AM – 8:45 AM
Ballroom ABC
(2) Maintenance of Certification (MOC) – Adult and Pediatric Brain
Audience Response Plus (AR+)*
(2) Adult Brain
— Pia Sundgren, MD, PhD
(3) Pediatric Brain
— Andrea Rossi, MD
Moderators: Pia Sundgren, MD, PhD
Andrea Rossi, MD

*An educational grant was received by Bayer Healthcare Pharmaceuticals, Inc. in support of the Audience Response Plus+ (AR+) technology in the Maintenance of Certification (MOC) Review Sessions.

Adult Brain
Pia Sundgren, MD, PhD

LEARNING OBJECTIVES
Upon completion of this presentation, participants will be able to:
1) Repeat common and uncommon infectious/inflammatory diseases in the adult brain
2) Identify common and uncommon neoplastic disorders in the adult brain
3) Review common vascular disorders
4) Prepare for MOC recertification examination

PRESENTATION SUMMARY
The presenter will provide unknown cases demonstrating important common and uncommon adult brain CT, MR imaging and angiograms with pertinent associated multiple choice questions. Participants can answer using the Audience Response Plus (AR+) system and cumulative results will be displayed. The imaging findings and diagnostic features will be discussed to improve understanding of both common and rare entities with an emphasis on practical discussion. Illustrative cases will cover a gamut of categories of disease such as neoplastic, infectious/inflammatory, and vascular disorders. Level of difficulty will be commensurate with the fund of knowledge expected for the practicing neuroradiologist and tailored to MOC recertification examination preparation.

Pediatric Brain
Andrea Rossi, MD

LEARNING OBJECTIVES
Upon completion of this presentation, participants will be able to:
1) Review a number of interesting cases of pediatric central nervous system disease.
2) Illustrate the contribution of MR imaging to the differential diagnosis of such diseases.

PRESENTATION SUMMARY
This is an interactive case-based review session in which a number of interesting cases of pediatric central nervous system diseases will be presented. The session will be focused on differential diagnosis and neuroradiologic decision-making.
The Edge of the Film: Navigating Non-CNS Findings on Spine Imaging Studies Cardiothoracic Findings

Phillip M. Boiselle, MD

Dr. Phillip M. Boiselle is the Director of Thoracic Imaging and Associate Chief of Administrative Affairs in the Department of Diagnostic Radiology at Beth Israel Deaconess Medical Center. He is also an Associate Professor in Radiology at Harvard Medical School. Dr. Boiselle is the author of over 150 scientific articles, reviews, and book chapters. He also has co-authored and co-edited five textbooks devoted to thoracic imaging. His major research interest is the application of advanced CT imaging methods to noninvasively diagnose a variety of central airway abnormalities, most notably tracheobronchomalacia. He is currently the principal investigator for an NIH-RO1 grant from the National Heart Lung and Blood Institute that is designed to assess the prevalence and natural history of tracheomalacia among patients with COPD using a low-dose CT technique. He is also the Editor of the Journal of Thoracic Imaging. The official journal of the Society of Thoracic Radiology and the Japanese and Korean Societies of Thoracic Radiology.

Learning Objectives
Upon completion of this presentation, participants will be able to:
1) Recognize cardiopulmonary findings on spinal imaging studies.
2) Discuss appropriate management of incidental findings such as lung nodules.

Presentation Summary
This presentation will review common cardiopulmonary findings that may be observed on spine imaging studies with an emphasis upon accurate diagnosis and appropriate management of incidental findings.

Abdomen/Pelvis Findings

Neil M. Rofsky, MD

Dr. Neil M. Rofsky is Professor of Radiology at Harvard Medical School and the Director of MR imaging at Beth Israel Deaconess Medical Center. He leads a translational research group of physicians and scientists dedicated to the development of new sequences and techniques, targeted towards rapid clinical adoption. His own interests are primarily in body and vascular MR imaging applications and his research in prostate cancer is supported by the NIH. Dr. Rofsky attended New York Medical College and undertook his radiology residency followed by an MR imaging fellowship at New York University Medical Center. He is the author of over 120 peer-reviewed articles, and coauthor of a new textbook: CT and MR Angiography, Comprehensive Vascular Assessment. Dr. Rofsky serves on the Board of Trustees to the ISMRM and the SCBT/MR.

Learning Objectives
Upon completion of this presentation, participants will be able to:
1) Identify normal anatomical structures in the peripheral field of view.
2) Describe common incidental findings outside the CNS within the abdomen and pelvis.
3) Indicate appropriate next steps following detection of unsuspected findings.

Presentation Summary
The identification of findings outside the central nervous system and an understanding of appropriate next steps in patient management are important components of a comprehensive image interpretation. Renal, pancreatic and adnexal cysts commonly are encountered; however, important nuances to the imaging findings require more rigorous attention to detail. Neoplasms may be detected first as incidental findings. Furthermore, vascular disorders and relevant consequences of these to the downstream organs may be discovered first on a neurologic cross-sectional imaging study. A reacquaintance with the adjacent normal and variant anatomy, an understanding of signal and enhancement features that can mimic pathology will be emphasized.
State of the Art of NSF and Gadolinium-Based Contrast Agents Today

Emanuel Kanal, MD

Learning Objectives
Upon completion of this presentation, participants will be able to:
1) Recognize what appear to be those at greatest risk for developing NSF.
2) Identify recent changes in the regulatory guidelines.
3) Compare and contrast the current regulatory guidelines in the U.S. and in Europe regarding utilization of the various GBCAs in renal disease patients.
4) Review the most current thinking and theories regarding the etiology of NSF and perceived relative risks of the various GBCAs.

Presentation Summary
There have been numerous significant advances during the past 12 months in the pharmaceutical industry's and various international regulatory bodies' recommendations and activities pertaining to nephrogenic systemic fibrosis (NSF) and drug/patient management in specific patients. This presentation will present the state of the art, up to the minute status of the recent research as well as international regulatory changes and advances made in the realm of NSF, gadolinium-based contrast agents, and patients with significant renal disease. Specific attention will be focused on recent advances and numerous new regulatory changes, and how they compare between U.S., European, and other regulatory agencies and practices.

Low SAR Brain MR Imaging for Patients with Active Neuroimplants

Sarkar, S. N.; Papavassiliou, E.; Bhadelia, R.; Alsop, D.; Madhuranthakam, A.; Busse, R.; Rofsky, N.; Hackney, D.

1Beth Israel Deaconess Medical Center, Boston, MA, 2GE Healthcare, Boston, MA, 3GE Healthcare, Madison, WI

Purpose
Neurostimulators are contraindicated for MR imaging mainly due to significant tissue heating (1). We have modified 3D $T_2$ and FLAIR Cube sequences (2) based on earlier approach (3-5) using transmit-receive head coil and obtained high quality brain images at 1.5 T at 10-20 times lower SAR than clinical 2D sequences.

Materials & Methods
3D FSE Cube sequences (2) were optimized on phantoms and normal volunteers under IRB approval with low-flip angle refocusing pulse trains and were applied in a transmit-receive head coil avoiding RF exposure from the body coil on ten movement disorder patients with corrective deep brain stimulators to assess postsurgical complications and implantation accuracy. Five patients with vagal nerve stimulators and two patients with depth electrodes also were scanned for seizure and related follow ups. Stimulators were turned off during the scan. A 3D MPRAGE $T_1$ was performed pre and postcontrast at 1 x 1 x 1 mm$^3$ resolution and axial 3D Cube $T_2$ and axial and coronal 3D FLAIR were performed with approximately 0.8 x 0.8 x 5 mm$^3$ resolution. In addition a low dB/dt EPI diffusion-weighted sequence was run. Scan time/patient = 40 min, average SAR = 0.1 W/kg. Low-SAR is a requirement only for DBS but we followed it across all stimulator patients due to reported complications on VNS patients otherwise. 2D clinical high-SAR results from nonimplant patients were compared with low-SAR data from implant patient pool.

Results
Figure at left shows a 5 mm section from low-SAR 3D FLAIR image for a patient with infection along the right DBS while the left DBS seems normal. Figure at right shows another FLAIR image from a patient with complications arising from the right sided depth electrodes. The images were interpreted by two senior neuroradiologists and a neurosurgeon. The low-SAR images were considered equivalent in quality as compared to nonimplant patients imaged at normal SAR. There were no patient-related complications or device malfunction reported after MR imaging.
Using low-angle refocusing RF pulses with modulation to sustain magnetization, high quality 3D FSE imaging with 10 - 20 times lower SAR is achievable for patients with active neuro implants. This drastically reduces the MR imaging risk potential for brain imaging for these patients and may open up MR imaging options for patients with pacemakers.

REFERENCES

KEY WORDS: Implants, neurostimulators, low SAR

Paper 8 Starting at 10:53 AM, Ending at 11:01 AM
Dose Reduction of Brain CT Images Using 3D Nonlinear Postprocessing

Gomori, J. M.² · Kanal, E.² · Aiken, A. H.³ · Bradley, W. G.³ · Russell, E. J.⁵ · Yuh, W.⁴ · Zaaroor, M.⁷ · Bar-Meir, E.⁸
¹Hadassah Hebrew University Medical Center, Jerusalem, ISRAEL, ²University of Pittsburgh Medical Center, Pittsburgh, PA, ³Emory University School of Medicine, Atlanta, GA, ⁴University of California San Diego Medical Center, San Diego, CA, ⁵Feinberg School of Medicine, Northwestern University, Chicago, IL, ⁶Ohio State University Medical Center, Columbus, OH, ⁷Rambam Medical, The Technion Israel Institute of Technology, Haifa, ISRAEL, ⁸Bnai Zion Medical Center, Haifa, ISRAEL.

PURPOSE
The need for CT dose reduction, especially recently, has become a prime focus for radiology due to ever-increasing CT utilization and doses. To address this issue, filters for postprocessing of low dose CT images have been developed, but most of these filters are either two-dimensional or based on a spatially adaptive combination of multiple linear filters. This study was designed to assess the clinical adequacy of low-dose brain CT images processed with a novel 3D nonlinear filter.

MATERIALS & METHODS
Under IRB approval, 35 patients who had undergone both a low dose (200mAs) multidetector CT (MDCT), and standard (400mAs) unenhanced MDCT of the brain were identified retrospectively. The standard dose images were rigidly registered to the low dose images. The low dose images were processed by the SafeCT algorithm (Medic Vision Brain Technologies Ltd.), and displayed for side-by-side comparison review by five senior neuroradiologists. Random left/right positioning was utilized and all images were anonymized. The images were graded for image quality and diagnostic value on a scale of 1-5, with 3 signifying qualitative equivalence, 1 indicating clear superiority of the normal dose study, and 5 indicating clear superiority of the processed low dose study.

RESULTS
The processed low dose images were strongly and consistently felt to demonstrate equivalence or preferential image and diagnostic quality when compared to the normal, higher dose study. Statistically significant superiority (p < 0.05) of the processed low dose CT scans over the normal dose studies was seen for both diagnostic value (average value of 3.30 +/- 0.82) and image quality (average value of 3.58 +/- 1.10).

CONCLUSION
Blinded comparative studies of normal to low dose images suggest that the SafeCT novel 3D nonlinear filter allows for at least a 50% dose reduction in brain CT scans, where anatomy is the most noise sensitive. Further studies are warranted to assess the SafeCT algorithm for dose reduction in CT studies of other anatomical regions of interest.

KEY WORDS: Dose reduction, postprocessing, filters

Paper 9 Starting at 11:01 AM, Ending at 11:09 AM
CT Radiation Reduction: Postprocessing Algorithm for Noise Reduction in Low Dose Head CT, Prospective Qualitative and Quantitative Assessment

Shreiber, R. · Fischer, D. · Zaaroor, M. · Eran, A.
Rambam Health Care Campus
Haifa, ISRAEL

PURPOSE
Prospective assessment of a novel algorithm for noise reduction in low-dose head CT.

MATERIALS & METHODS
Patients admitted with mild to moderate head trauma and with imaging findings on routine head CT performed on admittance were recruited prospectively to the study. Follow-up CT, as clinically indicated, was obtained with low-dose radiation (50-35% dose reduction), within 48 hours. All admittance head CTs were obtained using multidetector row CT (MDCT) with 16 or 64 detectors rows. Reduced-dose head CTs were obtained with 64 slices MDCT and postprocessed using a dedicated noise reduction algorithm (Medic vision, Haifa, Israel). Two experienced neuroradiologists reviewed patient’s studies side by side on a workstation, blinded to the method of acquisition. Each study was graded, on a scale of 1 to 5, for visual accuracy of anatomical structures appearance, and visualization of pathologic findings. Additionally, contrast to noise ratio (CNR), was measured in each study at the basal ganglia - internal capsule interface. The study protocol was approved by the institutional IRB.

RESULTS
The study group included 50 adult patients (16 women, 34 men). Traumatic imaging findings were small subdural and epidural hematomas, mild traumatic subarachnoid hemorrhage, small parenchymal hematomas and cortical contusions. All studies were of diagnostic quality. There was no significant difference in visualization of anatomical structures, pathologic findings and CNR measurements between regular-dose head CT and low-dose head CT processed with noise reduction algorithm.

CONCLUSION
Low-dose head CT is comparable to regular-dose CT in diagnostic quality when using a noise reduction algorithm. Routine use of such method would decrease patient’s exposure to radiation.

KEY WORDS: Dose reduction, postprocessing
Altered Cerebral Venous Drainage in Patients with Migraine during an Attack and during the Asymptomatic Interval

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Purpose
The etiology of migraine headaches remains to be elucidated. We aimed to assess hemodynamic characteristics in migraine patients compared to healthy controls and in patients during an acute migraine attack compared to the asymptomatic interval.

Materials & Methods
We examined 19 patients (age 34.05 ± 12.77 years) with clinically proved recurring migraine headaches and 20 healthy controls (age 33.3 ± 12.48 years) on a 3 T MR (Siemens Verio). Additionally seven patients of the migraine group were scanned during an acute migraine attack. A 3D time-of-flight MRV of the upper neck region was performed to visualize the venous vasculature, while cine-phase contrast scans with high and low velocity encoding were employed to quantify arterial inflow and venous drainage in the primary channels (internal jugular veins) and secondary channels (epidural, vertebral and deep cervical veins). Percentage of drainage to the primary and secondary channels was calculated. Statistical analysis was performed using student t-test.

Results
Patients with migraine showed a significantly larger percentage of venous outflow through secondary channels when compared to healthy controls (349.94 vs 216.69 ml/min; 39.88 vs 26.32% normalized to total cerebral blood flow, p < 0.02). This included main venous drainage through epidural, vertebral and deep cervical veins. However, after accounting for secondary venous drainage there was still a near-significant higher degree of undetectable venous outflow compared to the control group (33.16 vs 25.21% of total cerebral blood flow, p = 0.055). No differences were found in arterial inflow parameters. No significant differences were found between the examination during an attack and during the asymptomatic interval. The Figure shows an example of the controls (A) compared to one of the migraine group (B).

Conclusion
Migraine patients showed an altered venous drainage pattern with a larger percentage of venous outflow through secondary venous channels. Even after accounting for secondary venous outflow the percentage of undetected venous outflow tended still to be higher. This phenomenon could be due to a venous drainage pattern through a network of very small vessels. The mechanism for this altered drainage is yet unclear; however, these altered drainage patterns may point toward a new aspect of disease etiology.

Key Words: Migraine, MRCP, venous drainage
Purpose
Gamma-aminobutyric acid (GABA) (1) is the most abundant inhibitory neurotransmitter. Usually, GABA is measured in vivo in humans using single voxel MR spectroscopy ('MEGA-PRESS' (2, 3) at low spatial resolution (e.g., > 27 cm^3). In this abstract, a method is developed for high resolution (4.5 cm^3) whole slice, multivoxel spectroscopic imaging of GABA at 3 T.

Materials & Methods
Experiments were performed on three normal volunteers on a 3 T Achieva system (Philips Healthcare) with a prototype 32-channel phased array coil (Invivo Inc.). Editing pulses (Gaussian, 14 ms, 150 Hz bandwidth) were added to a spinecho 2D-MRSI sequence with optimized dual-band water and lipid suppression and outer-volume lipid suppression (4). The editing pulses were placed on the H3 protons at 1.9 ppm in the ON acquisition, and at 0.7 ppm in the OFF acquisition. TE/TR was 68 ms/2s. For 2D-MRSI, the FOV was 21 x 18 cm, 14 x 12 acquisition matrix (interpolated to 33 x 27), 20 mm slice thickness, giving a nominal voxel size of 1.5 x 1.5 x 2.0 = 4.5 cm^3. Four averages were performed resulting in a total scan time of 17 min 38 sec.

Results
The figure shows the central 6 x 5 MRSI grid from one subject at the level of the centrum semiovale, showing high SNR spectra from GABA and co-edited glutamate and glutamine (Glx). A metabolic images of GABA also is shown, with lower levels in white matter compared to gray. Average GABA SNR measured in central voxel locations over the three subjects was 13.6 ± 3.3.

Conclusion
The MEGA-MRSI sequence with dualband suppression can acquire edited GABA spectra with excellent SNR within a reasonable scan time. The spatial resolution (4.5 cm^3) of the current scans exceeds by nearly an order of magnitude that of prior single-voxel and multiple-quantum filtered multivoxel experiments. The excellent SNR of the current study can be attributed to (a) the efficiency of the pulse sequence, (b) the 3 T field strength, and (c) the 32-channel head coil. Further refinements of the method include potential extension to multislice coverage and higher field (e.g., 7 T).

References

Key Words: GABA, MR spectroscopic imaging, brain
Whole Genome Association Study Using Atlas Proscribed Brain Volumes Obtained with Deformation-Based Morphometry

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PURPOSE
Deformation-based morphometry (DBM) enables automated labeling of subject brain images using a reference brain atlas (1). Whole genome association (WGA) is a common human genetics technique where thousands of single nucleotide polymorphisms (SNPs) are assayed to implicate those SNPs/gene regulating a quantitative trait or disease process (2). For the first time, we describe a method utilizing these techniques together to identify candidate SNPs (and therefore the underlying gene products) regulating regional brain volume.

MATERIALS & METHODS
Adult (mean: 34.7 years old) normal control (n = 24) and schizophrenic (n = 21) subjects were enrolled in a study of cognition in schizophrenia. The subjects’ genomic DNA was harvested from whole blood and analyzed using the Affymetrix 6.0 human genotyping array consisting of probes for 909,622 individual SNPs that provide redundant coverage of the human genome. Isotropic 1 mm MP RAGE structural 3.0 T brain MR images were obtained, and a brain atlas was warped to subject brains using “Hierarchical Attribute Matching Mechanism for Elastic Registration” (HAMMER) DBM (3). A two way ANCOVA model factoring in sex, age, diagnosis, genotype, and genotype-diagnosis interaction was regressed against brain ROI volumes for each SNP. To minimize multiple comparisons, only 70 brain ROIs were used as the dependent variables for regression analysis. Results were analyzed according to subject race to minimize impact on disease status including: 18q 22.3 (carnosinase brain metabolic proteinase, 2, 6 x 10 8), 7q12.3 (microtubule associated serine-threonine kinase 4, 6, all 2.5 x 10 10), and 8p23.2 (microcephalin, 7, 5 x 10 10). Likewise, several gene loci affected left hippocampal volume depending on disease status including: 18q 22.3 (carnosinase brain metalloproteinase, 2, 6 x 10 8), 7p21.3 (neurexophilin synapase structural protein, 5, 8 x 10 10), 15q25.2 (neuromedin B, 3, 2.7 x 10 10), 15q12 (GABA receptor beta3, 2, 3.8 x 10 10), and 16p13.2 (NM DA receptor 2A, 5, 4 x 10 9). A meta-analysis of all SNP data was performed. In this abstract, reduced SAR refocusing pulses were applied to MRSI.

RESULTS
After standard quality control procedures, 691,206 SNPs were available for association testing. Although, the observed volume-SNP association p-values fell above the Bonferroni corrected cut-off for whole genome association used in human genetics (p < 10 8), numerous interesting candidate (p < 0.0001) associations were observed across the 70 ROIs analyzed, illustrating the promise of this technique. For example, several chromosomal loci contained multiple SNPs with an effect on the size of the left hippocampus including (gene product, number of SNPs, lowest p-value): 22q11.23 (CDCC42 serine threonine kinase, 2 hits, 1.8 x 10 6), 5q12.3 (gene product, number of SNPs, lowest p-value): 22q11.23 (gene product, number of SNPs, lowest p-value): 5q12.3 (gene product, number of SNPs, lowest p-value): 22q11.23 (gene product, number of SNPs, lowest p-value) (18q 22.3 (carnosinase brain metalloproteinase, 2, 6 x 10 8), 7p21.3 (neurexophilin synapase structural protein, 5, 8 x 10 10), 15q25.2 (neuromedin B, 3, 2.7 x 10 10), 15q12 (GABA receptor beta3, 2, 3.8 x 10 10), and 16p13.2 (NM DA receptor 2A, 5, 4 x 10 9).

CONCLUSION
We have shown it is possible to perform WGA using volumes from computationally labeled brain MR images as a quantitative trait. The technique is unbiased by a priori hypotheses, addressable to any ROI, and produces biologically plausible results. Obtained effect sizes also will allow power calculations for larger scale experiments.

REFERENCES

KEY WORDS: Brain morphometry, single nucleotide polymorphism

Reduced Flip Angle Refocusing Pulses for SENSE-MRSI at High Magnetic Field Strengths in the Human Brain

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Johns Hopkins University School of Medicine Baltimore, MD

PURPOSE
Magnetic resonance spectroscopic imaging (MRSI) at field strengths of 3 T or higher offers significant improvements in terms of spectral resolution and sensitivity (SNR) compared to 1.5 T. However, high bandwidth slice selective pulses are required to minimize chemical shift displacement artifacts, whose radiofrequency power may exceed FDA guidelines for specific absorption rate (SAR) as field strength increases. In this abstract, reduced SAR refocusing pulses were applied to MRSI.

MATERIALS & METHODS
Three numerically optimized, frequency modulated refocusing pulses, with flip angles of 90°, 120° and 180° were compared in a spin-echo, multi-slice MRSI sequence performed at 3 T with body-coil transmit and an 8-channel phased-array receive coil. With a maximum B1 field of 13.5µT, 90°, 120° and 180° pulse bandwidths were 4.8 kHz, 3.55 kHz and 2.15 kHz, corresponding to Lac-Cho displacements of 5%, 7% and 11% respectively (1). Three axial 15 mm slices were recorded with TR/TE of 2500 ms/144 ms. Field of view was 197 x 240 mm with matrix size of 27 x 33, giving a nominal voxel size of 0.8 cm3. Total scan time was 8.5 min with a SENSE acceleration factor of 2. Water and lipid suppression were performed with dual-band hyper-geometric pulses and outer volume suppression (2).

RESULTS
Sequence SAR was 1.3, 1.9 and 2.5 W/kg for the 90°, 120° and 180° pulse sequences respectively. The figure shows metabolic images of Cr and NAA of the middle slice acquired by the 90° - 120° configuration. The average ratio of the NAA peak integral is 0.55:0.71:1.0, in good agreement with the predicted values of 0.50:0.75:1.0.
CONCLUSION

Three numerically optimized, frequency modulated refocusing pulses, with flip angles of 90°, 120° and 180° were compared in a spin-echo, multi-slice MRSI sequence performed at 3 T with body-coil transmit and an 8-channel phased-array receive coil. With a maximum B1 field of 13.5µT, 90°, 120° and 180° pulse bandwidths were 4.8 kHz, 3.55 kHz and 2.15 kHz, corresponding to Lac-Cho displacements of 5%, 7% and 11% respectively (1). Three axial 15 mm slices were recorded with TR/TE of 2500 ms/144 ms. Field of view was 197 x 240 mm with matrix size of 27 x 33, giving a nominal voxel size of 0.8 cm3. Total scan time was 8.5 min with a SENSE acceleration factor of 2. Water and lipid suppression were performed with dual-band hyper-geometric pulses and outer volume suppression (2).

REFERENCES

1. J. Murdoch, Philips Healthcare

KEY WORDS: Brain, MR spectroscopic imaging, high field

PAPER 16 STARTING AT 11:57 AM, ENDING AT 12:05 PM
TRACER ARRIVAL TIMING-INSENSITIVE DECONVOLUTION TECHNIQUE FOR ESTIMATING CEREBRAL BLOOD FLOW FROM CT PERFUSION IMAGES

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M assachusetts General Hospital
Charlestown, MA

PURPOSE

The tracer arrival timing-insensitive deconvolution method using block circulant singular value decomposition with minimization of oscillation index (oSVD) has been shown to perform accurately for estimating cerebral blood flow (CBF) from MR perfusion-weighted imaging. However, the method was shown to perform suboptimally in conditions of low signal-to-noise ratios (SNR), which is often the case with raw CT perfusion (CTP) data. Our purpose was to investigate the combination of wavelet-based noise reduction and oSVD to estimate CBF for conditions of low SNR.

MATERIALS & METHODS

Numerical simulations were used to compare calculated CBF with true CBF values. Concentration-time curves were modeled using cerebral blood volume (CBV) fixed at 4% and CBF varying from 10-70 ml/100 g/min in increments of 10 ml/100 g/min. Simulations were conducted for box-car, linear and monoeponential residue functions, over 200s sampled every 1.0s. Gaussian noise was added to achieve SNR = 5. This simulation was repeated for 11 time-shifts (± 5s) relative to the arterial input function (AIF) to test the dependence of flow estimates on tracer arrival time. The AIF was modeled using a gamma-variate function. One thousand twenty-four voxels were examined in each permutation. Wavelet-based denoising was performed using a fourth-order Symlet and two levels of decomposition with automated thresholding (Matlab). Maps of CBF were computed for the raw and denoised images using oSVD. The oscillation index (OI) was determined by simultaneously minimizing the error in measured CBF vs true CBF across all residue functions.

RESULTS

Denoising improved SNR from 5 to 20. The optimal OI was 0.016 for the raw image, and 0.038 for the wavelet denoised image. Fit between measured and true CBF improved considerably with wavelet denoising (see Figure A), and was independent of tracer arrival time (see Figure B).

CONCLUSION

Improvement in SNR from denoising with wavelet thresholding permits calculation of CBF using oSVD. This was expected given the known noise-dependence of oSVD. However, we suspect that the observed SNR improvements may be affected by periodicity within the simulated images, and that the gains in SNR may be less dramatic in the case of clinically acquired CTP. Therefore, increases in SNR that may be achieved with further postprocessing may enable additional improvements in our ability to accurately measure CBF.

KEY WORDS: CT perfusion, ischemia, deconvolution
Development and Utilization of a Computer-Assisted Diagnostic Tool in the Evaluation of Brain Metastasis

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University of Maryland
Baltimore, MD

PURPOSE
To develop and assess the accuracy of a computer-assisted diagnostic (CAD) tool designed to evaluate changes in the burden of disease in patients with intracranial metastasis on serial MR scans.

MATERIALS & METHODS
Ten MR studies on five patients (two per patient) with known intracranial metastasis were selected retrospectively. All were axial T1 postgadolinium isovolumetric voxel datasets. The baseline MR imaging (MRI) was aligned anatomically to the follow-up MRI using an intensity-based rigid image registration technique developed at our center. Image registration was performed locally on the workstation as well as on an eight-PC cluster system. The registered image then was subtracted from the follow-up MRI. The CAD tool nulls all areas that remained stable between the paired data set with only areas of change highlighted. The resulting subtraction image was color coded with blue representing lesions decreasing in size between the two scans and red representing lesions that are increasing in size or are new. The subtracted color-coded image was compared to the original paired data set by an experienced neuroradiologist who represented the gold standard for the study.

RESULTS
A total of 91 lesions were evaluated in the five paired MR scans. Thirteen lesions regressed in size. There were 34 lesions that were either new or increasing in size. The remainder were considered not significantly changed. The lesions that remained stable and were nulled successfully were counted as true negatives. The sensitivity and specificity of the CAD tool in this small sample population were 94 and 98%, respectively, using an experienced neuroradiologist reading as the current gold standard. The postprocessing times were reduced significantly when using the cluster system making this a clinically viable tool.

KEY WORDS: Metastasis, CAD, MR imaging

Assessment of Mobile Display Technology for Evaluation of Acute Stroke

Mogensen, M. A. · Kim, P. E. · Lerner, A. · Liu, B. J. · Wang, K. · Rajderkar, D. · Guo, B. · Park, Y. · Law, M.
University of Southern California
Los Angeles, CA

PURPOSE
Radiologic evaluation of disease pathology on handheld mobile devices has become more common among physicians due to increased use of mobile display technologies. Mobile device technologies likely will be utilized with increasing frequency for assessment of acute disease pathologies, such as stroke, where the initial noncontrast head CT scan is crucial to identify and properly triage patients in a timely manner. Such technology may be particularly useful to physicians who may not otherwise have immediate access to a dedicated radiology workstation. The purpose of this study was to assess the intraobserver accuracy and confidence of a neuroradiologist interpreting a noncontrast head CT scan utilizing mobile display technologies on a mobile device (iPhone) in the evaluation of stroke patients.

MATERIALS & METHODS
Three fellowship-trained neuroradiologists (R1, R2, R3) retrospectively reviewed 33 noncontrast head CT scans of patients presenting to the emergency department with an acute stroke. CT scans selected for inclusion into the study had a range of findings including hemorrhage (8), subtle infarct (9), obvious infarct (8), and normal (8). Cases were reviewed first on a mobile device (iPhone) with a 480 x 320 pixel screen resolution (163 ppi) utilizing a mobile display technology with a web-based thin-client application system. Cases then were reviewed on a standard PC display system with a workstation monitor resolution of 1600 x 1200 pixels (163 ppi) on a separate viewing application that is utilized in clinical workflow. The readers were asked to identify the abnormality if present and grade their confidence level, 1 (lowest) to 4 (highest), that the interpretation is correct. Simple intraobserver agreement between the mobile device and standard PC workstation interpretations, as well as average confidence level, was calculated.

RESULTS
Simple intraobserver agreement between the interpretation on the mobile device and standard PC workstations was high for all readers (R1 = 100%, R2 = 91%, R3 = 94%). Differences in simple agreement were primarily secondary to subtle infarcts not seen during interpretation on the mobile device. All acute abnormalities reported on the mobile device were seen on the standard PC workstation clinical application. Average confidence levels of interpretations on the mobile device vs the PC workstation were as follows: R1 = 3.60 vs 3.79, R2 = 3.73 vs 3.91, and R3 = 3.40 vs 3.73.
**Key Words:** Mobile technology, stroke

**Paper 19 Starting at 12:21 PM, Ending at 12:29 PM**

**Compressed Sensing Reconstruction in Clinical Neuroimaging**

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Los Angeles, CA

**Purpose**

Compressed sensing (CS) is a new approach for MR imaging reconstruction using undersampled k-space data. We investigate the utility of CS for clinical imaging in a double-blind assessment of CS MR imaging quality.

**Materials & Methods**

Data were collected on a GE Signa 3 T XITE HDx system using an 8-channel head coil, from five patients. Three sequences were chosen: coronal T2, coronal FLAIR, and coronal SPGR. Compressed sensing reconstruction was performed using retrospective variable-density downsampling. The CS-reconstructed images and reference image from fully sampled data were randomly ordered. Image quality then was assessed by two blinded radiologists. The signal-to-noise ratio (SNR) was calculated as: SNR = st/σ, where st is the mean signal intensity and σ is the standard deviation of background noise. A qualitative assessment was performed with a scoring system.

**Results**

Table 1 shows the quantitative measurements and qualitative scores: average SNR and CNR for each sequence, and the average score of all evaluated anatomical structures, for the fully sampled reference data and compressed images.

<table>
<thead>
<tr>
<th>Sequence</th>
<th>T2 SNR</th>
<th>FLAIR SNR</th>
<th>SPGR SNR</th>
<th>T2 CNR</th>
<th>FLAIR CNR</th>
<th>SPGR CNR</th>
<th>T2 score</th>
<th>FLAIR score</th>
<th>SPGR score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reference</td>
<td>26.4</td>
<td>21.0</td>
<td>21.3</td>
<td>7.8</td>
<td>6.2</td>
<td>6.2</td>
<td>3.0</td>
<td>2.8</td>
<td>2.8</td>
</tr>
<tr>
<td>CS x 2</td>
<td>16.1</td>
<td>13.9</td>
<td>21.6</td>
<td>10.5</td>
<td>6.2</td>
<td>6.2</td>
<td>2.7</td>
<td>2.2</td>
<td>2.2</td>
</tr>
<tr>
<td>CS x 3</td>
<td>22.3</td>
<td>13.7</td>
<td>19.5</td>
<td>13.0</td>
<td>4.7</td>
<td>6.2</td>
<td>2.4</td>
<td>1.7</td>
<td>1.7</td>
</tr>
<tr>
<td>CS x 4</td>
<td>24.4</td>
<td>15.2</td>
<td>21.1</td>
<td>15.2</td>
<td>5.2</td>
<td>6.4</td>
<td>2.0</td>
<td>1.2</td>
<td>1.5</td>
</tr>
</tbody>
</table>

The qualitative results correspond well with the degree of compression. The readers felt that the T2 reference and 2x CS images, FLAIR reference, and SPGR reference images were of diagnostic quality. Of some diagnostic quality were the T2 3x CS, FLAIR 2x CS and SPGR 2x CS images. The more accelerated CS sequences were not thought to be of diagnostic quality, as the images became blurry with pronounced ringing artifacts. The quantitative results demonstrate that the average CNR trended upwards with increased acceleration, which may be the result of denoising from compression. The average SNR did not appear to have any correlation with the degree of compression. Unlike parallel imaging, CS can decrease imaging time without adversely affecting SNR. Compressed sensing could lead to proportionate decreases in imaging time, such that using 2x CS would lead to a 50% decrease in imaging time, and 3x CS would lead to a 67% decrease in imaging time.

**Conclusion**

This study suggests that CS can be used to decrease imaging time in existing brain MR protocol sequences, without significant loss in diagnostic image quality.

**Key Words:** Compressed sensing, CS, parallel imaging

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**Monday Morning**

**10:45 AM - 12:30 PM**

**Room 302-304-306**

(4b) Adult Brain: Cerebrovascular Occlusive Disease I

(Scientific Papers 20 - 32)

See also Parallel Sessions

(4a) Adult Brain: New Techniques/Postprocessing

(4c) Trauma: Adult Brain and Spine

(4d) Pediatric: Neoplasms & Cerebrovascular

(4e) Excerpta Extraordinaire: Head and Neck

**Moderators:** Pamela W. Schaefer, MD

Doris D.M. Lin, M.D.

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**Paper 20 Starting at 10:45 AM, Ending at 10:53 AM**

Mean Transit Time Can Best Identify the Brain Tissue Destined to Infarct in Acute Stroke Patients with No Arterial Recanalization: Using Either Delay-Sensitive or Delay-Corrected Algorithm for CT Perfusion Postprocessing

Kamalian, S.1 · Kamalian, S.2 · Payabvash, S.1 · Pomerantz, S. R.1 · Gonzalez, R. G.1 · Furie, K. L.1 · Lev, M. H.1

1Massachusetts General Hospital, Boston, MA, 2Winthrop University Hospital, Mineola, NY

**Purpose**

Rapid and reliable identification of the salvageable brain tis-
sue - operational penumbra - within first hours after acute ischemic stroke (AIS) onset can guide stroke treatment and help triage patients for thrombolytic therapy. Our purpose was to determine the optimal CT perfusion (CTP) parameter and threshold to define the “penumbra”, using concurrent diffusion-weighted imaging (DWI) and follow up imaging as the reference standard.

Materials & Methods
We reviewed imaging records of 98 consecutive anterior circulation AIS cases who underwent 66-second biphasic cine CTP scan within 9 hours of symptoms onset. Twenty-one patients met our inclusion criteria: (1) vessel occlusion on admission CT angiography; (2) CTP obtained within 9 hours of the CTP; (3) follow-up CT or MR images obtained later than 48 hours from ictus; (4) no evidence of clinical improvement between the admission and follow-up scans; and (5) no thrombolytic therapy. All CTP maps were created using both conventional delay sensitive as well as delay-corrected software from the same vendor (CTP3 and CTP4, GE Healthcare, Milwaukie, WI). After coregistration of follow-up images and admission DWI to admission CTP scan, regions of interest (ROIs) were drawn for the “admission infarct core” (based on admission DWI) the “final infarct lesion” (based on follow-up noncontrast CT or MR imaging), and final normal brain tissue were overlaid on the slice with the largest tissue evolved to infarction and manually outlined. Normal contralateral hemisphere was used to calculate relative cerebral blood flow, volume and mean transit time (rCBF, rCBV, and rMTT, respectively). Pixel level ROC curve analysis was done to calculate the area under the curve (AUC), optimal thresholds, sensitivities and specificities for each perfusion parameter and the product of rCBF and rCBV (rCBV.rCBF).

Results
More than one million pixels were analyzed using ROC statistics. A absolute and relative MTT values had highest accuracy (AUC value) among all CTP parameters studied in terms of defining penumbra tissue destined to infarct. Using the CTP postprocessing software with conventional delay-sensitive algorithm, the corresponding AUCs for CTP parameters were 0.72, 0.74, 0.56, 0.59, 0.76, 0.77, 0.67 and 0.70 for CBF, rCBF, CBF, rCBV, MTT, rMTT and CBV.CBF and rCBV.rCBF, respectively. Using the delay-corrected software, the AUCs in the same order were 0.68, 0.69, 0.52, 0.52, 0.72, 0.71, 0.63 and 0.63, respectively. With delay-sensitive software, the optimal MTT threshold defining penumbra destined to infarct was 13s absolute MTT value or 242% rMTT of the contralateral normal side (sensitivity = 65% and specificity = 77%); whereas with delay-corrected software the optimal MTT threshold defining penumbra destined to infarct was 13.4s absolute MTT value or 154% rMTT of the contralateral normal side (sensitivity = 64% and specificity = 70%).

Conclusion
Absolute and relative MTT values calculated using either conventional (12s MTT, 242% rMTT) or delay-corrected postprocessing software (13.4s MTT, 154% rMTT), provide the optimal accuracy in defining the operational penumbra destined to infarct in acute stroke patients.

Key Words: Stroke, CT, perfusion

Correlation of Vertebrobasilar Calcium Score with Acute Infarction

Mogensen, M. A · Rajderkar, D · Sanossian, N · Burgos, A · Kim, P. E · Shiroishi, M. S · Zee, C. S · Go, J. L · Lerner, A · Sung, G · Kim-Tenser, M · Law, M

University of Southern California Los Angeles, CA

Purpose
Calcium scoring has gained favor for predicting acute myocardial infarction and patient outcome in coronary ischemia. Coronary artery calcification also has been shown to have predictive value for future ischemic stroke. Several recent studies have examined the association of cerebral ischemia and atherosclerotic calcification of the internal carotid artery (ICA) with variable methodology and results. While the majority of these studies did not show that ICA calcium scoring has predictive value for acute ischemic events, the results may be different for the vertebral and basilar arteries. Unlike the anterior circulation, stroke in the vertebrobasilar system can be occlusive similar to coronary infarction because of the smaller caliber of the vessels. The purpose of this study was to examine the association of atherosclerotic calcification in the vertebrobasilar system with acute ischemic stroke in the posterior circulation.

Materials & Methods
We performed a retrospective analysis of 87 patients (43 females, 44 males; median age, 58 years; range, 22-92 years), who presented with stroke-like symptoms between August 2008 and August 2009 to LAC-USC Medical Center. Using a noncontrast head CT scan, a total Agatston calcium score and calcium volume was calculated for the intracranial vertebral and basilar arteries using dedicated calcium scoring software (Fuji Vincent 3D application). Clinical diagnosis of acute infarct, hemorrhage, or transient ischemic attack was confirmed by review of CT and MR imaging. Pearson and point-biserial correlation coefficients were used to assess the correlation of vertebrobasilar calcification with posterior circulation stroke.

Results
Sixty-one of 87 patients had an acute infarct in the anterior (n = 37) or posterior (n = 18) circulation, or involving both territories (n = 6). Twelve of 87 patients had vertebrobasilar calcification in sufficient quantity to permit calculation of an Agatston calcium score and perform volumetric quantification. Of the 24 patients with a posterior circulation acute infarct, only 3/24 (12.5%) had vertebrobasilar calcifications. There was no correlation between the total Agatston score and acute ischemic stroke (Pearson correlation = 0.10). When only patients with vertebrobasilar calcifications were analyzed, there was a statistically significant correlation (point-biserial correlation) between the presence of a posterior circulation acute infarct and severity of both the Agatston score (rpb = 0.77, p-value < 0.002) and calcium volume (rpb = 0.84, p-value < 0.001). There was also a statistically significant correlation (point-biserial correlation) between any posterior circulation ischemic changes (acute or chronic infarct) and the Agatston score (rpb = 0.69, p-value < 0.007) and calcium volume (rpb = 0.72, p-value < 0.004).
CONCLUSION
The results suggest that the absence of calcification in the intracranial vertebrobasilar circulation does not lower a patient’s risk of a posterior circulation acute ischemic infarct. When vertebral or basilar calcifications are present, there is a statistically significant association between the presence of a posterior circulation acute infarct and the severity of the Agatston calcium score and calcium volume. These findings will be further investigated with a larger sample size and covariant analysis with patient age and clinical risk factors for stroke.

KEY WORDS: Calcium score, stroke, cerebrovascular

REFERENCES

CONCLUSION
This study demonstrates the feasibility of using absolute values of BOLD MRI CVR to measure the hemodynamic effect of surgical revascularization in patients with arterial steno-occlusive disease.

KEY WORDS: Cerebrovascular reactivity, cerebrovascular reserve

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negative or inconclusive for ischemia. In 4/6 patients, DTI trace imaging was more conspicuous than DWI b1000 and b2000.

DWI b1000 (left panel) and DTI trace image (right panel) showing increased conspicuity of left MLF diffusion restriction on DTI trace.

**CONCLUSION**

Novel application of diffusion tensor imaging to detect MLF ischemia allows specific identification of an anatomical lesion causing clinically relevant findings. If INO is suspected, DTI can be utilized to demonstrate previously unresolvable ischemia on conventional DWI. Diffusion tensor imaging is more sensitive than DWI for the detection of small midbrain strokes.

**KEY WORDS:** Stroke, DTI, ophthalmoplegia

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**Paper 24 Starting at 11:17 AM, Ending at 11:25 AM**

**Glasgow Coma Scale Does Not Predict Outcome Postintraarterial Treatment for Basilar Artery Thrombosis**

Chandra, R. V. · Law, C. · Yan, B. · Dowling, R. J. · Mitchell, P. J.

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Melbourne, AUSTRALIA

**PURPOSE**

Evidence to guide patient selection for intraarterial therapy (IAT) in acute basilar artery thrombosis is lacking. Glasgow Coma Scale (GCS) is used frequently as a selection criterion, based on the view that higher GCS correlates with better neurologic outcome. This has not been systematically studied. We hypothesize that low GCS does not correlate with poor outcome and that it does not preclude intraarterial therapy.

**MATERIALS & METHODS**

We included 40 consecutive patients with basilar artery thrombosis treated with IAT. Clinical characteristics, GCS, time to intervention and postprocedural thrombolysis in myocardial infarction (TIMI) score were collected. Recanalization was defined as TIMI-2/3; clinical outcome was measured by 90-day modified Rankin score (mRS). Good neurologic outcome was defined as mRS ≤1.

**RESULTS**

Median age was 63.5 years. Majority presented with gaze palsy (67.5%) or hemiparesis (45%). Median GCS was 9; median time to intervention was 7.2 hours; treatment included intraarterial urokinase (95%), thrombectomy (7.5%), angioplasty (35%), and stent insertion (17.5%). Recanalization rate was 82.5%. Good neurologic outcome (mRS ≤1) occurred in 30%. There was no correlation between GCS and 90-day mRS (Spearman’s rho -0.174, p = 0.283). Equal numbers of patients with good neurologic outcome (n = 12) had GCS ≤ 6 or > 6. In those GCS ≤ 6 for > 3 hours 33.3% had good neurologic outcome, a similar rate to the overall cohort.

**CONCLUSION**

Low GCS does not correlate with poor neurologic outcome in patients with acute basilar artery thrombosis managed with IAT. It is not appropriate to exclude patients from IAT based on low GCS.

**KEY WORDS:** Intraarterial, basilar, thrombosis

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**Paper 25 Starting at 11:25 AM, Ending at 11:33 AM**

**Reperfusion in Acute Stroke Assessed with Whole Brain Arterial Spin Labeling: An Alternative to Gadolinium-Based Perfusion Imaging**

Mirasol, R. V. · Hernandez, D. A. · Bokkers, R. P. H. · Warach, S. · Latour, L.

‘National Institute of Neurological Disorders and Stroke, Bethesda, MD, ‘University Medical Center Utrecht, Utrecht, NETHERLANDS

**PURPOSE**

Reperfusion assessed by perfusion-weighted imaging is an important marker of outcome in ischemic stroke (IS) and can be evaluated using MR dynamic susceptibility contrast (DSC) imaging. Recently, nephrogenic systemic fibrosis has been associated with administration of gadolinium in patients with renal failure, increasing concerns for repeat exposure in all patients. Arterial spin labeling (ASL), an MR imaging technique that does not use contrast agent, may offer a safe alternative for visualizing reperfusion and quantifying cerebral blood flow. This study compares ASL to DSC for detecting reperfusion.

**MATERIALS & METHODS**

Fifteen confirmed acute IS patients with 1) a perfusion deficit on DSC within 24 hours of symptom onset and 2) DSC and ASL at baseline and 1 day later were included. Whole brain perfusion MR imaging was performed on a 3 T Philips. A 1:24-minute, echo planar DSC sequence (3 x 3 x 7 mm resolution) was used to generate maps of time to peak and mean transit time (1st over 0th moment). A 2-minute, pseudo-continuous ASL sequence (3 x 3 x 7 mm resolution) produced 12 control and tagged images which were pairwise subtracted and averaged, producing relative blood flow maps. Blinded to the ASL perfusion images and aided by diffusion-weighted imaging, an expert reader evaluated DSC maps for perfusion deficits and the degree of reperfusion on follow up. Arterial spin labeling maps were similarly evaluated 1 week later. Site of vessel occlusion was noted using time-of-flight MRA.

**RESULTS**

Median time from onset to baseline perfusion was 3.5 hours. Median NIH Stroke Scale was eight. Vessel occlusion was distributed as follows: 1 ICA/M1/A1, 2 ICA/M1, 2 M1, 3
M2, 5 M3/distal, 2 PCA. Of the 15 patients with a deficit on baseline DSC, 14 perfusion deficits were detected with ASL. Follow-up perfusion imaging was evaluable in 13 using DSC and 13 using ASL and reperfusion was noted in five by DSC and six by ASL. Four of the five patients found to have reperfused by DSC also reperfused on ASL; the fifth patient did not have an evaluable follow-up ASL due to motion. The two determined to have reperfused by ASL but not DSC had distal M3 occlusions.

**CONCLUSION**

Good agreement was found between ASL and DSC for detecting reperfusion. Discrepant cases may reflect the non-specificity of ASL in detecting reperfusion for more distal occlusions. Arterial spin labeling may provide a safe means of assessing reperfusion in patients with renal impairment or for multiple-repeated measures for determining time of reperfusion. Work is ongoing to establish sensitivity and specificity.

**KEY WORDS:** Reperfusion, arterial spin labeling, gadolinium

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**Paper 26 Starting at 11:33 AM, Ending at 11:41 AM**

**Results of Intravenous Thrombolysis Using Exclusive MR Imaging Selection: A Series of 200 Acute Ischemic Stroke Patients**

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Marseille, FRANCE

**PURPOSE**

MR imaging (MRI) usually is less available than CT scanner for acute ischemic stroke (AIS) patients; however, in our University Hospital, AIS patients potentially eligible for IVT have had permanent free access to MR imaging since five years ago. We report a prospective open study of 200 AIS patients treated by IVT using standard dose of alteplase and exclusive MR imaging selection.

**MATERIALS & METHODS**

All the patients had a brain MRI within 41/2 hours from stroke onset (DWI, FLAIR, TOF angiography, T2* imaging, PWI). After analysis of MRI data using dedicated software Perfscape® and Neuroscape® (Olea Medica®), IVT was performed and monitored by a stroke neurologist. Manually guided transcranial doppler monitoring was performed during 2 hours in case of MCA M1 occlusion. One day after IVT, brain CT scan and CT angiography were performed systematically to check the absence of hemorrhage and assess the brain and cervical arteries. Patients with T occlusion were excluded from this study.

**RESULTS**

Between January 2005 and January 2008 we treated consecutively 200 patients (200 more patients treated after will be presented at the conference). Patients were male in 68% of the cases and had diabetes in 11.5% of the cases. Mean NIHSS score was 11 +/- 6, mean onset to needle delay was 156 +/- 49 mn, mean door to needle delay was 30 +/- 10 mn, 27% of the patients had a proximal MCA M1 occlusion and 17% a combined intracranial ICA and MCA occlusion. A complete recanalization of MCA M1 occlusion one day after IVT was observed in 70% of the cases and was highly predictive of a recovery of independence 3 months after stroke onset (after adjustment for stroke severity, OR = 6 ; IC 95% = 1.7 - 21 ; p = 0.005). These data must be analyzed in light of the potential therapeutic role of the prolonged TCD monitoring. Symptomatic hemorrhagic transformations (sHT), noted in 2.5% of the cases (NINDS definition), were more frequent in the intracranial tandem occlusion and significantly associated to post-IVT simultaneous recanalization of MCA and ICA suggesting a reperfusion injury. Three months after stroke onset, 57% of the patients had a modified Rankin score (mRS) of 0 to 1, 67.5% were independent and only 3% were dead. Moreover each year, MRI selection of potential candidates for IVT detects about 12% of stroke mimics, half would have been thrombolized using only CT selection.

**CONCLUSION**

Compared to data from the literature, the rate of early complete MCA M1 recanalization was remarkably high and predictive of a good functional prognosis 3 months after stroke onset. Symptomatic hemorrhagic transformations and death rates were similar to those reported in other series where MRI was used to select patients for IVT. After adjustment for stroke severity, our results seem to be better than the series from the literature where CT scan was used to select patients for IVT and suggest that MRI is feasible in clinical routine and probably the best method to select patients for IVT.

**KEY WORDS:** Stroke, thrombolysis, MR imaging

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**Paper 27 Starting at 11:41 AM, Ending at 11:49 AM**

**Yield of Perfusion MR Imaging in Diffusion Negative Transient Ischemic Attack Patients**

Zaharchuk, G. · Olivot, J. · Mlynash, M. · Straka, M. · Bammer, R. · Albers, G. W. · Moseley, M. E.

Stanford University
Stanford, CA

**PURPOSE**

Transient ischemic attack (TIA) can predict future stroke, with a 90-day risk of up to 10% (1). A diffusion-weighted imaging (DWI) lesion both verifies ischemia as the likely
cause of symptoms and puts the patient at higher risk of progression (2, 3). Diffusion-weighted imaging-negative patients remain diagnostically challenging, so we examined the yield of perfusion MR imaging [noncontrast arterial spin labeling (ASL) and bolus contrast perfusion-weighted imaging (PWI)] in this population.

**Materials & Methods**
Transient ischemic attack patients within 48 hours of symptom onset were enrolled prospectively and underwent imaging with DWI, MRA, pseudocontinuous ASL (4), and gradient-echo PWI, which was processed to create CBF, CBV, MTT, and normalized delay time (Tmax) maps (5). All images were evaluated for focal abnormalities by a neuroradiologist. Results were compared with imaging evidence of large artery atherosclerosis (LAA), defined as CTA or MRA stenosis ≥50% using NASCET criteria.

**Results**
Twenty-one patients underwent all required imaging, and 5/21 (24%) had DWI lesions and were excluded from subsequent analysis. In the remaining DWI-negative patients (n = 16, age 44-84 years, mean 66 years, M/F 4/12), LAA was seen in 5/16 patients (31%) (two unilateral ICA occlusions, one moderate basilar stenosis, two severe M1 stenoses). Tmax prolongation was present in three patients, all of whom had LAA. Arterial spin labeling abnormality, including hypoperfusion, the borderzone sign (6), or focal arterial transit artifact was observed in 8/16 patients (50%). Four had a borderzone sign. Arterial spin labeling was always abnormal in the setting of abnormal bolus PWI or LAA. However, ASL abnormality was identified in 3/11 cases (27%) with negative DWI, PWI, and LAA (Figure).

**Conclusion**
This small study confirms that perfusion imaging is frequently abnormal in TIA patients, consistent with prior reports (7). In DWI negative patients, bolus PWI was abnormal only if LAA or ASL abnormalities also were present.

Arterial spin labeling was the most sensitive sequence, with abnormalities detected in half of patients, some of whom had no other imaging evidence of TIA. This is likely due to its higher sensitivity to mild arterial arrival time delays (6). While these findings must be confirmed in a larger population, it suggests that a noncontrast TIA protocol may be feasible.

**References**

**Key Words:** Transient ischemic attack, MR imaging, perfusion

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**Infarct Location Matters: Evidence for a Neuroanatomical Basis of Stroke-Related Hospital-Acquired Pneumonia**

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**Purpose**
Hospital-acquired pneumonia (HAP) is a major complication of stroke. Presently, only infarction volume has been associated with poststroke infection. Recent neuroanatomical correlation suggests infarction in specific brain regions is associated with neurocardiac injury. The purpose of this study was to identify specific brain regions of acute infarction that are linked independently to hospital-acquired pneumonia (HAP).

**Materials & Methods**
A matched cases control study was conducted in 215 randomly sampled acute stroke patients with HAP matched with nonpneumonia control subjects based on sex, then NIH stroke scale, then age. Subacute ischemic brain lesions were outlined on a slice-by-slice basis in early MRI-DWI or CT stroke images (target of 48 hours after symptom onset). Original images and binary masks of infarction were coregistered automatically to standard MNI-152 brain (T1-2 mm) using FLIRT and manually corrected for coregistration errors using ANALYZE. Percentage of infarction in standardized brain regions in HAP-stroke and control cases was calculated using an MNI-152 template of the Harvard-Oxford cortical and subcortical structural atlases (HO) and JHU white-matter atlas (JHU). Stepwise binary logistic regression analysis was used to identify regression coefficients for each brain region independently correlated with HAP.

**Results**
Regions with highest positive (> 5.0) and negative (< -5.0) regression coefficients were identified in the HO atlas: Intracalcarine Cortex R (8.5), Cingulate Gyrus - posterior division L (7.5), Subcallosal Cortex L (5.7), Lingual Gyrus.
L (5.7), Paracingulate Gyrus L (5.6), Frontal Medial Cortex L (-9.7), Supracalcarine Cortex R (-9.0), Cingulate Gyrus - anterior division L (-8.3), Temporal Fusiform Cortex - anterior division L (-6.7). Figure depicts the regions of the probabilistic HO atlas with positively associated risk for pneumonia.

CONCLUSION
The anatomical pattern of acute stroke lesions is different between cases with and without HAP. There are distinct brain regions, which are associated independently with hospital-acquired pneumonia. This knowledge of anatomical association is of clinical interest and warrants further analysis since acute stroke patients at risk for hospital-acquired pneumonia may be identified.

KEY WORDS: Stroke, pneumonia, anatomy

Paper 29 Starting at 11:57 AM, Ending at 12:05 PM
Quantitative MR Perfusion and Cerebral Vasospasm after Aneurysmal Subarachnoid Hemorrhage

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PURPOSE
Cerebral vasospasm following aneurysmal subarachnoid hemorrhage continues to be a source of morbidity and mortality after rupture. Early detection of vasospasm, its location and severity are important considerations for proper patient selection for intervention. Unfortunately, the currently available methods for detecting cerebral vasospasm are unreliable, nonquantitative or too invasive for routine use. We hypothesize that quantitative MR perfusion (qMRP) imaging using post-Gd T1 changes can detect, quantify, and direct therapy for cerebral vasospasm following aneurysmal subarachnoid hemorrhage.

MATERIALS & METHODS
Eight aneurysmal subarachnoid patients were followed for vasospasm using a 1.5 T MR scanner (Avanto, Sienans AG Healthcare Sector, Erlangen, Germany) with GRE-EPI perfusion sequences. Images were acquired using a single-dose injections of Gd-DTPA (0.1 mmol/kg b.w.), each time at a rate of 4ml/s. Quantification of qMRP was calculated using post-Gd T1 changes and the “Bookend” technique.

RESULTS
The presence of cerebral vasospasm seen on qMRP imaging correlated with the timing of the flow velocity spikes as determined by transcranial doppler measurements. Furthermore, quantitative changes in the mean transit time (MTT) were the most correlative with the degree and location of vasospasm as seen during subsequent angiography with a mean difference of 3 seconds between areas with and without spasm. Finally, postprocedural qMRP imaging showed normalization of MTT consistent with improvement of perfusion.

CONCLUSION
This report demonstrates supportive data for qMRP imaging using post-Gd T1 changes in the detection of cerebral vasospasm following aneurysmal subarachnoid hemorrhage. Quantitative MR perfusion, in addition to its noninvasive nature, short sequence acquisition time, and lack of radiation exposure makes this an attractive modality for use in this setting. Further analysis is required to establish the reproducibility, feasibility and practicality of this imaging modality.

KEY WORDS: Vasospasm, SAH, MR perfusion
Identification of Hemorrhagic Transformation in Acute Ischemic Stroke Using DCE-MR Imaging: Model-Based Permeability Estimates vs Model-Free Initial Area under the Curve Measures

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PURPOSE
Permeability imaging with dynamic contrast-enhanced (DCE) MR imaging can delineate areas of blood-brain barrier (BBB) disruption and thereby identify patients at increased risk of rtPA-related hemorrhagic transformation (HT) (1). However, successful estimation of BBB permeability requires the measurement of an arterial input function (AIF) and pharmacokinetic modeling. MODEL-free methods such as the initial area under the contrast-concentration curve (IAUC) may provide robust and convenient alternatives (2). However, the physiologic salience of IAUC is unclear (3) and, to the best of our knowledge, has not been investigated in AIS. Our purpose was to determine whether IAUC can identify HT and to assess its relationship with model-based permeability estimates.

MATERIALS & METHODS
Twenty-nine patients with a working diagnosis of AIS were examined <6 hours of symptom onset. MR imaging was performed on a 1.5 T clinical MR system. Dynamic contrast-enhanced MR imaging with a 3D-GRE sequence was performed as part of an AIS protocol (1). Gadodiamide was injected as a bolus (0.1 mmol/kg) following initiation of the 3D-GRE sequence. Hemorrhagic transformation was determined by follow-up CT and/or MR imaging 24-72 hours after initial imaging. Data were analyzed offline. Two tissue regions of interest (ROIs) were defined on diffusion-weighted images, one within the infarct core and another within the homologous location in the contralateral hemisphere. Regions of interest then were copied to the equivalent 3D-GRE slices. We calculated the IAUC corresponding to the area under the signal-intensity curve (IAUCinf and IAUCcontra) from \( t = 0-90 \) s. An AIF was selected from within the sagittal sinus. Mean permeability coefficients (KPS) were calculated (1) for infarct and contralateral ROIs. Mean permeability coefficients and \( \frac{IAUC_{inf}}{IAUC_{contra}} \) values were grouped according to HT and rtPA treatment and compared using Student’s t-tests. The relationship between KPS and \( \frac{IAUC_{inf}}{IAUC_{contra}} \) was investigated using linear regression.

RESULTS
Thirteen out of 29 patients proceeded to HT, including six who received IV-rtPA. The mean ± SD for both KPS and \( \frac{IAUC_{inf}}{IAUC_{contra}} \) ratios are provided in Figure 1. The mean KPS obtained from HT patients was increased significantly. Conversely, there was a trend toward decreased \( \frac{IAUC_{inf}}{IAUC_{contra}} \) ratio detected in patients who proceeded to HT. Meanwhile, the mean KPS and \( \frac{IAUC_{inf}}{IAUC_{contra}} \) were both elevated in patients treated with rtPA. There was no significant correlation between KPS and \( \frac{IAUC_{inf}}{IAUC_{contra}} \) (r = 0.17, P = 0.39).

CONCLUSION
Only KPS successfully delineated HT from non-HT infarcts. Considering the lack of correlation between KPS and \( \frac{IAUC_{inf}}{IAUC_{contra}} \), it is unlikely that IAUC reflects BBB permeability in this group of AIS patients.

REFERENCES
2. Eveloch JL. JMRI 1999;10:254

KEY WORDS: MR imaging, permeability, hemorrhagic transformation

Comparison of Baseline ASPECTS and Absolute Lesion Volume on Diffusion-Weighted Imaging for Predicting Symptomatic Hemorrhagic Transformation of Acute MCA Stroke

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1New York University Langone Medical Center, New York, NY, 2New York Presbyterian Hospital, New York, NY, 3Weill-Cornell Medical College, New York, NY

PURPOSE
A cute infarct volume on diffusion-weighted imaging (DWI) recently has been shown to be a predictor of symptomatic hemorrhagic transformation (SICH) and poor functional outcome irrespective of reperfusion. The Alberta Stroke Program Early CT Score (ASPECTS) is a fast, reliable, alternative method of describing MCA infarct extent. Our aim was to determine if the acute ASPECTS on DWI (DWI-ASPECTS) can predict SICH and to compare its utility with absolute DWI-lesion volume.

MATERIALS & METHODS
This was a retrospective study of patients with acute nonlacunar MCA strokes presenting < 12 hours from symptom onset, and were evaluated with DWI at baseline. Two observers blinded to clinical and follow-up data assigned ASPECTS to DWI using the conventional 10-point negative ordinal scale. DWI-lesion volume was measured using a
semiautomated thresholding technique to segment the lesion based on signal intensity > 3 standard deviations of the mean intensity of the contralateral hemisphere. Clinical data, including the NIH Stroke Scale (NIHSS) score and thrombolytic treatment, were collected. Hemorrhagic transformation (HT) was sought on follow-up CT or MR imaging according to the ECASS II trial criteria. Symptomatic hemorrhagic transformation was deemed present if the temporal appearance of HT was associated with > 4 point increase in NIHSS. Univariate logistic regression analysis was performed for all baseline variables. Those with p-value < 0.05 were entered into a multivariate stepwise logistic regression model to determine independent predictors; DWI-ASPECTS and DWI-lesion volume were entered into the model separately. Receiver operating characteristics curve (ROC) analyses for DWI-ASPECTS and DWI-lesion volume were performed to obtain optimal thresholds and detection rates.

**RESULTS**

Fifty-four patients were included, with median (interquartile range) time from stroke onset to DWI of 6 (3-7.9) hours and NIHSS score of 9 (3-14). Median DWI-ASPECTS was 8 (7-9) and DWI-lesion volume was 13.8 (5.9-29.2) mL. Six (11.1%) patients received iv tPA, 2 (3.7%) received endovascular therapy. Seventeen (31.5%) patients showed HT on follow-up imaging (9 hemorrhagic infarctions, 8 parenchymal hematomas), of which four were deemed SICH (all parenchymal hematomas). Univariate analysis revealed NIHSS score [OR = 1.67 (95% CI: 1.12-2.49), p = 0.012], tPA [OR = 9.00 (1.03-78.6), p = 0.047], DWI-ASPECTS [OR = 0.46 (0.27-0.79), p = 0.005], and DWI-lesion volume [OR = 1.04 (1.01-1.07), p = 0.014] as being associated with SICH. On multivariate analysis, only DWI-ASPECTS and DWI-lesion volume were significant predictors. Receiver operating characteristic analyses showed area under the curve for DWI-ASPECTS and DWI-lesion volume as 0.95 (0.85-0.99) and 0.96 (0.87-0.99), respectively. The optimal DWI-ASPECTS threshold was ≤ 6 with sensitivity, specificity, +PV, and -PV of 100%, 86%, 36.4%, and 100%, respectively. The optimal DWI-lesion volume threshold was > 68.9 mL with sensitivity, specificity, +PV, and -PV of 100%, 92%, 50%, and 100%, respectively. There was no significant difference between the areas of the two ROC curves (p = 0.83).

**Conclusion**

In a retrospective cohort of acute MCA strokes imaged < 12 hours from onset with DWI, both DWI-ASPECTS and DWI-lesion volume are comparable in predicting SICH with high negative predictive value. Optimal ASPECTS and volume thresholds are ≤ 6 and > 70 mL, respectively.

**Key Words:** Diffusion-weighted imaging, Alberta Stroke Program Early CT Score, hemorrhagic transformation

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**Paper 32 Starting at 12:21 PM, Ending at 12:29 PM**

**Susceptibility-Weighted Imaging in Acute Ischemic Stroke**

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**Purpose**

The authors have demonstrated previously in a rodent animal model that reversible signal loss within venous vascular on so called “susceptibility-weighted imaging” within ischemic tissue imaged 1 hour into middle cerebral artery occlusion corresponds to regions of hypoxia on immunohistochemical staining. This signal loss presumably is produced by susceptibility effects derived from greater concentrations of deoxy-hemoglobin. The small case series presented here describes imaging findings on susceptibility-weighted imaging in the setting of acute ischemic stroke in humans.

**Materials & Methods**

Six patients with acute middle cerebral artery territory stroke, underwent acute ischemic stroke MR imaging (Siemens 3 T Trio) for potential treatment. Imaging included diffusion-weighted imaging with corresponding apparent diffusion coefficient (ADC) maps, perfusion-weighted imaging with corresponding mean transit time (MTT) maps and susceptibility-weighted imaging. Images were reviewed for visibility of venous vasculature relative to the uninvolved territory. Signal intensity within the ischemic zone identified on MTT maps was compared to that of the corresponding contralateral brain.

**Results**

Comparison of ADC with MTT maps indicated that three had large diffusion perfusion mismatches and three had small diffusion perfusion mismatch. Loss of signal within the medullary draining veins and cortical draining veins resulted in greater visibility of these vascular structures in all six cases in the ischemic territory (Figure). Mean signal intensity on SWI within the ischemic territory was similar to the corresponding normal hemispheric territory. Territories with increased visibility of venous vasculature corresponded to delayed MTT and were larger than areas of restricted diffusion on ADC maps (Figure).

![Figure](image)

**Conclusion**

Preliminary evidence indicates that visibility of venous vas-
cultural on susceptibility-weighted images, is greater in the ischemic zone than in the normal brain and is similar in extent when compared to mean transit time maps. Presumably these effects are an indirect indication of tissue hypoxia.

**Key Words:** Acute ischemic stroke, susceptibility-weighted imaging, hypoxia

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**Paper 32a Starting at 12:29 PM, Ending at 12:37 PM**

Detection of Chronic Hemorrhage with Iron Deposition in Neuro-Behçet Syndrome by Using Susceptibility-Weighted Imaging

Albayram, S.1 · Saip, S.1 · Teke, M.2 · Isik, Z.1 · Kantarcı, F.1 · Kın, A.1 · Tutuncu, M.1 · Özer, H.1 · Selçuk, H.1 · Siva, A.1
1 Cerrahpasa Medical School, Istanbul, TURKEY, 2 Taksim Government Hospital, Istanbul, TURKEY, 3 University of Virginia Health System, Charlottesville, VA, 4 Bakırköy Sadi Konuk Hospital, Istanbul, TURKEY

**Purpose**
The objective is to investigate chronic hemorrhage with iron deposition in brain parenchymal lesions with susceptibility-weighted imaging (SWI) in Neuro-Behçet syndrome.

**Materials & Methods**
Twenty patients with definitive diagnosis of Neuro-Behçet syndrome underwent brain MR imaging including following protocols: pre and postcontrast T1-weighted, T2-weighted, FLAIR, T2-weighted gradient-echo (GRE) and susceptibility-weighted imaging at 1.5 T MR unit. The parenchymal lesions of Neuro-Behçet syndrome were identified on each imaging sequence and each sequence was reviewed separately.

**Results**
There were 12 male patients and eight were females. The mean age ± standard deviation was 37.3 ± 8.07 years. Conventional T2-weighted sequences detected 14 parenchymal lesions in 20 patients. T2-weighted GRE imaging depicted an additional lesion (15 lesions). The SWI demonstrated 21 parenchymal lesions in 20 patients. The SWI detected nine hemorrhagic lesions which were not detected by conventional T2-weighted sequences. Also eight of these lesions also were not seen in T2-weighted GRE imaging. Two lesions seen on conventional and GRE imaging were not seen clearly on SWI. Iron deposits due to hemorrhage were seen only in one (4%) lesion in T2-weighted imaging and three (13%) lesions in T2-weighted GRE images. However, iron deposits were detected in 20 lesions on SWI (87%). Additionally, prominent venous structures were seen adjacent to iron depositing lesions in four lesions.

**Conclusion**
Susceptibility-weighted imaging showed additional lesions that were not visible on conventional methods including T2-weighted GRE sequence. The venous system involvement which is believed to be the etiology of Neuro-Behçet syndrome was substantiated in this study by demonstrating hemorrhagic iron deposits in the majority of the parenchymal lesions. Additionally, SWI is definitely better technique to delineate the extent of parenchymal involvement in Neuro-Behçet syndrome.

**Key Words:** Neuro-Behçet, susceptibility-weighted imaging, iron deposition

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**Monday Morning**

10:45 AM - 12:30 PM
Room 311

(4c) Trauma: Adult Brain and Spine
(Scientific Papers 33 - 45)

See also Parallel Sessions
(4a) Adult Brain: New Techniques/Postprocessing
(4b) Adult Brain: Cerebrovascular Occlusive Disease I
(4d) Pediatric: Neoplasms and Cerebrovascular
(4e) Excerpta Extraordinaire: Head and Neck

**Moderators:** Nafi Aygun, MD
Madja M. Thurnher, MD

**Paper 33 Starting at 10:45 AM, Ending at 10:53 AM**

Diffusion Tensor Imaging and Tractography of Traumatic Brachial Plexus Palsies: Preliminary Experience

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Brescia, ITALY

**Purpose**
In traumatic injuries of the brachial plexus the preoperative assessment of nerve root avulsions is essential for surgical planning. In the diagnostic workup MR myelography has almost completely replaced CT myelography as the first choice examination. To our knowledge there are no reports on the application of diffusion tensor imaging to the study of traumatic brachial plexus palsies. Evaluation of the clinical feasibility of diffusion tensor tractography of the brachial plexus in a selected population of patients with traumatic brachial plexus injuries.

**Materials & Methods**
Ten patients (8 males, 2 females, mean age 27.4 years, range 16-52 years) with traumatic brachial plexus palsies (6 left, 4 right) have been examined with 1.5 T scanner (Siemens, Avanto) with the following imaging protocol: a) 3D MR myelography (3DMRM) with multiplanar reconstructions along the course of cervical nerve roots (3D T2 fast spin echo sequences, 0.7 mm isotropic voxel), b) 3D T2 STIR SPACE sequences (TR 2000, TE 149, TI 160, 1 mm isotropic voxel), C) DTI (64 contiguous axial sections from C3 to T2, TR 9200 TE 90, 12 directions, 2.2 mm isotropic voxel, 5 runs, peripheral triggering, FOV 250 mm). Diffusion tensor
image data were preprocessed coregistering every single direction of each run with the first b0 and corrected for eddy currents with FSL (FMRIB Software Library; Oxford, UK) FDT tool. Tractography of the brachial plexus and cervical spinal cord was obtained placing multiple 3D ROIs along the extrafornaminal course of C5-T1 nerve roots on MPR reformatted b0 coronal images. Nerve root avulsions were defined on M R tractography on the basis of a loss of continuity with the spinal cord fibers. Brachial plexus tractography diagnostic accuracy was assessed comparing it with 3D M R findings on a per root basis on 100 nerve roots.

RESULTS
Three-dimensional M R M detected 18 avulsed nerve roots and 32 intact roots on the injured side. Brachial plexus tractography had 94% sensitivity, 87% specificity, 60% PPV and 98% NPV compared to 3DM R M, with 1 false negative and 12 false positives. The relatively elevated false positive rate is mainly related to the evaluation of C8-T1 nerve roots, which are displayed in a suboptimal way, due to their anatomical course adjacent to bone.

CONCLUSION
Diffusion tensor tractography is a cutting-edge technique for studying peripheral nerves, which cannot be performed as readily and reliably in the spinal cord and brachial plexus for technical and anatomical reasons such as pulsation artifacts, motion of organs in the thorax and large number of longitudinal fibers. Compared to 3DM R M brachial plexus tractography is characterized by an elevated diagnostic accuracy in the assessment of nerve root avulsions, which can be displayed easily as loss of continuity with spinal cord fibers. Although D T I of the brachial plexus is still an experimental technique which needs further testing in order to produce meaningful clinical results, our preliminary experience suggests its promising role in the assessment of nerve continuity in traumatic injuries of the brachial plexus.

KEY WORDS: Brachial plexus, trauma, diffusion tensor imaging

Paper 34 Starting at 10:53 AM, Ending at 11:01 AM
Longitudinal Analysis of M R Imaging Characteristics in Experimental Model of Cauda Equina Injury

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PURPOSE
To determine characteristic M R imaging features following nerve avulsion and reimplantation of cauda equina nerves using an experimental nonhuman primate model.

MATERIALS & METHODS
We present a primate cauda equina injury model in which the ventral lumbosacral roots (L6-S2) were unilaterally avulsed from the conus medularis (n = 8) followed by immediate reimplantation of the avulsed roots into the ipsilateral lateral funiculus (n = 3), or using an intercostal nerve graft (n = 5). Preoperative lumbar M R imaging at 1.5 T was performed to guide surgical planning, determine the exact level and positions of the lumbosacral nerves, and obtain basal signal intensity and enhancement values. Postoperative imaging was performed at 1, 3, 6, 12, 24, 48, and 72 weeks postoperatively. An identification of each lesioned ventral root by M R imaging was made from the intradural course of each nerve root to the intervertebral foramen. The target parameters included the lumbosacral nerve cross-sectional area on both axial T2- and T1-weighted postcontrast sequences, axial T2-weighted nerve signal intensity, and degree of nerve enhancement on axial T1-weighted postgadolinium sequences. All measures were obtained by two independent blinded readers. Left to right nerve differences were evaluated using a two-tailed t-test and the Wilcoxon Ranked test.

RESULTS
We identified distinct time-dependent changes in M R imaging nerve signal intensity, size, and gadolinium enhancement when comparing affected to contralateral control nerves (Figure 1). We demonstrate a time-dependent wave-form pattern with a sharp early increase in the ventral root ratio for T1 postgadolinium, and for T2 area between the avulsed and intact sides ranging between 2 - 2.2 and peaking at 6 weeks postoperatively, followed by a gradual normalization at 18 months postoperatively. Measurements of the T1 postgadolinium signal intensity revealed a similar time-dependent wave-form with enhancement peaking at only 3 weeks after the procedure, and a left to right difference ranging from 1.2 -1.3, and normalizing by 3 months postoperatively. The intraoperative and interoperative reliability values for the cross-sectional area were 0.923 and 0.903 and for signal intensity were 0.802 and 0.790, respectively.

CONCLUSION
M R imaging is able to detect longitudinal changes in cross-sectional area and enhancement of avulsed and reimplanted ventral nerve roots. Changes in cross-sectional area were more dramatic with later onset and normalization interval, as compared to nerve enhancement, which peaked and normalized earlier, and was less pronounced. Work is currently underway to correlate these M R features with histopathologic and ethologic studies in the same population.
REFERENCES


KEY WORDS: Cauda equina injury, MR imaging, spinal nerve root graft

RESULTS

We identified significant differences in cross-sectional area for the majority of the affected nerve roots. Table 1 lists the proportion of nerve roots with statistically significant differences vs their contralateral controls at each scan period.

<table>
<thead>
<tr>
<th>R/L Parameter compared</th>
<th>Group#</th>
<th>Days Postoperative</th>
<th>0</th>
<th>7</th>
<th>21</th>
<th>50</th>
<th>100</th>
<th>180</th>
<th>360</th>
<th>540</th>
</tr>
</thead>
<tbody>
<tr>
<td>Area</td>
<td></td>
<td>Enhancement</td>
<td>0</td>
<td>n/a</td>
<td>n/a</td>
<td>75%</td>
<td>83%</td>
<td>61%</td>
<td>46%</td>
<td>0%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(1-env)</td>
<td>0%</td>
<td>n/a</td>
<td>n/a</td>
<td>46%</td>
<td>13%</td>
<td>13%</td>
<td>25%</td>
</tr>
<tr>
<td>Area</td>
<td></td>
<td></td>
<td>(2-env)</td>
<td>0%</td>
<td>31%</td>
<td>66%</td>
<td>73%</td>
<td>47%</td>
<td>38%</td>
<td>n/a</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(2-env)</td>
<td>5%</td>
<td>3%</td>
<td>31%</td>
<td>8%</td>
<td>28%</td>
<td>19%</td>
<td>25%</td>
</tr>
</tbody>
</table>

The experiment uses MR imaging as a tool to identify and localize spinal nerve root injury. This tool allows us to access the effect of graft materials in direct implantation of the avulsed spinal nerve roots. Our results indicate that, beyond 50 days, the number of nerves with statistically significant differences in enhancement is larger for grafted vs nongrafted nerves. We also observed that beyond 50 days a larger proportion of nongrafted nerves demonstrate a statistically significant difference in cross-sectional area vs grafted nerves.

CONCLUSION

Our results suggest that longitudinal quantitative MR imaging can be used to detect and characterize differences in nerve cross-sectional area and enhancement patterns when comparing subjects with and without intercostal nerve grafts following experimental lumbar sacral nerve root avulsion and reimplantation.

REFERENCES


KEY WORDS: Cauda equina injury, MR imaging, spinal nerve root graft

PAPER 35 Starting at 11:01 AM, Ending at 11:09 AM

Experimental Longitudinal MR Imaging of Cauda Equina Injury Model: Impact of Graft Interposition

Obukhoff, D.1 • Samim, M. M.1 • Nieto, J. H.1,2 • Ohlsson, M.1,3 • Sayre, J. W.1 • Christe, K. L.1 • Havton, L. A.1,2 • Villablanca, J. P.1

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PURPOSE

To compare MR imaging characteristics of lumbosacral nerve roots with and without intercostal nerve graft following nerve root avulsion and reimplantation.

MATERIALS & METHODS

We performed two models of cauda equina injury. One primate model (n = 3) had S2, S1, L7, L6 and L5 lumbosacral ventral roots unilaterally avulsed and immediately reimplanted directly into the ipsilateral lateral funiculus. In a second model, (n = 5) we performed the above reimplantation using an intercostal nerve graft. The subjects underwent preoperative scans using a 1.5 T scanner and T1 postgadolinium and T2 noncontrast sequences to guide surgical planning and to obtain basal signal intensity and enhancement values. Postoperative imaging was performed at week 1, 3, 6, 12, 26, 52, and 78 weeks postoperative MRI imaging. Using the full-width half maximum technique, the cross-sectional area and signal intensity was measured for each of the affected and unaffected contralateral nerve roots by two independent blinded readers. Each affected and contralateral control nerve root was measured four times in cross section to obtain a nerve mean. All measures were obtained two or more vertebral levels away from the surgery site. Changes in cross-sectional area and intensity of the nerve roots were tabulated. Left to right nerve differences were evaluated using two-tailed t-test and Wilcoxon Ranked test

RESULTS


KEY WORDS: Cauda equina injury, MR imaging, spinal nerve root graft
Paper 36 Starting at 11:09 AM, Ending at 11:17 AM
Experimental MR Imaging of Cauda Equina Injury Model: Initial Feasibility

Obukhoff, D.1 · Samim, M. M.1 · Nieto, J. H.2 · Ohlsson, M.3 · Sayre, J. W.1 · Christe, K. L.4 · Havton, L. A.1 · Villablanca, J. P.1
1David Geffen School of Medicine, University of California, Los Angeles, Los Angeles, CA, 2Maimonides Medical Center, New York, NY, 3Karolinska Hospital, Stockholm, Sweden, 4University of California, Davis, Davis, CA

Purpose
To determine feasibility and initial MR imaging characteristics of cauda equina nerve roots in a primate model following nerve root avulsion and reimplantation.

Materials & Methods
We performed two models of cauda equina injury. One primate model (n = 3) had S2, S1, L7, L6 and L5 lumbar-sacral ventral roots unilaterally avulsed and immediately reimplanted directly into the lateral funiculus. In a second model (n = 5) we performed the above reimplantation using an intercostal nerve graft. The subjects underwent preoperative scans using a 1.5 T scanner and T1 postgadolinium and T2 noncontrast sequences to guide surgical planning and to obtain basal signal intensity and enhancement values. Postoperative imaging was performed at week 1, 3, 6, 12, 26, 52, and 78 weeks postoperative MR imaging. Using the full width half maximum technique, the cross-sectional area and signal intensity were measured for each of the affected and unaffected contralateral nerve roots by two independent blinded readers. Each affected and contralateral control nerve root was measured four times in cross-section. All measures were obtained two or more vertebral levels away from the surgery site. Changes in cross-sectional area of the nerve roots and intensity of the nerve roots were tabulated. Left to right nerve differences were evaluated using two-tailed t test and Wilcoxon Ranked test.

Results
MR imaging was performed successfully in all eight animals. The intraoperator and interoperator reliability values for cross-sectional area comparison were 0.923, and 0.903, and for intensity were 0.802 and 0.790 respectively. We identified statistically significant differences in the mean nerve cross-sectional area on both axial T2 and axial T1 postcontrast sequences in 0%. Differences in nerve enhancement and T2 nerve signal intensity between preoperative and first postoperative scans and between right and left homologous nerve roots postoperatively were statistically significant (25% group 1 and 5% group 2) for the study groups (Figure 1 a and b).

Conclusion
MR imaging at 1.5 T can be used to visualize cauda equina nerve roots in a primate model. MR imaging also can be used to visualize and quantitate changes in nerve cross-sectional area on both axial T2 and axial T1 post contrast sequences following nerve root avulsion and reimplantation.

References

Key Words: Cauda equina injury, MR imaging, spinal nerve root graft

Paper 37 Starting at 11:17 AM, Ending at 11:25 AM

Etesami, M.1 · Gujar, S. K.1 · Nidecker, A. E.3 · Portanova, A.2 · Abdalla, W. M. A.2 · Qiao, Y.1 · Steinman, D. A.3 · Astor, B. C.4 · Wasserman, B. A.1
1Johns Hopkins University School of Medicine, Baltimore, MD, 2University of Rochester Medical Center, Rochester, NY, 3University of Toronto, Toronto, ON, Canada, 4Johns Hopkins Bloomberg School of Public Health, Baltimore, MD

Purpose
Ulceration in carotid plaque is a risk indicator for ischemic stroke. Time-of-flight (TOF) and contrast-enhanced (CE) MR angiography (MRA) are the most commonly employed MRA techniques; however, the best approach for detecting ulceration by MRA has not been established and is the aim of our study. Although TOF-MRA is generally acquired at higher resolution, enhancing its ability to detect small ulcers, it is prone to signal loss from saturation of protons recirculating within the crater.

Materials & Methods
Carotid M R scans were acquired on 2066 participants in the Atherosclerosis Risk in Communities (ARIC) study. We studied 600 of these cases with the thickest plaques. For each case, we evaluated TOF-MRA, CE-MRA and black blood images of the carotid side that had the thicker plaque. An
ulcer was defined as a breach in the plaque surface \( \geq 2 \) mm depth. A total of 78 ulcers in 60 carotid arteries were detected, and these arteries were assigned randomly, along with 40 nonulcerated arteries, to be evaluated for ulcer presence by two neuroradiologists blinded to the study objectives. CE and TOF MRAs of each artery were assigned randomly in separate sessions. Reader reliability was estimated using ten repeat readings separated by \( > 3 \) weeks by \( \kappa \) statistics.

**RESULTS**

Reader 1 detected 76 ulcers, 48 (63%) on both TOF-MRA and CE-MRA, 26 (34%) only on CE-MRA, and two (3%) only on TOF-MRA, missing two of 78 (3%) ulcers by both methods. Reader 2 detected 68 ulcers, 32 (47%) on both TOF-MRA and CE-MRA, 32 (47%) only on CE-MRA, and four (6%) only on TOF-MRA, missing 10 of 78 (13%) ulcers by both methods. Intraobserver reliability for CE-MRA was excellent for both readers (\( \kappa =1.00 \) and \( \kappa = 0.8 \) for readers 1 and 2, respectively). Intraobserver reliability for TOF-MRA was excellent (\( \kappa = 1.00 \)) for reader 1 and good (\( \kappa = 0.60 \)) for reader 2. Interobserver reliability was excellent (\( \kappa = 0.89 \)) for CE-MRA and good (\( \kappa = 0.56 \)) for TOF-MRA. Missing ulcers on CE-MRA could be explained by motion artifact on CE-MRA and good (\( \kappa = 0.60 \)) for TOF-MRA. Missing ulcers by both methods. Intraobserver reliability for CE-MRA was excellent for both readers (\( \kappa =1.00 \) and \( \kappa = 0.8 \) for readers 1 and 2, respectively). Intraobserver reliability for TOF-MRA was excellent (\( \kappa = 1.00 \)) for reader 1 and good (\( \kappa = 0.60 \)) for reader 2. Interobserver reliability was excellent (\( \kappa = 0.89 \)) for CE-MRA and good (\( \kappa = 0.56 \)) for TOF-MRA. Missing ulcers on CE-MRA could be explained by motion artifact on CE-MRA and good (\( \kappa = 0.60 \)) for TOF-MRA. Missing ulcers on both TOF-MRA and CE-MRA were noted to have a different geometry and orientation than those detected by TOF-MRA.

**CONCLUSION**

Contrast-enhanced MRA misses fewer ulcers than TOF-MRA in carotid artery plaques when image quality is adequate. Time-of-flight MRA misses may depend on ulcer geometry and orientation.

**KEY WORDS:** Ulcer, MR angiography, carotid artery

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**Paper 38 Starting at 11:25 AM, Ending at 11:33 AM**

**Detection of High-Risk Cervical Carotid Plaques Using Clinical MR Angiographic Protocols: Beyond NASCET Criteria**

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**PURPOSE**

Although NASCET criteria is mandated as a part of pay for performance (P4P) initiatives, atherosclerotic plaque begins developing at the wall of the carotid artery without narrowing its lumen. It has been suggested that plaque morphology may represent an important determinant of stroke risk, even in the absence of significant luminal stenosis. It has been well documented that irregular carotid plaques with a large necrotic core are associated with an increased risk for plaque rupture and subsequent stroke. Detailed evaluation of carotid plaque morphology is reported only with highly specialized coils and dedicated imaging protocols, which may not be feasible for routine clinical practice. In this retrospective study, we sought to assess the feasibility of detecting high-risk carotid plaques using routine clinical MRA sequences.

**MATERIALS & METHODS**

Patients who presented with acute stroke symptoms that had both head CT and brain MR imaging within 48 hours were identified on Radiology Information System. Patients with no acute stroke on DWI, acute stroke in the posterior circulation, and embolic stroke were excluded. Twenty-six patients with anterior circulation stroke were enrolled in this study. All patients underwent MRA on a clinical 3 T scanner using a neurovascular coil. The following imaging sequences were obtained: axial 2D TOF, axial PD fat suppressed images, and 3D post gadolinium bolus. Each cervical carotid artery was evaluated for the presence of plaque and graded as follows: 0) normal, 1) mild luminal irregularity, 2) focal wall thickening, 3) eccentric focal plaque, 4) concentric plaque with high-grade narrowing, 5) complete occlusion. The imaging evaluation was performed on 52 vessels in 26 subjects, and the data were correlated with the side of acute stroke.

**RESULTS**

Of the 26 carotid arteries on the side of acute stroke, only seven had a high-grade stenosis by NASCET criteria (> 70% stenosis). Of the remaining 19 patients, nine had a focal low-grade lesion (grade 1-3) on the side of the stroke. Of the other 26 carotid arteries contralateral to acute stroke, 12 had a lesion with grade 1-3, and 14 had no detectible abnormality. The average grading score was 2.04 +/- 1.9 for disease and 1.00 +/- 1.23 for the control side. The area under the ROC curve showed 0.65 using the carotid plaque classification, and 0.64 using NASCET criteria. Fat-suppressed PD images provide better delineation of carotid wall morphology than 2D TOF or Gd bolus MRA.

**CONCLUSION**

This study demonstrates that focal atherosclerotic plaque lesions in the cervical internal carotid artery can be seen in a routine neck MRA, particularly using fat-suppressed proton density images. In addition to high degree of concentric stenosis, focal eccentric plaque is seen more frequently in the internal carotid artery with recent stroke. Diagnostic performance of carotid wall analysis is equally valuable as NASCET criteria using ROC curve analysis. Further evaluation is necessary to determine the predictive value of the carotid plaque morphology.

**KEY WORDS:** Stroke, carotid, MRA

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**Paper 39 Starting at 11:33 AM, Ending at 11:41 AM**

**Identification of Skull Base Internal Carotid Artery Dissection on Routine Head CT**

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Royal Oak, MI

**PURPOSE**

Internal carotid artery (ICA) dissection is an important cause of morbidity and mortality in relatively young patients. Although characteristic facial pain, ipsilateral headache, and Horner’s syndrome may suggest the diagnosis, patients may present with more nonspecific headache or stroke symptoms. In these cases, the patient’s initial imaging is often a routine head CT. CT or MR angiography may be delayed or never performed. At our institution, we have noted several patients with skull base dissections that were retrospectively apparent on preceding head CT, with crescentic hyperdensity and vascular enlargement. Noncontrast head CT is often part of
CT angiography protocols, with increased outer diameter indicating intramural hematoma (1), but we are unaware of any recent studies addressing findings of dissection on routine head CT scans performed independently. Our study assesses the ability to prospectively identify skull base ICA dissections on routine head CT. We hypothesize that increased attention to this area may permit earlier diagnosis of unsuspected dissections.

**Materials & Methods**

Reports from all MRA examinations of the neck from January 2006 through October 2009 were reviewed, in order to identify patients with distal ICA dissections (including those that extended from the proximal carotid). Patients who had a head CT in the 14 days preceding this diagnosis were included. Twenty-four additional consecutive patients were identified as controls, who similarly had undergone head CT followed by neck MRA, but whose MRA did not demonstrate evidence of dissection. Some vessels were excluded due to technically inadequate CT examination. In total, the series consisted of 29 dissected vessels and 66 controls (inclusive of normal contralateral vessels in cases of unilateral dissection). Each case was reviewed by a blinded, experienced neuroradiologist. Each vessel was subjectively graded as negative, equivocal, or positive with regard to hyperdensity, increased external diameter, and overall impression/suspicion for dissection.

**Results**

In total, 19 vessels were considered positive for dissection, 72 negative (including 7 false negatives), and four equivocal (including 3 dissected vessels and 1 control). When equivocal vessels are considered positive, 75.8% sensitivity and 98.4% specificity were achieved. When equivocal impressions are considered negative, 65.5% sensitivity and 100% specificity were achieved. In vessels with dissection, hyperdensity was seen in 15/29 cases and was not considered equivocal in any cases. Increased external diameter was seen in 21/29 dissection cases and was equivocal in one. In control vessels, hyperdensity was seen in 9/66 cases, was equivocal in four. Increased external diameter was described in one control vessel and was equivocal in six.

**Conclusion**

Our findings demonstrate surprisingly high sensitivity and specificity for detection and exclusion of distal/skull base ICA dissection. Increased attention to the appearance of the ICA on routine head CT may detect unsuspected dissections, prompting more definitive evaluation with MRA or CTA and ultimately leading to earlier diagnosis.

**References**


**Key Words:** Carotid dissection, computed tomography

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**Paper 40 Starting at 11:41 AM, Ending at 11:49 AM**

**Reproducibility of Semiautomated Vessel Analysis Software in the Measurement of Carotid Artery Stenosis on CT Angiography**

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University of Toronto

**Purpose**

To compare the reproducibility of semiautomated vessel analysis software to manual measurement of carotid artery stenosis on CT angiography (CTA).

**Materials & Methods**

Two observers separately analyzed 81 carotid artery CTA s using semiautomated vessel analysis software (GE Advantage Workstation, Version 4.2) according to a blinded standardized protocol. The software measured the narrowest stenosis in millimeters (mm), distal internal carotid artery (ICA) in mm, and calculated percent stenosis based on NASCET criteria. One observer performed this task twice on each carotid, the second analysis delayed 2 months in order to mitigate recall bias. Two other observers manually measured the narrowest stenosis in mm, distal ICA in mm, and calculated NASCET percent stenosis in a blinded fashion. Correlation coefficients were calculated for each group comparing the narrowest stenosis in mm, distal ICA in mm, and NASCET percent stenosis.

**Results**

The semiautomated vessel analysis software provided excellent intraobserver correlation for narrowest stenosis in mm, distal ICA in mm, and NASCET percent stenosis (Pearson correlation coefficients of 0.985, 0.954, and 0.977 respectively). The semiautomated vessel analysis software provided excellent interobserver correlation (0.925, 0.881, and 0.892 respectively). The interobserver correlation for manual measurement was good (0.595, 0.625, and 0.555 respectively). There was a statistically significant difference in the interobserver correlation between the semiautomated vessel analysis software observers and the manual measurement observers (P < 0.05).

**Conclusion**

Semiautomated vessel analysis software is a highly reproducible method of quantifying carotid artery stenosis on CTA. In this study, semiautomated vessel analysis software determination of carotid stenosis was shown to be more reproducible than manual measurement.

**Key Words:** Carotid stenosis, CTA, reproducibility
Association of Resting State MEG Functional Connectivity and Visuospatial Attention Performance in Patients with Traumatic Brain Injury

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**Purpose**

Although research in traumatic brain injury (TBI) has studied functional connectivity and found correlations with neurocognitive outcomes (1, 2), the specific relationship between components of cognitive functions and resting state connectivity remains poorly understood. This study investigates performance within three components of visuospatial attention and their association with magnetoencephalographic (MEG) functional connectivity during the “resting state”.

**Materials & Methods**

Sixteen patients with moderate to severe TBI (GCS 3-8) performed the Attention Network Task (ANT), which measures reaction time (RT) in response to visuospatial stimuli targeting three different components of attention (alerting, orienting, and conflict). 275-channel whole-head MEG recordings of spontaneous cortical activity during the resting state were obtained over a 1-minute epoch. A daptive temporal filtering technique was applied to calculate neural activity. The mean imaginary coherence (IC) between paired voxels was used as an index for functional connectivity (3). The ICs across the whole brain in each individual were regressed with the response time (RT) of each component of attention and corrected with FDR at p = 0.05.

**Results**

The mean ICs of the alpha frequency range showed significant correlations with components of attention. The RTs of the conflict component inversely correlated with the ICs in the left middle (Figure) and inferior frontal (r = -0.68, p = 0.004) and the right medial frontal gyri (r = -0.64, p = 0.008). The RTs of the orienting process also negatively correlated with ICs in the midline posterior frontal gyrus (r = -0.71, p = 0.002). However, IC in the midline parietal gyrus positively correlated with the RTs for the alerting process (r = 0.68, p = 0.004).

**Conclusion**

The regions that demonstrated significant correlations in the present study have been reported consistently to be involved in subprocesses of attention (4, 5). This suggests that impaired functional connectivity in the alpha frequency range is associated with visuospatial attentional dysfunction in TBI patients. Since attentional deficits are among the most common cognitive impairments of TBI, MEG functional connectivity deserves further investigation as a potential imaging biomarker for neurocognitive outcome after brain injury.

**References**


**Keywords:** Functional connectivity, magnetoencephalography, TBI

**Regional Analysis of Combined Quantitative 1H MR Spectroscopic Imaging and Diffusion Tensor Imaging in Patients with Mild Traumatic Brain Injury**

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**Purpose**

In patients with mild traumatic brain injury (mTBI), diffusion tensor imaging (DTI) studies have shown decreased white matter fractional anisotropy (FA) (1), while MRS spectroscopic imaging (MRSI) has demonstrated decreased N-acetyl aspartate (NAA) and increased choline (Cho) (2). In this study, we used novel methodology to measure tissue diffusivity along with NAA, creatine (Cr), and Cho metabolite levels in the same anatomical position in mTBI patients following remote (> 30 days) injury. We hypothesized that mTBI patients would show both tissue diffusivity and metabolic abnormalities in the absence of injury determined by anatomical MR imaging.

**Materials & Methods**

MR imaging/MRS data for 13 mTBI patients and eight age-matched controls were acquired on a Siemens Tim Trio 3 T whole body imaging system. Three-dimensional T1-weighted (pixel size = 1mm3) and T2 (pixel size = 0.9 cm3) MR images were acquired for segmentation and MRSI voxel positioning. Diffusion tensor imaging (EPI, TR/TE = 5600/98 ms, 12 directions, slice thickness = 3 mm, NA = 1) and 3D 1H MRSI (PRESS, TR/TE = 1700/144 ms, NA = 1) covering a 9 x 8 x 6 cm volume from the level of the centrum semiovale through the midbrain, were acquired. Fractional anisotropy and diffusion tensor images were generated using DTI studio; NAA/Cr, NAA/Cho and Cho/Cr ratios were determined using LCmodel. Using an in-house designed software incorporating routines from Matlab (version 7.0.4, Mathworks, USA) and SPM 5 (Wellcome Trust Center of Neuroimaging, University College of London), the MRSI grid was overlaid onto the segmented T1 and T2 images and DTI maps. Fractional anisotropy, diffusion tensor, and metabolite ratios were measured in each voxel. An independent samples t-test was employed to determine statistical significance between groups; p < 0.05 was considered significant.
RESULTS
Mild traumatic brain injury subjects showed decreased diffusion tensor in the left parietal white matter (LPW) compared to controls (p = 0.040). The mTBI group also showed significantly increased NAA/Cr (p = 0.010) and NAA/Cho (p = 0.021) in the right occipital white matter, and increased Cho/Cr in the right frontal white matter (p = 0.025) and right parietal white matter (p = 0.042). However, none of these changes appeared in the same voxel.

CONCLUSION
Using 3D MRSI we were able to identify regions of increased Cho/Cr in mTBI patients that suggest axonal injury may persist beyond 30 days after insult to these areas. Moreover, we identified regions of increased NAA/Cr and NAA/Cho that may reflect signs of neuronal repair. In contrast, DTI identified only a single region of diffusion abnormality occurring in the absence of metabolic abnormality. Whether these inconsistencies reflect the continuing action of injury processes or the onset of repair mechanisms remains to be fully elucidated; however, this study suggests that the degree of metabolic dysfunction, rather than anatomical disruption, is more strongly associated with continuing neurocognitive deficits in patients with remote mTBI.

REFERENCES

KEY WORDS: Traumatic brain injury, diffusion tensor imaging, MR spectroscopic imaging

Paper 43 Starting at 12:05 PM, Ending at 12:13 PM
Integrated Magnetoencephalography and Diffusion Tensor Imaging Detect Mild Traumatic Brain Injury
Lee, R. R.,1,2 Huang, M.,1,2 Theilmann, R. J.,1 Robb, A.,1,2 Angeles, A.,1,2 Nichols, S.,1,3 Cui, L.,1,2
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PURPOSE
Traumatic brain injury (TBI) is a leading cause of sustained cognitive deficits in the civilian population, and in military personnel (blast injury). However, conventional neuroimaging techniques have limited sensitivity to the physiologic alterations caused by TBI, and poor utility for predicting long-term outcome. Mild (and some moderate) TBI can be difficult to diagnose because the injuries often are not visible on conventional acute MRI or CT. The present study used an integrated multimodal neuroimaging approach involving magnetoencephalography (MEG) and diffusion tensor imaging (DTI) to test their utility for diagnosing and monitoring mild TBI in military personnel and civilians in whom conventional CT and MRI did not show visible lesions.

MATERIALS & METHODS
Ten patients (age 25.0 +/- 11.5 years, education 12.7 +/- 4.7 years) with mild TBI, and 14 age- and education-matched controls, were studied. Injured brain tissues in TBI patients generate pathologic low-frequency neuronal magnetic signal (delta waves: 1-4 Hz) that can be measured and localized by MEG. Awake, spontaneous MEG activity was recorded continuously for 15 minutes using a 306-channel whole-head MEG system, in a 6-layer magnetically shielded room. Data was preprocessed using Signal Space Separation and independent component analysis, then run through a 1-4 Hz band-pass filter. Signal amplitude with Z-score > 2.5 compared to the normative database of the 14 normal controls represents abnormal slow waves, which then was localized using vector-based spatial-temporal analysis using L1-minimum norm (VESTAL). We hypothesized that abnormal MEG delta-waves come from gray-matter neurons that experience deafferentiation due to axonal injury to the underlying white-matter fiber tracts. Diffusion tensor imaging (1.5 T; 2.5 mm slices, TR = 15.1 s; TE = 80.4 ms; 51 directions, b = 1000 s/mm²; isotropic voxels 2.5 mm³) was analyzed using the FSL software package and used to detect reduced diffusion anisotropy related to axonal injuries in white matter. Diffusion indices including fractional anisotropy, eigenvalues and eigenvectors were obtained, and FA-scaled color maps were correlated with loci of MEG slow-waves. We also studied the neurophysiologic basis of TBI-related cognitive impairments using an N-back working memory MEG task in mild TBI patients.

RESULTS
1) The multimodal imaging approach with MEG and DTI is substantially more sensitive than conventional CT and MRI in detecting subtle neuronal injury in mild TBI; 2) reduced DTI anisotropy in white-matter fiber tracts is associated highly with the generation of abnormal MEG delta-waves from neurons that are linked to the injured white-matter fibers; 3) DTI abnormalities and MEG delta-wave generation are linked closely to deficits in the working-memory network as measured by the MEG N-back task; 4) findings from the multimodal imaging approach is consistent with postconcussive symptoms and results of neuropsychologic exams; 5) in some cases, abnormal MEG delta-waves were observed in mild TBI patients without DTI abnormality, indicating that MEG is more sensitive than DTI in diagnosing mild TBI.

CONCLUSION
The multimodal imaging approach with MEG and DTI can improve detection of subtle neural injuries that are invisible with conventional neuroimaging techniques, and can improve our understanding of the neuronal mechanisms underlying mild TBI.

KEY WORDS: Traumatic brain injury, magnetoencephalography, diffusion tensor imaging

Paper 44 Starting at 12:13 PM, Ending at 12:21 PM
Accumulation of Iron in Mild Traumatic Brain Injury: A Magnetic Field Correlation Study
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PURPOSE
Injury to the thalamus and deep brain structures, although
not visible on conventional M R imaging, may affect the clinical outcome in patients with mild traumatic brain injury (mTBI). Our aim was to test the hypothesis that there is an excess accumulation of iron in the deep gray matter of mTBI patients by using a newly developed quantitative M R technique - magnetic field correlation (MFC) imaging.

**Materials & Methods**

We studied 24 consecutive patients (8 women, 17 men; mean age 35.8 years, range 18-56 years) with mTBI (as defined by the American Congress of Rehabilitation Medicine). Eleven patients (Group A - Chronic) underwent M R imaging within a mean interval of 907 (range 215-2463) days after the traumatic incident and 13 patients (Group B - Acute) after a mean period of 22 days (range 3-22 days). Sixteen age- and sex-matched healthy volunteers (5 women, 11 men; mean age 31.5 years, range 19-43 years) underwent the same M R imaging procedures. The M R scans were performed on a 3 T imager (Siemens Magnetom Trio). The M R protocol included SWI, T2-TSE, T2-FLAIR, T1-SE and MFC. Magnetic field correlation was acquired with a single-shot echo planar imaging asymmetric echo sequence (40 sections, TR = 2800 ms, TE = 59 ms, refocusing pulse time shifts = 0, 4, 8, 12, and 16 ms, scanning time for M FC = ‘35’). After 3D motion correction, M FC maps were generated using in-house software. The M FC maps were evaluated using a region of interest (ROIs) approach. Regions of interest were placed bilaterally in the frontal white matter, thalamus, head of the caudate nucleus, putamen, and globus pallidus and in the splenium of the corpus callosum on three consecutive slices. Magnetic field correlation values (unit of measurement = s-2) averaged over the ROIs of each brain region were compared between patients and controls by using a t test.

**Results**

Compared to healthy controls, mTBI patients showed significantly higher M FC level in the thalamus on both sides separately (right: 185.9 ± 63.0 vs 145.5 ± 46.4; left: 184.4 ± 54.6 vs 154.1 ± 47.4) and averaged over sides (185.1 ± 41.8 vs 149.8 ± 51.7) (p < 0.05) and in the globus pallidus, on both sides separately (right: 869.0 ± 241.1 vs 668.5 ± 208.5; left: 912.9 ± 260.4 vs 709.8 ± 182.8) and averaged over sides (890.9 ± 201.6 vs 689.2 ± 174.2) (p < 0.001). The average M FC increase was 19.4% in the thalamus and 22.5% in the globus pallidus. No differences were found between patients in group A and B in terms of regional M FC values.

**Conclusion**

Quantitative measurement of the M FC suggests increased accumulation of iron in the deep gray matter in patients with mTBI. This abnormal accumulation of iron might be due to the selective vulnerability of the thalamus in head injury and this damage may contribute to neuropsychologic impairment and postconcussive symptoms. This supports the hypothesis that the thalamus is a relevant site of injury in mTBI.

**Key Words:** Mild traumatic brain injury, iron, magnetic field correlation
PURPOSE

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Intratumoral lesion components were placed on apparent diffusion coefficient (ADC) maps and transferred to fractional anisotropy (FA), cerebral blood volume (CBV) and cerebral blood flow (CBF) parametric maps. Relative CBV and CBF values (rCBV/rCBF) were calculated with respect to normal cerebellar gray matter. Wilcoxon signed-rank test was used for statistical analysis.

RESULTS

A apparent diffusion coefficient (ADC) values (µm²/ms) were significantly (p = 0.031) lower (1.2 ± 0.4 vs 1.8 ± 0.2), and FA values significantly (p = 0.031) higher (0.2 ± 0.07 vs 0.1 ± 0.06) in T2HIF than in TU. Dynamic susceptibility-weighted contrast-enhanced perfusion data showed significantly higher rCBV (p = 0.014, 1.68 ± 0.92 vs 0.96 ± 0.67) and rCBF (p = 0.002, 1.96 ± 1.19 vs 1.14 ± 0.89) values in T2HIF than in TU.

CONCLUSION

Intratumoral T2 hypointense foci are relatively rare, but not exceptional in DIPG at diagnosis. Based on conventional MRI, their recognition is fairly straightforward, but their significance is yet poorly understood. Our data support the hypothesis that T2 hypointense foci within DIPG may indeed correspond to areas of focal anaplasia. Lower ADC values indicate higher cellularity, and higher rCBV and rCBF are likely related to angioneogenesis and resultant expansion of the intralabral blood compartment compared to T2 hyperintense tumor. These findings provide further insight in the dynamics of tumor biology and the underlying histopathologic processes in DIPG, which may have impact on clinical management and prognosis.

REFERENCES


KEY WORDS: Focal anaplasia, diffuse intrinsic pontine glioma, DSC perfusion MR imaging

Paper 47 Starting at 10:53 AM, Ending at 11:01 AM

Prognostic MR Imaging Features in Pediatric Medulloblastoma

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PURPOSE

To search for distinctive MR imaging (MRI) features of medulloblastoma (MB) subtypes, as defined by the WHO Tumors of the Central Nervous System (4th edition) classification, and correlate with clinical outcome.

MATERIALS & METHODS

A retrospective review was done of 89 patients (age range 2-21 years; median 8 years) with MB within the past 10 years. Of these, 31 had pretreatment MRI and original pathology slides along with five recurrent tumor. A total of 36 radiologic/pathologic correlates were evaluated, including blinded reviews by two neuroradiologists and two neuropathologists, respectively. MRI features investigated included T1, T2, DWI/ADC, and postgadolinium enhancement patterns. These parameters were correlated with the MB pathologic
subtypes [classic, desmoplastic/nodular, extensive nodularity, and large-cell/diffuse anaplasia (LC/DA)], initial clinical risk-stratification (average-risk vs high-risk), and clinical outcomes including relapse and mortality.

Results
Two MRI features correlated with tumor aggressiveness. The presence of a characteristic honeycomb enhancement (HE) pattern correlated with increased mortality (P = 0.0123), while T2 heterogeneity (T2H) trended towards significance (P = 0.1171). The presence of both T2H + HE pattern strongly correlated with increased mortality (P = 0.0023). Of 10 patients with both MRI features, seven died. All six patients with the aggressive LC/DA pathology had both features (P = 0.003), and four died. The combination of T2H + HE pattern raised the mortality predictive value from 45% (T2H) and 61% (HE) to 69% (T2H + HE), respectively. No single imaging characteristic, alone, was predictive of pathologic subtype.

Conclusion
The combined T2H / HE pattern is predictive of more aggressive MB behavior, irrespective of pathologic subtype (although strongly correlated with the LC/DA subtype). Such MRI features may indicate a less favorable prognosis and the need for more aggressive therapy strategies.

Key Words: Medulloblastoma, pediatric brain tumors, MRI imaging

Materials & Methods
A cohort of 12 patients (12 M, 11 medulloblastoma, 1 ATRT; mean age: 9 ± 3.2 years) with PFS were identified retrospectively from a prospectively designed IRB-approved therapeutic trial and matched for age and gender with patients from the same protocol without PFS. A blinded, randomized analysis of the IONs was performed using axial long TR (proton density-, T2-weighted) images on subsequent postoperative MRI studies (mean per patient 14 ± 5, mean follow up 38 ± 20 months). Damage to each ION was assessed (0 = no abnormality, 1 = questionable hypersignal within hilum or the entire ION, 2 = definite hypersignal within hilum or the entire ION). Patients were assigned into three groups: no damage, definite unilateral HOD, definite bilateral HOD. Statistical analysis was performed for patients with and without PFS to determine correlation with the pattern of HOD-related MRI abnormalities.

Results
Twelve patients with definite bilateral ION abnormalities had PFS clinically. Nine patients with no or unilateral ION abnormalities had no PFS clinically. Three patients were clinically diagnosed to have PFS, but had no concordant MRI findings. The correlation between bilateral damage and PFS was statistically significant by both T2 (p = 0.005) and proton density (p = 0.03) imaging.

Conclusion
Our data suggest that HOD is a reliable indicator of damage to the contralateral pECP in patients after surgery for midline tumors in the posterior fossa. Since the development of bilateral HOD was invariably associated with PFS, we speculate that bilateral HOD may be a sensitive and, in appropriate clinical settings, a specific indicator of PFS even though the MRI findings are delayed with respect to the development of the clinical syndrome. These data further contribute to the existing body of evidence that suggests a pathogenetic role of bilateral damage to the pECP in postoperative PFS. We speculate that the negative MRI studies in patients clinically diagnosed to have PFS may reflect the known inconsistencies in the diagnostic criteria of PFS.

Key Words: Posterior fossa syndrome, inferior olivary nucleus, posterior fossa neoplasm
MR Imaging Features of Pediatric Meningiomas

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Purpose
Meningiomas are rare tumors in children. Unlike adult counterparts, they have male predominance (1, 2, 3), atypical locations (1, 2, 3), cystic components (1) and worse clinical outcome (4). The purpose of our study was to evaluate the general MR imaging (MRI) features of pediatric meningiomas such as location, volume and signal characteristics, and enhancement pattern in 3 distinct groups of patients based on the underlying clinical condition.

Materials & Methods
Twenty-four patients with imaging/histopathologic diagnosis of meningioma who underwent presurgical MRI between 1994 and 2009 from two major medical institutions in USA were studied. MR imaging of the brain was analyzed by two pediatric neuroradiologists independently in three clinical subgroups based on the underlying clinical condition: a) spontaneous arising meningiomas (SAM), b) NF-2 related meningiomas (NF-2 related) and c) radiation induced meningiomas (RIM). Location, volume, presence of cystic components, T1 and T2 signal, contrast enhancement pattern and DWI characteristics were evaluated.

Results
A total number of 34 meningiomas in 24 patients were evaluated. There was no sex predominance in the entire data set. Differences were observed in clinical subgroups: a) SAM (n = 8); (8/34) were always single, appeared in younger patients (mean age: 9.5 years) with atypical locations (7/8) (anterior cranial fossa, paraclinoid, planum sphenoidale, intraventricular, intraparenchymal), had cystic components (4/8) and higher mean tumor volumes (106 cm³) b) NF-2 related meningiomas (NF-2 related) and c) radiation induced meningiomas (RIM). Location, volume, presence of cystic components, T1 and T2 signal, contrast enhancement pattern and DWI characteristics were evaluated.

Conclusion
Spontaneous arising meningiomas have atypical locations, cystic components and are diagnosed in younger children compared to NF-2 related meningiomas or RIM. Unlike the latter two groups they do not present with strong sex predominance. NF-2 related meningiomas also have a high incidence of atypical locations, especially the craniofacial region. Radiation-induced meningiomas have typical adult features.

References
CONCLUSION

The MR spectroscopic detection of lactate is a prognostic factor in patients with brain stem glioma. Additional studies on larger study populations are needed.

KEY WORDS: Brain stem glioma, MR spectroscopy, lactate

Paper 51 Starting at 11:25 AM, Ending at 11:33 AM

Correlation of MR Spectroscopy with Conventional MR Imaging in Patients with Diffuse Intrinsic Pontine Glioma

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PURPOSE

At diagnosis, diffuse intrinsic pontine gliomas (DIPG) histologically likely correspond to WHO grade 2 neoplasms, but at autopsy most patients are found to have glioblastoma. On current treatment protocols many patients show transient improvement, long-term prognosis, however, remains grim. Clinical follow up of DIPG relies heavily on MR imaging (MRI). MR imaging evaluation is based on the assessment of interval changes in volume and signal properties of the tumor including magnitude and extent of signal enhancement after intravenous contrast injection. In a single pediatric patient with DIPG, we observed a steady increase of the Choline/N-acetylaspartate (Cho/NAA) ratio despite apparent improvement both clinically and by traditional MRI criteria. We hypothesized that MR spectroscopy (MRS), in particular Cho/NAA ratio, may be more representative of actual tumor biology over time than conventional MRI-based metrics.

MATERIALS & METHODS

Single or multivoxel MRS was performed in 35 children with DIPG (as part of the imaging arm of an IRB-approved phase I clinical study of vandetanib administered simultaneously with conformal radiation) at enrollment and at 14, 28, 52, 112, 175 and 200+ days during treatment. After quality assessment of all data, 121 spectra of 31 patients (17F/14M, age 7.3 ± 3.8 years, average: 4 ± 2 scans/patient) were deemed adequate for Cho/NAA ratio calculation. One reviewer measured tumor size and recorded the longitudinal evolution of the overall T2 signal intensity, contrast enhancement (CE) and necrosis within the tumor. These quantitative and qualitative metrics were correlated individually with the corresponding Cho/NAA ratios at each time point using graphical analysis and generalized estimating equations, which take into account intrapatient variability.

RESULTS

Correlation between Cho/NAA ratios, tumor size, overall T2 signal intensity, intratumoral necrosis and CE were not significant. However, CE typically increased when Cho/NAA ratio increased. Most remarkably, when averaged for the entire cohort, Cho/NAA ratios showed the opposite trend in temporal evolution compared to the mean tumor size.

CONCLUSION

Our longitudinal data show that traditional MRI metrics used for the assessment of tumor evolution do not correlate well with the biological behavior of DIPG as reflected by the metabolic profile of the tumor tissue. After a short period of stagnation, the Cho/NAA ratio usually increases while the conventional MRI appearance of the tumor suggests improvement. We speculate that imaging improvement therefore may not indicate actual tumor control, but rather reflect therapy-induced changes in some of the secondary, noncritical aspects of the neoplastic process only (for example, decrease of edema).

KEY WORDS: Diffuse intrinsic pontine glioma, MR spectroscopy

Paper 52 Starting at 11:33 AM, Ending at 11:41 AM

Treatment Response of Diffuse Intrinsic Pontine Gliomas Assessed by Arterial Spin Labeling Perfusion Measurements

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PURPOSE

Diffuse intrinsic pontine gliomas (DIPG) are amongst the most devastating neoplasms in children. No treatment benefits have been observed from chemotherapy. Local radiation therapy (RT) only postpones tumor progression about 6 months (1). It is believed that antiangiogenic therapy normalizes abnormal tumor vasculature thereby improving the tumor perfusion and allowing better delivery of radiation (2). In a phase I trial of combined antiangiogenic and local RT of DIPGs we closely monitored changes in tumor perfusion by arterial spin labeling (ASL) measurements (3). Purpose of this study is to investigate whether ASL can be used as a biomarker for early detection of therapeutic response.
**Materials & Methods**

Twenty-seven patients (15 f, 12 m; age: 2-16 years) with diagnosed DIPG were enrolled in an ongoing IRB-approved phase I trial. Patients received a combination of local RT (54Gy) for a period of 6 weeks and permanent oral administration of vandetanib. Arterial spin labeling was performed at baseline, 2, 4 and 8 weeks and every 2 months thereafter. In total 139 ASL scans were available: Eleven patients had six to eight consecutive scans, 13 patients had three to five scans and three patients received less than three scans. Quantitative cerebral blood flow (CBF) maps were calculated (3) and coregistered with T2-weighted, 3D high-resolution images of the same time point. Tumors were segmented manually on T2-weighted images assuming active tumor is T2-hyperintense. The region then was applied to the CBF maps and absolute CBF measures were evaluated with respect of treatment time.

**Results**

Figure 1 displays tumor perfusion over time. Median tumor perfusion was fairly stable during RT (CBF = 19.3 ml/min/100 g), increased at the end of RT (CBF = 48.7 ml/min/100 g), and then was gradually decreasing (CBF = 16.0 ml/min/100 g). In addition an increased intersubject variability of the post-RT median tumor perfusion is observed.

![Figure 1: Tumor perfusion over time on protocol. Radiation therapy is applied during week 1 to 7. Increased median CBF and inter subject variation is observed directly after RT at week 8.](image)

**Conclusion**

The fact that tumor perfusion did not decrease during RT and even increased towards the end of RT suggests that radiation was delivered under favorable conditions. However, we cannot ascribe this effect solely to vandetanib, RT or the combination of both. The gradual decline of tumor perfusion at later time points suggests that vascular normalization had reached its climax right after RT. The higher variance in tumor perfusion directly after RT may suggest different tumor responses to treatment. However, future better controlled studies are necessary to allow significant conclusions. In summary ASL-MR imaging seems to be a promising tool for monitoring treatment strategies that affect tumor perfusion.

**References**


**Key Words:** Arterial spin labeling, antiangiogenic therapy, diffuse intrinsic pontine glioma

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**Paper 53 Starting at 11:41 AM, Ending at 11:49 AM**

**Significance of Imaging and Clinical Characteristics of Pathologically Proved Pilomyxoid Astrocytomas**

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**Purpose**

To establish the significance of imaging and clinical characteristics of pathologically proved pilomyxoid (PMA), pilocytic PCA, and fibrillary astrocytomas (FA) in the pediatric population.

**Materials & Methods**

The institutional brain tumor registry was searched for pathologically proved cases of PMA, PCA, and FA. As our first PMA was identified in 2003, retrospective review of imaging, reports, and clinical data included cases from 2003-2008. To capture non-istologically prove chiasmatic PCA, a radiology informatic system search was performed from 2003-2008.

**Results**

Seven patients were diagnosed with PMA. Six of seven patients were < 4 years of age; 1 was 13 years. Six were solid-enhancing masses; one presented with hemorrhage. Two were located in the hypothalamic/chiasmatic region; 2 were located in the basal ganglia/optic tract region; 1 was located in the left frontal region; 1 was located in the left lateral ventricle; and 1 was located in the posterior fossa. Five underwent resection, while 2 were biopsied. Five had residual PMA on postoperative imaging, but were doing well at last check up (follow up of 0-48 months; mean 11 months). Two underwent chemotherapy and 1 underwent radiotherapy; 1 was immediately postoperative. In contrast, there were 55 patients with histologically proved PCA, with 13 aged < 5 years, allowing for an age-matched comparison with the PMA patients. Eleven were large cystic lesions with associated enhancing solid tissue, while 1 was mainly solid tissue; imaging was not available for 1. Eleven PCA were in the posterior fossa, while 2 PCA were in the basal ganglia/thalamus. All PCA patients underwent operation; 2 received chemotherapy. Three had residual tumor on postoperative imaging, with 1 having CSF dissemination. All PCA patients were doing well at last check up (follow up of 2-71 months; mean 35 months). In addition to the above-stated 13 histologically proved PCA, 6 cases of presumed chiasmatic PCA were diagnosed in patients < 5 years. All lesions were mixed solid/cystic lesions. All underwent chemotherapy. All had residual tumor on follow-up imaging, but were clinically doing well (follow up of 6-58 months; mean 42 months). Seven patients were diagnosed with FA, with 2 patients aged < 5 years at diagnosis at 9 months and 4 years. One was located in the mesial temporal region, while 1 was in the cerebellum. Both FA underwent surgery with no residual tumor on postoperative imaging. Both FA were doing well at last check up (follow up of 16 and 65 months; mean 41 months).

**Conclusion**

In patients < 5 years with supratentorial predominantly solid-enhancing suspected astrocytomas, particularly in the
hypothalamus/basal ganglia region, PMA is more likely than PCA (or FA). In fact, in this series, all hypothalamic/basal ganglia astrocytomas in patients < 5 years were PMA. Also, in this series, in patients < 5 years, 2 of 8 chiasmatic tumors were PMA with 6 being presumed PCA, without biopsy. Given the reported worse prognosis and more aggressive nature of PMA compared with PCA, this may warrant consideration of more biopsies of chiasmatic tumors.

**Key Words:** Pilomyxoid astrocytoma, pilocytic astrocytoma, WHO grade II

### Paper 54 Starting at 11:49 AM, Ending at 11:57 AM

**Perfusion and Diffusion Characteristics of Pediatric Gliomas**

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**Purpose**
The goal of this study was to determine whether perfusion and diffusion MR imaging can be used to predict malignant progression of grade II and grade III astrocytoma in pediatrics.

**Materials & Methods**
Medical records and MR studies of pediatric patients with astrocytomas were reviewed retrospectively. Five patients were identified with low-grade astrocytomas (WHO II) and no clinical or radiologic progression over at least 2 years of follow up. Six patients were identified with low-grade astrocytomas with progression within 2 years after diagnosis. Twelve patients with high-grade (WHO III) astrocytomas and poor outcome also were included in this analysis. All studies were performed on a 1.5 T clinical system using GRE-EPI (TR 1250 ms, TE 54 ms) for perfusion studies and SE-EPI imaging (TR 10 s, TE 80 ms, b = 1000 s/mm²) for diffusion imaging. Apparent diffusion coefficient and cerebral blood volume (CBV) maps were computed and analyzed using NordicICE software (NordicNeuroLab Inc., Milwaukee, WI).

**Results**
Mean CBV (relative to control tissue) in stable grade II tumors was 1.1 ± 0.7 which was not different from 1.7 ± 1.4 measured in malignant grade II and 1.1 ± 1.2 in grade III astrocytoma. Mean minimum ADC was significantly higher in stable grade II vs malignant grade II (0.78 ± 0.10 vs 0.62 ± 0.09 × 10⁻⁹ m²/sec, p < 0.01) but was not different from ADC in grade III gliomas (0.78 ± 0.16). In this group minimum ADC and CBV did not correlate with disease course (Figure 1).

**Conclusion**
In adults, gliomas with high risk for poor outcome, when described in “physiological MR” features are typically cellular and highly perfused lesions (1, 2). This is consistent with histopathologic differences that are associated with increased malignancy such as an increased microvascular proliferation and mitosis and increased cellularity. This study demonstrates that MR perfusion does not predict clinical course of pediatric gliomas in individual patients. However, minimum ADC appeared to distinguish between stable and malignant grade II astrocytoma which is, if confirmed prospectively, of importance since there are currently no indicators that would allow a neurooncologist to predict at the time of diagnosis which low-grade II astrocytoma is likely to progress.

**References**

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**Key Words:** Glioma

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### Paper 55 Starting at 11:57 AM, Ending at 12:05 PM

**Multinational Evaluation of Gadobenate Dimeglumine for Contrast-Enhanced Pediatric MR Neuroimaging**

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**Purpose**
Preliminary findings from a multicenter trial of gadobenate dimeglumine (Gd-BOPTA) in children were presented in 2007. Herein we present the final report on this multinational clinical evaluation.
Materials & Methods
Ninety-two children (2-17 years) referred for cranial/spinal contrast-enhanced MR imaging (MRI) were enrolled at 17 centers in USA, Europe, or China as part of an open-label clinical study. Enrollment was stratified by age (2-5, 6-10, and 11-17 years). Sedation was performed at the discretion of the treating physician. Each subject received 0.1 mmol/kg gadobenate dimeglumine (0.2 mL/kg) at a rate of ≤ 2 mL/s (manually or by power injector), followed by a saline flush. T1-weighted SE, T2-weighted FSE, and FLAIR sequences were performed predose, and with T1-weighted SE sequence repeated at 3-10 minutes after contrast injection. Safety monitoring included incidence of AEs, changes in vital signs and serial 12-lead electrocardiograms (ECGs), urinanalysis, basic metabolic panel and complete blood count. Pathologies studied include malignant and benign neoplasms (germ cell tumor, high grade glioma, medulloblastoma, PNET, pineal cyst, pilocytic astrocytoma, fibrous meningioma, neurofibromatosis, etc.); vascular malformations (AVM and aneurysms); and other conditions (demyelinating processes, hemangiomas, pseudotumors). Images were evaluated by three blinded readers for lesion enhancement, border delineation, and visualization of internal morphology. Lesion-to-brain ratio (LBR) and contrast-to-noise ratio (CNR) were calculated from regions or interest placed by the readers. All subjects were monitored for AE for 72 hours and followed up at 30 days to determine final diagnosis.

Results
Ninety-two children [45 boys, 47 girls; mean age: 10.6 years (range: 2.0-17.8 years)] were enrolled and dosed with 89 children completing all safety evaluations (13 patients 2-5 years, 34 patients 6-10 years, and 45 patients were 11-17 years). The mean contrast dose was 8.4 mL (range: 2.0-22.8 mL). Diagnoses included: 28 (30.4%) nontumor, 60 (65.2%) tumor, and 4 (4.3%) normal parenchyma. Of the tumors, 43 (71.7%) were intraaxial and 17 (28.3%) were extraaxial; 25 (41.7%) were benign and 35 (58.3%) were malignant. A total of nine mild to moderate AEs were reported in eight children (8.7%), including three AEs in two patients considered possibly related to contrast injection. Headache was reported in two patients with all other reported AEs occurring once. Modest vital sign changes were recorded, but none of any clinical significance. No clinically meaningful changes in laboratory values or ECGs were observed. In all children with enhancing lesions, gadobenate dimeglumine resulted in improved definition of disease extent, lesion border delineation, and visualization of lesion internal morphology. Readers blinded to clinical history judged that gadobenate dimeglumine provided additional diagnostic information over predose images in 83.7 - 96.7% of all patients. Quantitatively, gadobenate dimeglumine resulted in significantly higher mean lesion-to-brain ratio (p < 0.0001) and contrast-to-noise ratio (p < 0.0016) vs predose images. The mean changes across readers ranged from 0.9 to 1.1 for lesion-to-brain ratio and from 49.9 to 74.6 for contrast-to-noise ratio.

Conclusion
At a dose of 0.1 mmol/kg, gadobenate dimeglumine was found to be safe and efficacious for contrast-enhanced MRI of CNS lesions in children.

Key Words: MR contrast, MR imaging, gadobenate
Paper 57 Starting at 12:13 PM, Ending at 12:21 PM
Etiology of Thalamic Injury in Neonatal Arterial Stroke

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PURPOSE
In neonates, arterial cortical infarction often is accompanied by regional decreased diffusion in the ipsilateral thalamus (Figure). Potential causes of thalamic abnormalities include arterial emboli, seizures, and Wallerian degeneration. Better understanding of the etiology of thalamic abnormalities will help guide treatment of neonatal stroke. It also may provide relevant prognostic information, as thalamic injury has been associated with poor cognitive outcomes. In this study, we examined sequential cases of neonatal arterial territory infarct and assessed for the presence, distribution, and time course of thalamic injury. We examined correlations between the extent and distribution of cortical infarct and the distribution of thalamic injury. We also used diffusion tensor tractography to identify cortico-thalamic pathways which may mediate the observed injury.

MATERIALS & METHODS
Neonates < 10 days with MR imaging reports of arterial infarct were examined. Sixteen cortical infarcts were identified in 15 patients. A parent diffusion coefficient (ADC) values were measured in five ROIs within each thalamus: one each in the anterior, medial, and posterior thalamus, and two in the lateral thalamus, corresponding to the expected locations of the ventrolateral (VL) and ventroposterolateral (VPL) nuclei. Diffusion was considered significantly decreased when ADC in a region was significantly less (p < 0.05) than average ADC in the contralateral thalamus. Diffusion tensor imaging tractography was performed in two patients.

RESULTS
Of 16 cases with cortical infarct, 10 demonstrated increased DWI signal and decreased ADC in the ipsilateral thalamus. Thalamic ADC abnormalities did not involve traditional vascular territories. Thalamic ADC was reduced 25-50%, compared to 60-70% in involved cortex, reached a minimum at ~3 days, and normalized at ~7 days. Follow-up imaging at 3-7 months, available in eight of 10 patients, demonstrated volume loss in the affected thalamus, without increased T2 signal. Ventrolateral/VPL thalamic ADC abnormality correlated with primary motor/sensory cortex involvement. When > 50% of the postcentral gyrus was involved, diffusion abnormalities were present in VPL thalamus (p = 0.006). When > 50% of the precentral gyrus was involved, VPL thalamus was abnormal (p = 0.05). Diffusion tensor imaging data available in two patients identified fiber tracts directly connecting areas of involved cortex and thalamus.

CONCLUSION
Many neonatal cortical infarcts are associated with decreased diffusion in the ipsilateral thalamus. Location and tractography studies suggest that thalamic involvement is not due to embolic stroke, but rather reflects seizure activity or Wallerian degeneration. Corresponding long-term volume loss without gliosis suggests apoptosis as the mechanism of injury. Implications for long-term cognitive function need to be determined.

KEY WORDS: Thalamus, neonatal, stroke

Paper 58 Starting at 12:21 PM, Ending at 12:29 PM
Intracranial Pediatric Dissection: A Shared Feature in Patterns of Pediatric Cerebral Arteriopathy

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PURPOSE
The purpose of this study is to identify and emphasize the role played by arterial dissection in diverse patterns of intracranial pediatric cerebral arteriopathy.

MATERIALS & METHODS
A retrospective review of 11 years of single institutional experience with pediatric cerebral angiography was conducted with IRB approval. Out of a total of 193 pediatric angiographic and interventional cases, 21 patients were identified in whom a presentation with cerebral ischemia or mass-effect was related to a focal or multifocal abnormality of arterial morphology. Case notes, laboratory data, imaging studies, and outcomes were reviewed for these cases with an eye towards categorizing the lesions identified and with a particular interest in identifying the role played by angiographic findings typically associated with intracranial dissection in various disease states.

RESULTS
Five predominant patterns of pediatric cerebral arteriopathy were identified: 1. Moyamoya disease-like states (6/21); 2. Focal cerebral arteriopathy of childhood (FCA) likely related to underlying inflammatory or postinfectious states; 3. Fusiform aneurysmal dilations of the posterior circulation likely related to “typical” dissection; 4. Atypical aneurysms, pseudoaneurysms, or aneurysmal irregularities of the anterior circulation presenting with cerebral ischemia or mass-effect was related to a focal or multifocal abnormality of arterial morphology. Case notes, laboratory data, imaging studies, and outcomes were reviewed for these cases with an eye towards categorizing the lesions identified and with a particular interest in identifying the role played by angiographic findings typically associated with intracranial dissection in various disease states.
**CONCLUSION**

Intracranial arterial dissection is likely a final common pathway of vessel injury in a variety of intracranial pediatric arteriopathies excluding moyamoya states. It is known, for instance, that histologic evidence of disruption of the internal elastic lamina, a precursor of mural dissection, can be identified postmortem in patients with postvaricella FCA (2). In our study, angiographic findings typically ascribed to dissection are prominently seen in this population. It is likely that this mechanism plays a role in the occlusion of intracranial perforator vessels typically seen in FCA. In other arteriopathic disease states, intracranial dissection is likely an underlying component of the pathologic changes which, in some patients, may require treatment specifically targeted at the dissected segment of vessel. In some, evidence of arterial dissection may be misleading with reference to the true nature of the underlying arteriopathy. In others, the possibility of evolving aneurysms requiring later treatment will need to be considered. In particular, in pediatric patients with cerebral aneurysms presenting with cerebral ischemia, underlying dissection should be considered as a possible genesis of the aneurysm.

**REFERENCES**


**KEY WORDS:** Dissection, aneurysm, arteriopathy

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**Paper 59 Starting at 12:29 PM, Ending at 12:37 PM**

**Pediatric Intracranial Aneurysms: New and Enlarging Untreated Aneurysms following Index Aneurysm Treatment or Observation**

Hetts, S. W.1 · Narvid, J.2 · English, J. D.1 · Higashida, R. T.1 · Dowd, C. F.1 · Halbach, V. V.1

1University of California San Francisco, San Francisco, CA, 2Stanford University, Stanford, CA

**PURPOSE**

To describe the subset of pediatric patients with intracranial aneurysms who developed de novo or enlarging untreated aneurysms.

**MATERIALS & METHODS**

Between 1981 and 2008, 77 patients aged 0-18 years with 103 intracranial aneurysms not associated with arteriovenous malformations, dural arteriovenous fistulas, or vein of Galen malformations were treated at our institution. Medical records of these patients were reviewed retrospectively. Clinical history, neurologic examination, and diagnostic work up were extracted.

**RESULTS**

Of 77 children harboring 103 intracranial aneurysms, six patients (8%) were determined to have new or enlarging untreated aneurysms during follow up for a treated or untreated index aneurysm. In four patients the index aneurysm(s) were fusiform and in two patients the index aneurysm(s) were saccular. Treatment of the index aneurysm was parent artery occlusion in two patients, bypass/trapping in one patient, selective coiling in one patient, surgical clipping of multiple ipsilateral aneurysms and selective coiling of contralateral aneurysm in one patient, and observation in a single patient. Comorbidities which may have related to aneurysmal diathesis included AIDS (1 patient), Majewski type II dwarfism (1 patient), vascular birthmark (1 patient), and tricuspid atresia (1 patient). New or enlarging aneurysms were detected at 6 months to 12 years following index aneurysm intervention (mean 5 years); one patient had significant enlargement of two aneurysms 6 months and 18 months after initial treatment. Four patients developed new fusiform aneurysms and two developed new saccular aneurysms. Of the seven new aneurysms seen in six patients, one underwent successful surgical clipping, one had successful coiling, one was stent-coiled successfully, one received combination surgical wrapping with completion coiling, one had unsuccessful attempted coiling with subsequent conservative observation, one was deemed untreatable and was followed with noninvasive imaging, and one new aneurysm in an AIDS patient presented with fatal subarachnoid hemorrhage 20 months after index aneurysm treatment. This was the only confirmed fatality in the series.

**CONCLUSION**

The development of new or enlarging intracranial aneurysms in pediatric patients is concerning and warrants close clinical and radiographic follow up of these patients.

**KEY WORDS:** Aneurysm, pediatric, treatment

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**Monday Morning**

**10:45 AM - 12:30 PM**

**Room 210**

(4e) Excerpta Extraordinaire: Head and Neck

(Scientific Papers 60 - 80a)

See also Parallel Sessions

(4a) Adult Brain: New Techniques/Postprocessing
(4b) Adult Brain: Cerebrovascular Occlusive Disease I
(4c) Trauma: Adult Brain and Spine
(4d) Pediatric: Neoplasms and Cerebrovascular

**Moderators:** Hugh D. Curtin, MD
Ashley H. Aiken, MD
To report a very rare neurovascular anatomical variation of unilateral intrathoracic left common carotid artery (CCA) bifurcation.

**Case Report**

A 60-year-old female presented with dizziness and syncope. Cardiovascular and ENT examinations were normal at the time of presentation. Her symptoms gradually were resolved without any particular treatment.

**Imaging Findings**

The left CCA bifurcation was located at the level of T1-2 disk space. However, the right side CCA bifurcation located normal range at the level of C4-5 disk space. The extracranial left internal carotid artery (ICA) remained posterior and slightly medial to the left external carotid artery (ECA) from the bifurcation. The diameter of the left extracranial ICA was smaller (about 40-50%) than that of right side from the CCA bifurcation to the level of supraclinoid segment of ICA. The right and left distal petrous canal diameter was 6.6 vs 5.1 mm respectively. There was no other associated vascular or bony anomaly.

**Summary**

Recognition and embryologic understanding of intrathoracic left CCA bifurcation is advised since this rare anatomical variation may cause clinical challenges in certain circumstances such as catheter angiography or carotid interventions.

**Key Words:** Vascular anomaly, common carotid artery, intrathoracic carotid bifurcation

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A 51-year-old woman presented with a 2 1/2-year history of numbness and tingling involving the right lateral tongue and anterior neck just inferior to the mandible. Subsequently, she gradually developed associated pain in these regions, as well as deep to the right ear and in the right throat. A multidisciplinary work up was performed. This included extensive imaging, with MRI, MRA, and PET scans all unrevealing. An anesthetic injection targeting the right glosopharyngeal nerve resulted in temporary relief of pain. She was diagnosed with glossopharyngeal neuralgia. A trial of medical therapy was unsuccessful. A suboccipital microvascular decompression was performed, with cauteryization of a vein that appeared to be compressing the glossopharyngeal nerve and sectioning of the glossopharyngeal nerve and upper first rootlet of the vagus nerve, via a right suboccipital craniectomy. Immaculate hemostasis was achieved at surgery. A cutely in the postoperative setting, she was noted to have progressively worsening left cervical swelling. Because of concern for an enlarging hematoma and potential airway compromise, a noncontrast neck CT was obtained in this patient with a contrast allergy (see below). A diagnosis of acute left submandibular salalidenitis was made, and although intubation was performed for airway precaution, the patient was otherwise managed conservatively with an uneventful recovery, including extubation on the second postoperative day.

**Imaging Findings**

A noncontrast soft tissue neck CT demonstrated an enlarged, moderately hypoattenuating left submandibular gland with multiple dilated intraparenchymal ducts. There was an associ-ated extensive amount of infiltrative low-attenuation fluid extending unilaterally from the left masticator space inferiorly into the sublingual space, the submandibular space, surrounding the strap muscles, and terminating at the inferior aspect of the thyroid gland. This extended medial to the hyoid bone to the vallecula. The left aspect of the hypopharynx was partially collapsed secondary to mass effect. The airway remained patent but displaced to the right. There was thickening of the overlying platysma muscle with soft tissue stranding in the fat extending through the buccal space along the inferior aspect of the neck. There was no evidence of hematoma.

**Summary**

This case demonstrates a rare neurosurgical complication: acute submandibular salalidenitis following contralateral skull base surgery. There is only a single small case series in the neurosurgical literature describing this particular complication. Our goal is to educate the neuroradiologist about this recently recognized phenomenon. The pathophysiology is thought to be the obstruction of Wharton’s duct contralateral to the side of surgery, related to the relatively extreme flexed/rotated intraoperative head position.

**Key Words:** Submandibular gland, salalidenitis, skull base surgery

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The authors of this presentation intend to present the most current knowledge that neuroradiologists should know in dealing with schwannomatosis, a recently recognized disease entity occurring in patients with multiple schwannomas who lack the phenotypic characteristics of neurofibromatosis type 2.
**Case Report**
We present three cases of schwannomatosis. All patients are in adulthood who harbor multiple schwannomas in the head and neck region and/or the spine, without the presence of vestibular schwannoma on MRI imaging. The description of patient’s profile and imaging findings are included in the presentation.

**Imaging Findings**
Multiple schwannomas are present in all patients without the presence of vestibular schwannoma on MRI imaging. The trigeminal nerve and spinal nerves are involved in our patients.

**Summary**
Schwannomatosis is recognized recently as a third major form of neurofibromatosis in which the responsible genetic abnormalities have been identified and recognized in genetic literatures. The diagnostic criteria have been proposed in order to identify patients with this disease and differentiate this entity from neurofibromatosis type 2.

**Key Words:** Schwannomatosis, schwannomas, neurofibromatosis

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**Paper 64 Starting at 11:00 AM, Ending at 11:05 AM**

**Periapical Cemental Dysplasia: A Common Misdiagnosis with Costly Ramifications**

Tamimi, D.
Epic Teleradiology
Orlando, FL

**Purpose**
To familiarize the radiologist with periapical cemental dysplasia (PCD) to prevent misdiagnosis which can lead to treatment that devitalizes the teeth.

**Imaging Findings**
Periapical cemental dysplasia is a benign cemento-osseous lesion that generally occurs at the apices of the mandibular anterior teeth, although there have been cases of isolated posterior tooth involvement. The early radiographic appearance can be misleading to the untrained eye, as it comprises of widening of the periodontal ligament space surrounding the apices of the teeth, a finding that is completely lucent or of low density. This easily can be mistaken for radicular abcesses or granulomas, and this misdiagnosis can lead to the overzealous attempt to control the "infection" by radical root canal treatment and subsequent crowning of the teeth. As the lesions progress, their appearance become more dense, and a mature lesion can be visualized as a high density surrounded by a low density rim. Examples of the progression of the lesions will be given, as well as some cases where unnecessary treatment was performed.

**Summary**
The inappropriate root canal treatment is costly and can be prevented by careful radiographic examination and performing vitality testing to the teeth involved.

**Key Words:** Cemental lesions, root canal, benign

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**Paper 65 Starting at 11:05 AM, Ending at 11:10 AM**

**Imaging Features of Lipodystrophy of HIV in the Head and Neck**

Hazany, S. · Rafael, R. · Moonis, G.
Beth Israel Deaconess Medical Center
Brookline, MA

**Purpose**
A subset of HIV-1-infected patients who are undergoing antiretroviral treatment, most commonly HIV-1 protease inhibitors (PIs), develop a lipodystrophy syndrome. It is characterized by loss of peripheral subcutaneous adipose tissue (face, limbs, buttocks), visceral fat accumulation, and, in some cases, lipomatosis, especially in the neck and dorsocervical area. Lipodystrophy in HIV-infected patients (LDHIV) is associated with insulin resistance and its metabolic complications such as diabetes and hyperlipidemia. It is thought that a complex combination of HIV-1 infection and drug treatment-related events triggers the syndrome and lipotoxicity contribute to the development of the syndrome. Active lipolysis in subcutaneous fat, combined with impaired fat storage capacity in the subcutaneous depot, drive ectopic deposition of lipids, either in the viscera or in nonadipose sites. Protease inhibitors have been the strongest link to LDHIV; however, other factors, such as duration of HIV infection, age, and gender, also may contribute to the risk of development of LDHIV. Objective criteria for the assessment of patients with LDHIV have not been established. Our goal is to describe imaging features of head and neck involvement in five cases of LDHIV and discuss its distinct imaging findings on ultrasound, CT, and/or MRI imaging (MRI) as compared to head and neck adipose tissue prominence in obesity vs lipoma.

**Case Report**
Our index case is an otherwise asymptomatic 62-year-old HIV-positive male, without AIDS, who was referred to otolaryngology clinic for progressive enlargement of submental area over several years. He was on Tenofovir (TDF), Epivir (3TC) and Efavirenz at the time of presentation and had been on HAART therapy for about 11 years. Initially ultrasound was performed followed by MRI to exclude neoplasm.

**Imaging Findings**
On ultrasound asymmetric soft tissue vs fat deposits of uncertain origin was seen and MRI was recommended. On MRI large accumulations of fat with nonenhancing scant septations were noted in a mass-like configuration predominantly in the dorsocervical, posterior triangle and submental regions, with sparing of the pververtebral and retropharyngeal spaces. There was partial fat infiltration of bilateral parotid glands and notably scarce fat in the face.

**Summary**
Lipodystrophy in HIV syndrome, involving the head and neck, can be disfiguring and may be confused with neoplasm on physical exam. This condition can be differentiated from head and neck adipose tissue prominence in obesity by its characteristic mass- like fat deposition in the neck and dorsocervical region and markedly scarce fat in the subcutaneous tissues of the face. Its diffuse appearance excludes lipoma as an alternative diagnosis. We conclude that MRI or CT evaluation can be used for definitive diagnosis of this.
condition. This potentially can alert clinicians to the possible presence of LDHIV-associated metabolic abnormalities and subsequently alter the treatment course of the patients; for example, by using non-PI antiviral therapy.

**Key Words:** Lipodystrophy, HIV, LDHIV

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**Paper 66 Starting at 11:10 AM, Ending at 11:15 AM**

**Imaging Appearances of a Hydrated Scleral Buckle**

Kang, J.1 • Curtin, H. D.2 • Moonis, G.1

1Beth Israel Deaconess Medical Center, Boston, MA, 2Massachusetts Eye and Ear Infirmary, Boston, MA

**Purpose**

Scleral buckling is a commonly performed procedure for treatment of retinal detachment. The use of hydrogel buckling elements, which were composed of hydrophilic polymers, were thought to decrease the risk of infection and scleral erosions associated with scleral buckles. However, long term complications have been recognized, including hydration of the buckle, with subsequent fragmentation, erosion and extrusion of the explant. On imaging, hydrated buckles mimic a mass, and often pose a diagnostic dilemma, particularly given its late manifestations. Recognizing the appearances of this complication on imaging is important to guide the ophthalmologist in the proper diagnosis and management of the patient.

**Case Report**

A 60-year-old patient presented with increasing discomfort of the left eye and an increasing bulge of the eyelid. There was a remote history of retinal detachment of the left eye that previously had been treated surgically. The initial concern was of a new orbital mass. However, a CT of the orbits revealed the typical imaging findings of a complication related to swelling of a hydrogel scleral buckle rather than a mass. The hydrated scleral buckle was removed surgically.

**Imaging Findings**

A circumferential low density lesion surrounds the left globe, with dystrophic calcifications noted. Findings are most compatible with a left hydrogel scleral buckle, that is increased in size secondary to absorption of fluid.

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**Paper 67 Starting at 11:15 AM, Ending at 11:20 AM**

**Orbital Amyloidosis: CT and MR Features**

Thota, S. N.1 • Saraf-Lavi, E.1 • Bhatia, R.1 • Kubal, A. A.1 • Tse, D.2

1University of Miami, Miami, FL, 2Bascom Palmer Eye Institute, Miami, FL

**Purpose**

To review a unique case of orbital amyloidosis with involvement of the optic nerve. Clinical presentation, imaging findings and pathology are discussed.

**Case Report**

A 73-year-old female presented with bulging of her eyes. She was earlier diagnosed with Graves Ophthalmopathy and showed partial response to corticosteroids. Her past medical history is pertinent for hypertension, arthritis and anxiety. T3, T4, thyroid stimulating hormone (TSH), immunoglobulin (TSI) and thyroid peroxidase antibodies were all within normal limits. Biopsy of the medial rectus showed fibrocellular tissue containing moderate amount of acellular periodic acid shift (PAS) positive material. Congo red stain was positive on the acellular material consistent with amyloid. There was no evidence of systemic amyloidosis or chronic inflammatory disease.

**Imaging Findings**

MR imaging of the orbits demonstrated bilateral proptosis with diffuse enlargement of extraocular muscles. On the right greatest enlargement was noted in the lateral and inferior rectus which demonstrated heterogeneous hypo to isointensity on T1- and T2-weighted images. On the left the medial rectus was markedly enlarged and showed areas of low signal on T1 that corresponded to areas of calcification seen on CT. The tendons of the extraocular muscles were not involved. Right optic nerve sheath complex was prominent, iso on T1 and T2 with mild enhancement on postcontrast studies.

**Summary**

Recognizing the appearances of a hydrated scleral buckle on imaging is important to aid the ophthalmologist in appropriate diagnosis and management, particularly as the hydrated buckle mimics an intraorbital mass.

**Key Words:** Scleral buckle

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optic nerve rarer, this possibility should be considered in the differential diagnosis of proptosis.

REFERENCES

KEY WORDS: Orbital amyloidosis, CT, MR imaging

Paper 68 Starting at 11:20 AM, Ending at 11:25 AM

Usefulness of Tomographic Reconstructions of Catheter Angiograms (Dyna CT) for Vascular Lesions of the Skull Base

Radvany, M. G.1 2 · Pearl, M. 1 · Bowkley, C.1 · Gailloud, P.1
1 Johns Hopkins Hospital, Baltimore, MD, 2 Uniformed Services University of the Health Sciences, Bethesda, MD

PURPOSE
To demonstrate the role of tomographic reconstructions of catheter angiograms using high-resolution flat panel technology for the evaluation of vascular lesions located at the skull base.

CASE REPORT
A similar technique was used in the three shown examples. Selective catheterization of the targeted vessel was performed with a 5F diagnostic catheter. Rotational image acquisition (20-second rotation, 25 frame/sec) was obtained during injection of a nonionic contrast agent (2 ml/sec for 22 seconds, volume of 44 ml at 25% contrast dilution, total of 11 ml of contrast agent). Reconstruction of the region of interest was done using a high-resolution protocol (0.1 mm).

IMAGING FINDINGS
Case 1: 46-year-old female with pain in the right ear and diminished hearing and suspicion of a vascular anomaly in the inner ear by CT and MRI. A glomus tympanicum tumor is clearly documented by Dyna CT (Figure). Case 2: 29-year-old male with a hypervascular mass in the right temporal region diagnosed as an AVM by MRI. Catheter angiography suggested a dural arteriovenous fistula; however Dyna CT established the location of the lesion as diploic (diploic arteriovenous fistula). Case 3: 68-year-old female with left pulsatile tinnitus. No etiology detected by CT/CTA and MRI/MRA. Catheter angiography demonstrated a dural arteriovenous fistula at the left condylic canal. Dyna CT offered detailed angioarchitectural analysis and helped plan the endovascular approach to the lesion.

SUMMARY
In our experience, Dyna CT supplements conventional angiography by offering unparalleled detailed morphologic evaluation of vascular lesions located at the skull base.

KEY WORDS: Tomographic reconstruction, vascular lesions, skull base

Paper 69 Starting at 11:25 AM, Ending at 11:30 AM

Neurocutaneous Melanosis

Lehman, V. T. · Morris, J. M. · Watson, R. E. · K. N.
Mayo Graduate School of Medical Education Rochester, MN

PURPOSE
This report of a child with neurocutaneous melanosis highlights the major clinical and magnetic resonance (MR) features of this uncommon disease and discusses recommendations regarding clinical management and radiographic monitoring.

CASE REPORT
At birth, the patient was discovered to have a “bathing trunk” giant congenital nevus with numerous scattered satellite nevi (see graphic). He had a normal head circumference, a soft anterior fontanelle, absence of papilledema, and an unremarkable neurologic examination. Following appropriate imaging studies, a multidisciplinary evaluation by dermatology, plastic surgery, neurology, neurosurgery, and neuroradiology yielded a consensus diagnosis of neurocutaneous melanosis (NCM). No neurologic deficits developed in subsequent months of close surveillance. At age 4 months, two nodular foci within the cutaneous pigmented lesions were excised and found to be benign.

IMAGING FINDINGS
MR imaging without gadolinium at 1 day of age demonstrated scattered small foci of T1 hyperintensity involving the temporal lobes, brainstem, inferior colliculus, and cerebellum. There was no mass lesion or hydrocephalus. MR imaging of entire spine was unremarkable. Follow-up MR
imaging at 4 months of age with gadolinium demonstrated lack of progression (see graphic). No enhancing lesions were present.

**Summary**

Neurocutaneous melanosis is a rare congenital condition defined by 1) large (predicted adult size > 20 cm) or multiple (≥3) congenital melanocytic nevi, 2) meningeal melanosis or melanoma, and 3) absence of coexistent central nervous system (CNS) and cutaneous melanoma to exclude metastases as the cause of CNS disease. The onset of symptoms, often related to hydrocephalus or seizures, typically occurs in childhood and portends a poor prognosis. Malignant melanoma, cutaneous, intracranial, or intraspinal, develops in 40-60% of patients. MR imaging should be considered in patients with multiple or large congenital melanocytic nevi, particularly involving the posterior midline or head. With MR imaging, areas of T1 hyperintensity are found within the brain parenchyma, often involving the amygdala, brainstem, and cerebellum, and the leptomeninges. Leptomeningeal enhancement and atypical hyperintensity on T2 or FLAIR have been reported. Initial MR imaging can be negative. Central nervous system melanoma is suspected with development of intracranial or intraspinal masses or parenchymal invasion (especially with growth, necrosis, surrounding edema), and nodular leptomeningeal enhancement. The differential diagnosis includes primary leptomeningeal melanomatosis, metastatic melanoma, and primary malignant melanoma of the CNS. Frequent evaluation for signs of elevated ICP or malignant transformation of cutaneous lesions is advised. A ventriculoperitoneal shunt might be indicated. Chemotherapy and radiation do not improve the prognosis of NCM with melanoma of the central nervous system.

**Key Words:** Neurocutaneous melanosis

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**Case Report**

A 47-year-old female was referred to our institution for evaluation of persistent primary hyperparathyroidism after bilateral neck exploration 4 years ago. She had a right inferior parathyroidectomy and biopsy of the left inferior thyroid gland. Pathology showed no evidence of adenoma. The superior parathyroid glands were not identified. Parathyroid hormone (PTH) remained elevated after surgery. Despite medical management she had persistent hypercalcemia, hypercalciuria and worsening symptoms of fatigue, memory loss, and muscle aches. A recent DEXA scan showed that she had developed osteopenia.

**Imaging Findings**

Sestamibi parathyroid scan with SPECT imaging was reported to be negative for PTA, but noted a small area of tracer activity in the region of the right retropharyngeal space. This was only present on the SPECT images and not seen on the planar images. No activity was present in the left neck. Four-dimensional CT of the neck was performed. On arterial phase images two hyperenhancing lesions (arrows), right larger than left, were seen in the retropharyngeal space at the level of the pyriform sinus. On delayed images there was rapid washout of contrast in the lesions. On reformatted coronal and sagittal arterial phase images both lesions (arrows) were demonstrated to be oval in shape. Based on these findings the surgeon performed minimally invasive surgery in the retropharyngeal space. Parathyroid hormone normalized after surgery. Pathology confirmed the presence of bilateral PTA.

**Summary**

Ectopic adenomas are reported in 18-25% of cases of primary hyperparathyroidism. The retropharyngeal space is an extremely rare location. There are no reported cases of bilateral adenomas. The location of the retropharyngeal parathyroid gland at the level of the pyriform sinus can be explained by embryology. An accurate diagnosis and localization of PTA on preoperative imaging is essential for minimally invasive parathyroid surgery. Four-dimensional CT should be considered as a second tier option to investigating primary hyperparathyroidism when ultrasound and scintigraphy are indeterminate or negative. This case also shows the value of adding SPECT imaging to parathyroid sestamibi scan and the phenomenon of rapid wash-out of the left PTA. The latter can be a pitfall of scintigraphy and an advantage of 4D CT.

**Key Words:** Parathyroid adenoma, retropharyngeal

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**Paper 70 Starting at 11:30 AM, Ending at 11:35 AM**

**Bilateral Retropharyngeal Parathyroid Adenomas Detected with 4D MDCT**

Welling, R. D. · Olson, J. A. · Eastwood, J. E. · Kranz, P. G. · Hoang, J. K.

Duke University
Durham, NC

**Purpose**

1. To present a case of bilateral retropharyngeal parathyroid adenomas (PTA) diagnosed with 4D CT of the neck. 2. To explain the embryology of the retropharyngeal parathyroid gland. 3. To discuss the imaging work up of PTA.

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**Paper 70**

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**Purpose**

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Paper 71 Starting at 11:35 AM, Ending at 11:40 AM

Cystic Parathyroid Adenomas on Dynamic CT

Sillery, J. C. · DeLone, D. · Welker, K.
Mayo Clinic Rochester, M N

PURPOSE
Dynamic parathyroid CT frequently is performed at our institution in cases with equivocal results on scintigraphy or ultrasound. We recently encountered two cases of atypical cystic parathyroid adenomas which displayed unusual CT imaging characteristics.

CASE REPORT
The first patient, a 54-year-old female, initially was found to have hyperparathyroidism with a PTH of 169 pg/mL. Preoperative imaging included a Tc-99 m sestamibi/iodine-123 subtraction scan which demonstrated discordant sestamibi uptake at the superior pole of the left thyroid lobe, compatible with a parathyroid adenoma or thyroid nodule with discordant sestamibi avidity. Neck ultrasound showed a 1.6 x 3.1 cm partially solid, partially cystic nodule arising in juxtaposition to the posterior aspect of the upper pole of the left lobe of the thyroid. Dynamic CT confirmed a 2.5 cm cystic mass adjacent to the mid to superior left lobe of the thyroid. This was confirmed at surgery to represent a 2800 mg parathyroid adenoma. In the second case, a 65-year-old female with a history of surgery for hyperparathyroidism was diagnosed with recurrent hyperparathyroidism (PTH 185 pg/mL) despite negative outside imaging exams. Preoperative imaging at our institution included a Tc-99 m sestamibi/iodine-123 subtraction scan which demonstrated an area of increased sestamibi uptake, without radioiodine uptake, adjacent to the mid portion of the right thyroid lobe on subtraction images. Neck ultrasound showed no evidence of a parathyroid adenoma. Dynamic CT demonstrated a large peripherally enhancing centrally cystic structure adjacent to the esophagus and an equivocal area of enhancement in the right thyroid. Despite the discordant preoperative imaging, the surgeon was able to localize the cystic mass and confirm a 4800 mg parathyroid gland.

IMAGING FINDINGS
In both cases, the parathyroid adenoma was a large peripherally enhancing, centrally cystic mass that showed less hyper-enhancement than usually seen with parathyroid adenomas, and did not have the usual rapid contrast washout.

SUMMARY
We describe two cases of parathyroid adenoma with atypical CT imaging characteristics. Hopefully, our experience will aid other radiologists in accurate preoperative identification of similar atypical adenomas thus allowing minimally invasive parathyroidectomy to be performed.

KEY WORDS: Parathyroid, adenoma

Paper 72 Starting at 11:40 AM, Ending at 11:45 AM

IgG4-Related Sclerosing Disease of the Larynx

Fujita, A. · Sakai, O. · Shinozaki, T. · Kobayashi, S. · Sugimoto, H.
1Jichi Medical University, Shimotsuke, J A P A N, 2Boston University, Boston Medical Center, Boston, M A

PURPOSE
Recently, IgG4-related sclerosing disease has been established as a distinct clinicopathologic entity. In the head and neck region it is well known that IgG4-related sclerosing disease can occur in the submandibular gland (Kütter’s tumor), lacrimal and parotid glands (Mikulicz’s disease), and pituitary gland (lymphoplasmacytic hypophysitis). Here we report a case of a laryngeal lesion of systemic IgG4-related sclerosing disease and discuss the imaging findings.

CASE REPORT
A 46-year-old man presented with hoarseness. CT demonstrated masses in the larynx and mediastinum, and lymphoma was suspected by imaging findings. Biopsy revealed IgG4-related sclerosing disease, and elevated serum IgG4 concentration was noted. The patient discharged on oral steroids and had improvement in hoarseness. Follow-up imaging demonstrated significant reduction of the lesions.

IMAGING FINDINGS
Contrast-enhanced CT showed a homogeneous, moderately enhancing submucosal lesion in the supraglottic and glottic larynx (Figure). No destruction of the laryngeal cartilage was identified. A lesion with similar imaging findings also was noted in the mediastinum. PET CT demonstrated marked uptake of FDG in the both laryngeal and mediastinal lesions.
IgG4-related sclerosing disease is a systemic disease that can affect multiple organs with or without autoimmune pancreatitis. It is uncommon in the head and neck and particularly rare in the larynx. We present a case of submucosal laryngeal lesion of IgG4-related sclerosing disease with mediastinal lesion (fibrosing mediastinitis). We should consider this rare entity as a differential diagnosis of the submucosal laryngeal lesion.

REFERENCES

KEY WORDS: Larynx, FDG-PET, IgG4-related sclerosing disease

Summary
Though still rare, ectopic thyroid tissue off midline is now well established in the clinical literature and has been described in the retropharyngeal, parapharyngeal, and submandibular spaces, as well as in the trachea, esophagus, and heart. That implantation of lateral thyroid tissue may occur from prior trauma or surgery remains a valid consideration to be addressed in individual cases, as should be the concern that lateral thyroid tissue may represent metastatic disease. The notion, though, that all lateral aberrant thyroid tissue represents metastatic cancer is clearly no longer valid.
Though the embryology of lateral thyroid ectopia remains a
matter of debate, as this case demonstrates, the presence of a
eutopic thyroid does not preclude the existence of lateral
ectopic thyroid tissue. From a clinical standpoint, familiarity
with this entity may help avoid unnecessary therapy.

**Key Words:** Ectopic thyroid, eutopic thyroid, retropharyn-
geal thyroid

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**Paper 74 Starting at 11:50 AM, Ending at 11:55 AM**

Hyperparathyroidism Due to Parathyroid Hormone-
Secreting Hyperplastic Paraganglion Tissue Detected on
4D CT

Salvatore, J. K. · Eastwood, J. D. · Olson, J. A. · Untch, B. ·
Hoang, J. K.
Duke University Medical Center
Durham, NC

**Purpose**

1. To present the history and imaging findings of PTH-
secreting hyperplastic paraganglion tissue in the carotid
bifurcation. 2. To discuss the imaging work up for parathy-
roid adenomas and the role of 4D CT.

**Case Report**

A 15-year-old-female presented with persistent primary
hyperparathyroidism following two unsuccessful neck
explorations for suspected parathyroid adenoma. Initial
exploratory pathology showed hypercellular left upper
parathyroid tissue, and left lower parathyroid tissue with scar
and suture granuloma. There was no evidence of parathyroid
adenoma. The right parathyroid glands were not identified.
Calcium levels and parathyroid hormone (PTH) remained
elevated following surgery.

**Imaging Findings**

Parathyroid scintigraphy revealed asymmetric retained trac-
er activity in the region of the right thyroid lobe suggesting
either asymmetric thyroid tissue or parathyroid adenoma. A
4D CT of the neck was performed. On arterial phase CT
imaging there was a hyperenhancing oval-shaped mass in the
left carotid space at the carotid bifurcation. There was
washout of contrast on delayed phase imaging. No mass was
identified within the right neck.

Based on CT results, the surgeon targeted the left carotid
space mass. Intraoperative fine needle aspiration of the mass
showed high PTH levels (2500 pg/ml). The mass was resect-
ed completely. The patient's serum PTH normalized follow-
 ing resection. The final pathology showed the mass to be
hyperplastic paraganglion tissue.

**Summary**

There are several reports of synchronous parathyroid adeno-
ma/hyperplasia and carotid body tumors, but paraganglial
hyperplasia secreting PTH has not been described in the lit-
erature. This excerpta extraordinaire further supports the the-
ory of a common neuroendocrine cell origin. We also show
the utility of neck 4D CT when there are indeterminate
parathyroid scintigraphy and ultrasound results. Any hyper-
enhancing mass on 4D CT should be suspected as a cause of
hyperparathyroidism in correct clinical setting. Accurate
diagnosis and localization of the source of hyperparathy-
roidism on preoperative imaging is essential for patients who
are considered for repeat surgery.

**Key Words:** Hyperparathyroidism, hyperplastic paragan-
glion tissue, hypercellular parathyroid tissue

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**Paper 75 Starting at 11:55 AM, Ending at 12:00 PM**

Rare Presentation of Intratympanic Inverting Papilloma

Paz, D. A. · Mafee, M.
University of California San Diego
San Diego, CA

**Purpose**

1. Describe a rare presentation of intratympanic inverting
papilloma. 2. Review the clinical and radiologic manifesta-
tions of inverted papilloma as well as the histologic subtypes
of sinonasal papillomas. 3. Establish the importance of imag-
ing for the protean manifestations of sinonasal papillomas
and their clinical relevance.

**Case Report**

1. Epidemiology of sinonasal papillomas. 2. Brief discussion
of sinonasal papillomas (inverted, fungiform, cylindrical)
with a focus on the Schneiderian membrane relevant to this
case. 3. Algorithmic selection of imaging modalities and pro-
tocols appropriate in cases of suspected sinonasal papillo-
mas.

**Imaging Findings**

This is a case displaying a rare presentation of intratympan-
ic inverted papilloma. The patient originally presented with
a middle ear mass that was biopsied revealing inverting
papilloma. Past medical history subsequently revealed prior
inverting papilloma removed from the nasal cavity. It is
believed that this is a case of inverting papilloma of
Eustachian tube origin with extension to the nasal cavity or
possibly an inverted papilloma originating in the middle ear.

**Summary**

Proper deployment of imaging in the appropriate clinical set-
ting of suspected sinonasal papilloma can guide clinical
management including potential surgical intervention. Past
medical history coupled with prior imaging can be para-
mount in obtaining a precise imaging-based diagnosis.

**Key Words:** Inverting papilloma, middle ear, intratympan-
ic
Duplicated Internal Auditory Canal with Agenesis of Cochlear Nerve

Noujaim, D. L. · Noujaim, S. E.
William Beaumont Hospital
Royal Oak, MI

**Purpose**
Small duplicated internal auditory canal is a rare temporal bone abnormality. A narrow internal auditory canal accounts for 12% of congenital malformations of the temporal bone. In patients with congenital sensorineural hearing loss a radiologic abnormality is found in 20%. The normal range of the vertical dimension of the internal auditory canal is 2 to 8 mm, with an average dimension of 4 mm. Internal auditory canal stenosis is defined as a vertical diameter < 2 mm on high-resolution computed tomography (CT). While high-resolution CT will better depict anomalies of the bony labyrinth, IAC, middle and external ear, high-resolution MR imaging will better depict the membranous labyrinth and the cranial nerves CN VII and CN VIII. It is of great importance to make the diagnosis of aplasia or hypoplasia of the vestibulocochlear nerve in the IAC for cochlear implant candidates and for purpose of treatment planning.

**Case Report**
A four-year-old boy with Down syndrome presented with a history of chronic ear infections, sensorineural hearing loss and severe speech delay. Head and neck examination was normal apart from Down facies and the presence of a patent and dry left pressure equalization tube. The facial nerve function was unimpaired and symmetric. The child did not present with any vestibular symptoms. Audiology was not obtainable. Intraoperative auditory brainstem responses were suggestive of a severe to profound hearing loss in the right ear and mild hearing loss on the left.

**Imaging Findings**
High-resolution CT (HRCT) with reformatted coronal images and sagittal images, demonstrated a duplicated right internal auditory canal (IAC). A small anterosuperior canal measuring 1.2 mm, housing a normally-functioning facial nerve (CN VII), was separated from a smaller, stenotic inferoposterior canal for the vestibulocochlear nerve (CN VIII), measuring 0.8 mm. The lateral end of the right IAC formed a common space at the fundus. The inner ear and the course of the facial nerve were normal. The left temporal bone was normal. High-resolution, heavily T2-weighted MR imaging was used to better define the cranial nerves VII and VIII. In this case, three-dimensional constructive interference of steady state (3D CISS) image sequences was used. There was a normal facial nerve coursing through the anterosuperior facial canal and hypoplasia of the vestibulocochlear nerve passing through a markedly narrowed posteroinferior canal with aplasia of the cochlear nerve. The left IAC and CN VII and VIII were normal.

**Summary**
In conclusion, congenital deafness has many different etiologies. A narrow duplicated IAC with congenital sensorineural hearing loss and normal facial nerve function is extremely rare. An examination of this anomaly should include a past medical history and physical examination, audiometry including auditory brainstem response, a high-resolution CT scan, and high-resolution MR imaging. In this case the cochlear division of CN VIII is not identified on imaging, indicating aplasia or severe hypoplasia of the cochlear nerve. This will impact on the treatment choices to be offered.

**Key Words:** Temporal bone, congenital, hearing loss

Middle Ear Osteoma: Rare Cause of Conductive Hearing Loss in Young Adults

Garwal, A. · Zachariah, T. · Vijay, K. · Nguyen, D.
Penn State Hershey Medical Center
Hershey, PA

**Purpose**
Osteomas of the middle ear are rare benign neoplasms. To date, around 22 cases have been reported in literature. They most commonly arise from the promontory, and very rarely from the ossicles. The most common symptom is conductive hearing loss because of the impingement of the ossicular chain. We present two cases of middle ear osteoma presenting with intermittent otorrhea and conductive hearing loss.

**Case Report**
Case 1: A 26-year-old woman presented with conductive hearing loss in the right ear and recurrent ear infections. Otoscopy showed a posterior retro-tympanic mass of whitish appearance and thickening of the tympanic membrane. Audiogram revealed mild to moderate conductive hearing loss in the high frequencies. Computed tomography (CT) showed a bony mass measuring approximately 5 mm x 4.8 mm in the right epitympanum, superomedial to the incus, abutting the otic capsule (Figure). The ossicles appeared normal and there was no evidence of erosive changes in the otic capsule. Case 2: A 22-year-old female presented with a moderate right-sided hearing loss. Physical examination revealed a white mass behind an intact right tympanic membrane located in the posterior-inferior quadrant. Audiometry revealed a 20 decibel conductive hearing loss. CT showed a bony mass measuring approximately 3 mm x 4 mm in the right hypotympanum, extending into the mesotympanum and abutting the ossicles. The ossicles otherwise appeared normal with no evidence of erosive changes.
IMAGING FINDINGS
Osteomas of the middle ear are a rare entity, but should be considered in the differential diagnosis of middle ear masses. These lesions may be asymptomatic or patients may have a conductive hearing loss. Hearing loss is the most common initial symptom, primarily due to impingement of the ossicles. In most patients, the diagnosis is confirmed by CT or at the time of surgical exploration. CT is particularly useful to define the extent of the lesion and to evaluate the involvement of the ossicular chain. Osteomas are slow growing and surgical excision is recommended only for symptomatic lesions. In both our cases, CT revealed typical appearance of osteoma with well circumscribed bony masses and absence of any bony erosion or soft tissue component.

SUMMARY
Osteomas are benign pedunculated tumors of the lamellar bone, which commonly originate from paranasal sinuses. Osteomas originating from the middle ear are very rare. We present two such rare cases of middle ear osteoma, with typical imaging findings.

KEY WORDS: Osteoma, middle, CT

Paper 78 Starting at 12:10 PM, Ending at 12:15 PM
Temporal Bone Chondroblastoma: A Case Report

Lagemann, G. M. · Fukui, M. B.
Western Pennsylvania Allegheny Health System
Pittsburgh, PA

PURPOSE
Chondroblastoma of the temporal bone is extremely rare. We report a new case and review the tumor’s imaging.

CASE REPORT
A 49-year-old male presented with one year of right jaw pain with mastication and a palpable right jaw mass. Contrast-enhanced CT and MRI showed a lesion concerning for chondrosarcoma. The mass was removed surgically, and histopathology showed immature chondroblasts, osteoclasts, and osteoid-like matrix without cellular atypia, findings diagnostic of chondroblastoma. The patient did not undergo radiation therapy.

IMAGING FINDINGS
Contrast-enhanced CT demonstrated a 3.2 x 1.9 cm, partially calcified, enhancing soft tissue mass arising from the zygomatic process of the right temporal bone and extending into the right masticator space. Although there was some remodeling of the zygomatic process, no frank bone destruction was detected. Contrast-enhanced MRI found no evidence of dural extension or temporomandibular joint involvement.

SUMMARY
Chondroblastoma of the temporal bone is exceedingly rare, with only about 75 reported cases in the literature (1). On CT, temporal bone chondroblastoma characteristically appears as soft tissue density, focally-calcified, homogeneously-enhancing mass with surrounding bony destruction. It radiologically closely resembles chondrosarcoma, giant cell tumor, and aneurysmal bone cyst (2). Contrast-enhanced MRI is an accurate predictor of dural spread and temporomandibular involvement (1). Because chondroblastoma sometimes exhibits local invasion (3) and frequently recurs after curettage (4), complete surgical resection of the tumor is the treatment of choice and has a very low recurrence rate (1). Radiotherapy has been demonstrated to cause degeneration into chondrosarcoma, so it is only used in nonresectable cases (5).

REFERENCES

KEY WORDS: Temporal bone, chondroblastoma
Imaging of Carotid Canal Sympathetic Plexus Schwannoma

Hamilton, J. D. · Ginsberg, L. E.
M. D. Anderson Cancer Center
Houston, TX

Purpose
A variety of pathologies have been reported to involve the petrous temporal bone and the contained carotid canal, including both neoplastic and vascular causes. Only one case of an internal carotid plexus schwannoma has been reported to occupy the carotid canal.

Case Report
A 27-year-old Hispanic female presented with hearing loss secondary to a middle ear effusion, relieved by tympanostomy. The patient subsequently developed 4 months of headache and 2 weeks of diplopia. On physical exam, there was a mild left abducens palsy, intact ipsilateral facial sensation, and no other relevant clinical findings.

Imaging Findings
CT and MR imaging demonstrated a homogenously enhancing mass extending from the upper carotid space through the a smoothly enlarged, remodeled petrous carotid canal. Small posterolateral projections of the mass corresponded to expected location of the carticotympanic nerve of the internal carotid sympathetic plexus. At angiography, occlusion of the cavernous-supraclinoid junction was confirmed with reconstitution of the supraclinoid carotid via ophthalmic and posterior communicating collaterals. The mass resulted in cavernous sinus and Eustachian tube compression, explaining the patient’s symptoms. At surgery, a carotid sympathetic plexus schwannoma was confirmed.

Summary
To the authors’ knowledge this is only the second reported case of a pathology-proved internal carotid plexus schwannoma to occupy the carotid canal. The unique relationship to anatomical structures and imaging characteristics differentiate it from more common pathologies.

Key Words: Schwannoma, carotid canal

Juvenile Xanthogranuloma of the Orbital and Periorbital Region

Chokshi, F. H. · Saigal, G. · Rodriguez, M. M.
University of Miami/Jackson Memorial Hospital
Miami, FL

Purpose
To present the MR imaging characteristics of juvenile xanthogranuloma in two pediatric patients.

Case Report
Patient 1: Five-month-old male with right eye proptosis and a large peri-orbital mass found on imaging at an outside institution. MR findings mentioned below confirmed the mass. Endoscopic sinus surgery revealed a bulging mass with large bulky components that was biopsied and surgically debulked. Pathology revealed a juvenile xanthogranuloma, positive for CD68 immunostain. Patient 2: Three-and-half-month old male with “lazy” left eye at 1 month of age, subsequently developed proptosis. MR imaging revealed a left retro-orbital mass as described below. Surgical biopsy found juvenile xanthogranuloma. After chemotherapy, the mass mildly decreased in size, showing no further change in size or configuration to date.

Imaging Findings
Patient 1: A right masticator space mass extending into the right orbit, pterygopalatine fossa, infratemporal fossa, middle cranial fossa, foramen ovale, right cavernous sinus and Meckel’s cave. Patient 2: A left retro-orbital mass with intra and extracranial components and avid enhancement. Inferomedial displacement of the left globe and encasement of the left optic nerve were present. The mass also extended into the inferior left middle cranial fossa.
SUMMARY
Two clinical presentations of juvenile xanthogranuloma are described. Imaging findings are nonspecific. Utility of cross-sectional imaging is mainly for description of morphology and extent of tumor for pretherapeutic planning.

KEY WORDS: Juvenile xanthogranuloma, non-Langerhans cell histiocytosis

Paper 80a Starting at 12:25 PM, Ending at 12:30 PM

Oppenheimer, A. G. · Shifteh, K. · Chang, J. · Brook, A. · Shanske, A. L. · Shprintzen, R. J. · Bello, J. A.
1Montefiore Medical Center, Bronx, NY, 2Upstate Medical University, Syracuse, NY

PURPOSE
Velo-cardio-facial syndrome (VCFS), the most common genetic syndrome of cleft palate, is associated with internal carotid and vertebral artery anomalies, as well as upper airway asymmetry. Medially displaced internal carotid arteries, often immediately submucosal, are at risk for vascular injury during pharyngeal flap surgery for velopharyngeal insufficiency. We evaluate the spectrum and frequency of cervical vascular anomalies in a large cohort of VCFS patients, correlating MRA with nasopharyngolaryngoscopy in detecting at-risk carotid arteries. Furthermore, we assess the relationship with respect to laterality between vascular anomalies and structural asymmetry of the upper airway in these patients.

MATERIALS & METHODS
Cervical MRA of 86 patients with VCFS and 50 control subjects were reviewed independently by three neuroradiologists. The course of the internal carotid and vertebral arteries was identified within the pharyngeal soft tissues. Medial deviation, level of bifurcation, dominance, anomalous origin, and vessel tortuosity were recorded. Since the vertebral artery occupies a relatively constant position within the transverse foramen it serves as a reference point in assessing carotid displacement. Nasopharyngoscopy examinations available in 43 patients were assessed for palatal and posterior pharyngeal wall symmetry, true vocal cord motion and size, and for presence or absence of carotid pulsations. Endoscopic findings were compared with MRA results.

RESULTS
Of the 86 patients, 93% had one or more vascular anomalies; 42 patients (49%) were found to have medial deviation of at least one internal carotid artery. In 24 patients (28%) the anomalous internal carotid artery was directly submucosal, and in four of these cases bilateral. Other carotid anomalies included low carotid bifurcation (51%), anomalous origin of the right common carotid (37%), and two cases of internal carotid agenesis/hypoplasia. Vertebral artery anomalies included vessel tortuosity (40%), hypoplasia (12%), looping (5%), and one case of a double left vertebral artery. Patients in our study showed a random distribution of vascular anomalies, with no association found between the laterality of upper airway structural asymmetry and cervical vascular anomalies. Only nine of the 33 pulsatile carotid arteries visualized at nasopharyngoscopy were found to be submucosal on MRA. Furthermore, 11 submucosal carotid arteries confirmed at MRA demonstrated no visible pulsations. Positive and negative predictive values for endoscopic observation of pulsatile carotid arteries confirmed to be submucosal in location on MRA 27% and 79% respectively.

CONCLUSION
Carotid and vertebral artery anomalies are common in VCFS including marked medial deviation of the internal carotid artery in close proximity to the donor site for pharyngeal flap surgery. Lack of correlation between laterality of vascular anomalies and upper airway structural asymmetry in VCFS does not support the hypothesis that palatal, pharyngeal, and laryngeal anomalies are due to secondary developmental sequences caused by in utero vascular insufficiency. The presence or absence of carotid pulsations seen by nasopharyngoscopy does not correlate with a submucosal carotid location identified on MRA. Furthermore, identification of the relative medial-lateral retropharyngeal position of a submucosal carotid affords the option of modifying the surgical approach. These findings support the routine use of preoperative neck MRA in VCFS patients in surgical planning.

KEY WORDS: Congenital syndrome, MRA, vascular anomalies
**Monday Morning**

**10:45 AM - 12:30 PM**
**Room 208**

(5) Synaptic Junction Programming: Lecture - The Business of Neuroradiology

(81) Informatics Solutions to Business Pressures in Radiology

—— Alan M. Pitt, M.D.

(82) Future Directions in the Business of Neuroradiology

—— Frank J. Lexa VII, M.D.

(83) Future Directions in the Business of Neuroradiology

—— Alan M. Pitt, M.D.

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**Informatics Solutions to Business Pressures in Radiology**

Alan M. Pitt, M.D.

**Learning Objectives**

Upon completion of this presentation, participants will be able to:
1) Define common errors in data aggregation during revenue cycle.
2) Review software as a service model (SaaS).
3) Review the Continuum of Care and implications for P4P data.

**Presentation Summary**

Beyond PACS and RIS...Technology Solutions to Manage Revenue Cycle and other Opportunities. Internal audits of medical documentation and the revenue cycle commonly find errors. This can result in either over or under billing. Opportunities to capture and correct for these errors at the point of service exist. The presentation will review an experience at the Barrow Institute with a software as a service (SaaS) model that has broad application. Additional opportunities to use these strategies to manage the continuum of care including referral to revenue will be discussed.

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**Future Directions in the Business of Neuroradiology**

Frank J. Lexa VII, M.D.

Alan M. Pitt, M.D.

**Learning Objectives**

Upon completion of this presentation, participants will be able to:
1) Discuss the value chain that surrounds the core tasks that most neuroradiologists perform.
2) Review how that value is captured or lost in current practice.
3) Predict how future business models will be able to increase the potential value of neuroradiology.

**Presentation Summary**

Neuroradiologists need to be more aware of the value, both real and potential in their work. Many existing and future business models are based upon capturing these types of value. Whether we participate directly or not, we should be cognizant of the entire value chain in imaging. This lecture will discuss where many of these innovations will be possible and consider how that will transform the practice of neuroradiology.
The Role of Imaging in Nontraumatic Pediatric Back Pain
Tina Y. Poussaint, MD

Learning Objectives
Upon completion of this presentation, participants will be able to:
1) Review the diseases that commonly present with back pain in children.
2) Discuss the role of diagnostic neuroimaging in the evaluation of back pain in children.
3) Identify the neuroimaging findings in the specific nontraumatic disease entities in children.

Presentation Summary
While back pain presents less frequently in children than in adults, it still poses a significant clinical challenge with respect to making a firm diagnosis and developing an effective treatment plan. The actual incidence of back pain in children is unknown. When children complain of back pain and medical attention is sought, an underlying pathology usually is suspected. Pediatric patients are evaluated first with a complete clinical history and clinical exam; second, by an imaging workup that is based on initial findings, including the child's age and size, signs and symptoms, and suspected etiology. This lecture will review the epidemiology and imaging workup of back pain in children; how imaging findings correlate with disease entities that may cause back pain in the pediatric patient. The focus will be on the most commonly identified nontraumatic pathologies and disorders among young children and adolescents.

The Role of Imaging in Traumatic Pediatric Back Pain
Sanjay P. Prabhu, MD

Learning Objectives
Upon completion of this presentation, participants will be able to:
1) Discuss challenges in imaging pediatric patients with traumatic back pain.
2) Define imaging algorithms for traumatic pediatric back pain with special emphasis on imaging back pain in young sports persons.
3) Discuss how to optimize imaging studies to detect and follow up diskogenic herniation, spondylolysis and spondylolisthesis and ring apophyseal fractures in pediatric patients.

Presentation Summary
Imaging pediatric patients with traumatic back pain is challenging, especially with regards to minimizing use of radiation and optimizing algorithms for diagnosis and followup. This problem is especially relevant to the active young athletes. This presentation will discuss these issues and suggest protocols for imaging these patients and ensuring optimal management.

Clinical and Surgical Approach
Mark R. Proctor, MD

Dr. Proctor is a pediatric neurosurgeon at Children’s Hospital Boston, with staff appointments at Brigham and Women’s Hospital and Dana Farber Cancer Institute. He obtained his undergraduate education at Dartmouth College and medical degree at Columbia University College of Physicians and Surgeons, followed by neurosurgery residency at Georgetown University and pediatric neurosurgery fellowship at Children’s Hospital Boston. He has been on staff at Children’s since 1997, where he is actively involved in the treatment of congenital, degenerative, neoplastic and traumatic disorders of the spine, and has an active practice in sports-related injuries. He is the founder and sponsoring surgeon of the Boston chapter of ThinkFirst, and Chairman of the Board of the National ThinkFirst Injury Prevention Foundation.

Learning Objectives
Upon completion of this presentation, participants will be able to:
1) Review the causes of back pain in children.
2) Cite the clinical workup of back pain, and how radiographic studies aid in the diagnosis.
3) Review surgical treatments of back pain, including the use of radiographic adjuncts in the operating room
4) Discuss non-surgical treatments of back pain.

Presentation Summary
This talk will focus on the clinical approach to evaluating a child with back pain, and both operative and nonoperative interventions for the treatment of children with back pain of multiple etiologies, including congenital disorders, trauma, neoplasm and infection.
LEARNING OBJECTIVES
Upon completion of this presentation, participants will be able to:
1) Discuss the variety of pediatric brain tumors and see that what looks ominous is not always so.
2) Review the role of diffusion imaging in helping to characterize cellularity of malignant pediatric brain tumors.
3) Define and appraise the value that proton MRS can add to the evaluation of pediatric brain tumors.

PRESENTATION SUMMARY
Pediatric brain tumors have a greater variety of tumor types than those seen in adults, and therefore, a greater variety of imaging findings. The incidence is 25-40/million with a slight male to female predilection (1.2 to 1). Astrocytic tumors constitute 40-55%, primitive neuroectodermal tumors 20-30%, and ependymomas 10-15%. In pediatric tumors, there is a higher incidence of primary infratentorial tumors than that seen in adults; however, there are still more pediatric supratentorial tumors than infratentorial. Glial tumors, the most frequent in adults, are malignant in two thirds, but in pediatrics, benign in three fourths. The state-of-the-art evaluation of pediatric brain tumors in 2010 involves primarily the use of magnetic resonance imaging (MRI) to try to characterize the type of tumor, its aggressiveness and its response to therapy. While 1.5 T MRI imaging is satisfactory, there is a trend to 3 T imaging, based on its higher resolution, greater susceptibility effects, and rapidity of imaging in sequences such as perfusion and higher signal-to-noise for proton spectroscopy. The current evaluation involves the use of T1, FLAIR and T2 prior to gadolinium, and, if indicated, T2* susceptibility-weighted imaging (SWI), perfusion with either gadolinium or arterial spin labeling (ASL), proton spectroscopy, postgadolinium T1-weighted images with and without fat suppression, as well as diffusion-weighted imaging (DWI) with fractional anisotropy and diffusion tensor imaging. Functional cortical mapping by Bold fMRI or MEG is performed when indicated, where there is concern for involvement of exquisite cortex by tumor. The use of all these imaging sequences is customized to the location and characteristics of the tumor being studied. Currently, many of the investigative aspects of brain tumor imaging are involved in protocols at the research level involving the Children’s Pediatric Brain Tumor Consortium relative to the use of anti-angiogenesis agents and the treatment of patients with supratentorial malignant gliomas and infratentorial brainstem gliomas.

REFERENCES

Functional Neuroradiology of Pediatric Brain Tumors
Robert A. Zimmerman, MD

Presurgical Brain Mapping (Functional MR Imaging/Diffusion Tensor Imaging) for Pediatric Brain Lesions
Nolan R. Altman, MD

Quantitative, Evolving Neuroradiology of Neonatal Hypoxic Ischemic Injury
A. James Barkovich, MD

LEARNING OBJECTIVES
Upon completion of this presentation, participants will be able to:
1) Review the value of MR in the assessment of neonatal brain injury.
2) Define the imaging characteristics of neonatal brain injury as they evolve.
3) Recommend the optimal time for MR imaging in encephalopathic neonates.

PRESENTATION SUMMARY
Modern neuroimaging provides precise presurgical evaluation of pediatric patients. The majority of the patients evaluated are those with brain neoplasms and epileptogenic regions. Functional MR and DTI studies are tailored specifically for lesions identified on anatomical imaging. The fMR paradigms and the DTI fiber tracts are planned accordingly. Case studies will demonstrate the utility of these modalities in the presurgical work up of these children.
Neonatal encephalopathy is a common problem in which a neonate has an abnormal neurologic exam or neonatal seizures. MR imaging can be a useful tool to assess the cause of neonatal encephalopathy. This lecture will discuss how anatomical MR imaging in conjunction with diffusion imaging and proton MR spectroscopy can help to assess the type and severity of brain injury. It also will emphasize the rapid evolution of imaging findings over the first 7-10 days after the injury occurs.

**Monday Afternoon**

**1:30 PM - 3:00 PM**

**Ballroom ABC**

(8) Socioeconomic Programming:
Comparative Effective Research
Audience Response Plus (AR+)*
Self-Assessment Module (SAM)**

(90) Introduction of Comparative Effective Research - What Neuroradiologists Need to Know in 2010
— Frank J. Lexa, VII, MD, MBA

(91) Comparative Effective Research - Why Is It Important to Your Practice?
— Jeffrey G. Jarvik, MD, MPH

(92) Comparative Effective Research Challenges and Pitfalls
— David J. Seidenwurm, MD

Moderator: Scott Gazelle, M.D., PhD, MPH

*An educational grant was received by Bayer Healthcare Pharmaceuticals, Inc. in support of the Audience Response Plus+ (AR+) technology in the Maintenance of Certification (MOC) Review Sessions.

**Session is under review as of April 6, 2010 by the American Board of Radiology to meet the criteria for self-assessment toward the purpose of fulfilling requirements in the ABR Maintenance of Certification. To obtain current SAM credit information, visit www.asnr.org.

**Introduction of Comparative Effective Research - What Neuroradiologists Need to Know in 2010**

Frank J. Lexa, VII, MD, MBA

**Learning Objectives**

Upon completion of this presentation, participants will be able to:
1) Define CER and how it pertains to imaging.
2) Discuss current methodology in CER research.
3) Discuss the use of CER by government, payors, physicians and other key stakeholders in the US health care system.

**Presentation Summary**

Comparative Effectiveness Research has increased in prominence in the USA in recent years and that accelerated with explicit funding in the stimulus package and in the health reform proposals. Neuroradiologists need to understand what CER is, what it isn’t, and what it’s limitations are. Most importantly, they need to understand how they can be involved and what uses and perhaps abuses of CER will affect their careers.

**Comparative Effective Research - Why Is It Important to Your Practice?**

Jeffrey G. Jarvik, MD, MPH

**Learning Objectives**

Upon completion of this presentation, participants will be able to:
1) Explain the importance of comparative effectiveness research (CER) in the evidence hierarchy.
2) Describe how CER is likely to be used by CMS and other payers for reimbursement decisions.
3) Review recent examples of CER.

**Presentation Summary**

Congress, the President, NIH, AHRQ, and industry are all talking about the importance of comparative effectiveness research (CER). I will review why CER suddenly is viewed as so important and how CMS and other payers are likely to use this information. While there are clearly risks associated with embracing comparative effectiveness and evidence-based medicine, the risks of not doing so are even greater.

**Comparative Effective Research Challenges and Pitfalls**

David J. Seidenwurm, MD

**Learning Objectives**

Upon completion of this presentation, participants will be able to:
1) Discuss challenges and pitfalls in Comparative Effectiveness Research.
2) Cite the importance of assessing the relative value of different health states.
3) Select among methods for comparing effectiveness of medical imaging and image-guided procedures.

4) Prepare for further developments in medical technology assessment.

**PRESENTATION SUMMARY**
Comparative effectiveness research seeks to define optimal practice of medicine through direct comparison of outcomes for patients treated one way with those treated another. This is a challenging and complex enterprise that holds great promise and will certainly improve the overall quality of medicine. Significant problems must be overcome in order for this approach to be maximally useful. First, definitions of effectiveness must be specified and refined, and the relative importance of various outcomes must be weighed. It is not clear that a single continuous variable can be defined for patient outcome because preferences differ among subjects systematically as well as idiosyncratically. Furthermore, it is extremely difficult to isolate populations and subgroups of populations for rigorous study when patient autonomy is respected. Many relevant variables are not always distributed unimodally or normally within populations, so interpretations of group means and differences among them may be problematic. Some also challenge the notion that a procedure that produces equal results at a lower monetary cost is superior. The enterprise of comparative effectiveness research will be enormously expensive because of the number of questions to be asked and the need to update results frequently as technology evolves. Translating the results of comparative effectiveness studies into clinical practice has been challenging, even when the stakes are relatively low and general consensus in the medical community has been achieved. Results of studies using this methodology must be adopted or criticized using the same standards that are applied to research conclusions using other commonly accepted methodological and conceptual frameworks. Recent examples of controversy regarding well studied, widely applied screening, diagnostic and therapeutic procedures relating to breast and prostate cancer provide concrete examples of the problems and promise of current methods of comparative effectiveness problem solving. Neuroradiologic applications are less well defined, and suffer from challenges primarily related to crossover and confounding due to downstream treatment effects and outcome heterogeneity that overwhelm the differences among imaging techniques. Furthermore, functional specialization within the brain and spinal cord require that imaging findings are used as indirect outcome measures, limiting the space within which direct comparison of imaging modalities can be studied. Interventional techniques may offer a greater opportunity for comparative effectiveness research if structured correctly. Recent examples illustrate the challenges in the area of back pain and other domains. Patient skepticism regarding research results that are contrary to previous practice also can diminish the impact of comparative effectiveness research.

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**Sinus CT: Beyond the Osteomeatal Complex**
Amit M. Saindane, MD

**LEARNING OBJECTIVES**
Upon completion of this presentation, participants will be able to:
1) Review the major drainage pathways for the paranasal sinuses.
2) Describe common anatomical variants that are important in planning for endoscopic sinus surgery.
3) Utilize sagittal images to demonstrate important aspects of the frontal sinus drainage pathway.

**PRESENTATION SUMMARY**
Sinusitis is an extremely common medical problem in the United States, affecting 14-16% of adults. Imaging is complementary to the clinical and endoscopic evaluation of patients with sinusitis, and an essential part of presurgical evaluation and monitoring of refractory, recurrent, and postsurgical disease. CT is the modality of choice to evaluate the bony architecture of the nasal cavity and the paranasal sinus drainage pathways. An understanding of the complex anatomy of the paranasal sinus drainage pathways and their relationship to adjacent orbital, vascular, and intracranial structures is critical for planning of effective and safe endoscopic sinus surgery. Evaluation of the ostiomeatal unit (OMU) on coronal images is no longer sufficient for presurgical planning, as endoscopic surgery is directed based on patterns of disease at subites of the OMU such as the frontal sinus outflow tract, maxillary sinus ostium, anterior ethmoid complex, or at posterior drainage pathways of the posterior eth-

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**Monday Afternoon**
1:30 PM - 3:00 PM
Room 312

(9) General Session: Head and Neck: Sinus

(93) Sinus CT: Beyond the Osteomeatal Complex
— Amit M. Saindane, MD

(94) Imaging for Failed Endoscopic Sinus Surgery
— Patricia A. Hudgins, MD

(95) Invasive and Aggressive Sinonasal Cavity Processes
— Ashley H. Aiken, MD

Moderator: Patricia A. Hudgins, MD
mold and sphenoid sinuses. The frontal sinus drainage pathway is the most complex, and careful attention to sagittal reformats is imperative to understanding its relationship to normal anatomical structures and anatomical variants that may predispose to recurrent sinus disease. Sinonasal anatomy and important normal variants will be reviewed during this presentation with a focus on their importance in planning for endoscopic surgery.

**References**


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**Imaging for Failed Endoscopic Sinus Surgery**

Patricia A. Hudgins, M D

**Learning Objectives**

Upon completion of this presentation, participants will be able to:

1. Identify imaging findings frequently seen in a patient with recurrent sino-nasal inflammatory disease after endoscopic sinus surgery (ESS).
2. Demonstrate the CT findings that may predispose to surgical or treatment complications after ESS.

**Presentation Summary**

Although endoscopic sinus surgery carries a high success rate, recurrent inflammatory disease and associated symptoms may occur even after definitive surgery and meticulous postoperative care. Recurrent infection may be secondary to systemic disease processes, such as ciliary dysmotility or sino-nasal polyposis syndromes, and CT findings are predictable. These will be reviewed during this presentation, with an emphasis on findings that usually require repeat surgery. Recurrent disease also may occur due to ostial restenosis at the maxillary sinus, frontal outflow tract, ethmoid complex, ostiomeatal complex, or posterior ethmoid and sphenoid location. Each sinus is prone to a specific mechanical obstruction, and the different lesions contributing to each chamber restenosis will be reviewed. Examples include residual uncinate process, obstructing variant frontal cells, prominent ethmoidal variants (agger nasi, ethmoid bulla, etc) and ostial osteoneogenesis. Obstructing sinus lesions have been described thoroughly in the surgical literature, and will be discussed so that the interpreting radiologist is familiar with concepts and terms used by referring surgeons. Finally, with each subsequent surgery there is increased risk of surgical complications. Patient safety is of paramount concern for both the rhinologic surgeon and the radiologist. Imaging findings that may contribute to or increase surgical risk will be described carefully. A collegial relationship between the radiologist and the surgeon is the ultimate goal, and can only improve outcomes and patient safety.

**References**


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**Invasive and Aggressive Sinonasal Cavity Processes**

Ashley H. Aiken, M D

**Learning Objectives**

Upon completion of this presentation, participants will be able to:

1. Recognize the imaging appearance of invasive fungal sinusitis on CT and MR imaging.
2. Recognize the complications of invasive fungal sinusitis and bacterial sinusitis, including intraorbital and intracranial invasion.
3. Review the clinical presentation, diagnosis and treatment options for invasive fungal sinusitis and complicated bacterial sinusitis.

**Presentation Summary**

The role of CT and MR imaging in diagnosis of aggressive sinonasal processes will be addressed. Emphasis will be on the imaging appearance of invasive fungal sinusitis. Early CT imaging findings will be reviewed, along with clinical presentation and population at risk, in order to emphasize the importance of high clinical suspicion and early diagnosis. The complimentary role of MR to characterize late complications such as intraorbital, intracranial or vascular invasion also will be covered. Other nonneoplastic aggressive sinonasal processes also will be discussed, including complications of bacterial rhinosinusitis, sarcoidosis, Wegener’s granulomatosis, and irritants such as cocaine.

**References**

5. Silverman CS, Mancuso AA. Periantral soft-tissue infiltra-
tion and its relevance to the early detection of invasive fun-
gal sinusitis: CT and MR findings. AJNR Am J Neuroradio.
1998;19:321-325

Monday Afternoon
1:30 PM - 3:00 PM
Room 208

(10) Synaptic Junction Programming -
Lecture: Do We Really Need
Standardized Reporting?
“Point-Counter Point”

(96) The Advantages of Structured Reporting
— C. Douglas Phillips, M D, FACR

(97) The Myth of Structured Reporting
— Barton F. Branstetter IV, M D

Debate

The Advantages of Structured Reporting
C. Douglas Phillips, M D, FACR

Learning Objectives
Upon completion of this presentation, participants will be
able to:
1) Identify pressures to make standardized reports a routine
practice policy.
2) Identify payor expectations.
3) Identify clinician expectations for reports.

Presentation Summary
I will discuss why standardized reporting is critical to ensure
reimbursements, meet our clinical expectations, and also
improve patient care.

The Myth of Structured Reporting
Barton F. Branstetter IV, M D

Learning Objectives
Upon completion of this presentation, participants will be
able to:
1) Cite the benefits and risks of using Structured Reporting
in Radiology.

2) Identify areas of uncertainty and incomplete research in
our knowledge of the impact of Structured Reporting.

Presentation Summary
Many organizations, including the RSNA, have been emphasi-
sing the benefits of reorganizing every radiology report
into a format that makes the radiologist's interpretation more
understandable to clinicians and to computers: Structured
Reporting. But do we really have the tools and infrastructure
we need to make the move to Structured Reporting? Will it
herald a golden age of Radiology, or is it just one more
obnoxious barrier to efficiency? What are the benefits and
risks of making this major change to the way we do our jobs?
Two radiologist/informaticians will debate this issue back
and forth in a point-counterpoint format. You can expect the
fur to fly!

Monday Afternoon
3:30 PM - 5:00 PM
Ballroom ABC

(11a) Adult Brain: Neoplasms I
(Scientific Papers 98 - 108)

See also Parallel Sessions
(11b) Adult Brain: Epilepsy and Other
(11c) Pediatric: Functional Imaging
(11d) Head and Neck: New Techniques

Moderators: Pratik Mukherjee, M D, PhD
Esperanza Pacheco, M D

Paper 98 Starting at 3:30 PM, Ending at 3:38 PM
New Approach to Imaging of Tumor Vascularity in
Malignant Glioma: MR Imaging at 7 T

Gerigk, L.1 · Biller, A.2 · Nagel, A.3 · Dinkel, J.4 · Schuster,
L.4 · Hauser, T.1 · Puderbach, M.1 · Essig, M.1 · Delorme, S.1
· Bock, M.1
1German Cancer Research Center, Heidelberg, GERMANY,
2University Hospital Heidelberg, Heidelberg, GERMANY

Purpose
New antiangiogenic agents like Bevacizumab used in the
therapy of malignant glioma suppress the extravasation of
contrast agents, making MR imaging (MRI) therapy moni-
toring based on the extent of contrast enhancement unreli-
able. Perfusion quantification is not well established in clin-
cal settings because of standardization and reliability issues.
Therefore, our goal was to design an imaging protocol for
direct imaging of the tumor vasculature using high-resolu-
tion MRI at 7 T.
Materials & Methods
Fifteen patients with astrocytomas including glioblastoma multiforme (GBM) were examined on a 7 T whole body system using a 24-channel head coil. Pulse sequences used were: 2D T2 turbo spin-echo (TR 12000, TE 57 ms, 0.3 × 0.3 × 2.0 mm voxel size), T1 3D FLASH (TR 6.6, TE 2.38 ms, 0.5 × 0.5 × 0.7 mm), T2 FLAIR (TR 12000, TE 94 ms, 0.6 × 0.4 × 2.5 mm), SWI (TR 23, TE 15 ms, 0.5 × 0.4 × 0.4 mm) and time-of-flight angiography (TOF-MRA, TR 15, TE 4.76 ms, 0.3 × 0.3× 0.4 mm). T1 sequences were acquired unenhanced, after administration of Gd-BOPTA or both. For identification of intratumoral vessels, a targeted MIP of the TOF-MRA with a thickness of 15 mm was registered to the T1- and susceptibility-weighted images.

Results
The resolution of T2- and T1-weighted imaging (A) could be improved up to a resolution of 0.3 mm voxel size at an acquisition time of 4.5 to 6.5 minutes per sequence. The TOF-MRA was superior to the T1- and T2-weighted sequences in visualizing the arterial tumor vessels (B). After registration of a thin slice MIP to morphologic images, the vessels could be identified clearly as tumor vessels. Susceptibility-weighted imaging showed the venous vessels, but also susceptibility artifacts caused by microhemorrhage or surgery. The image fusion of SWI with TOF-MRA depicted arterial and venous vessels simultaneously.

Conclusion
A high resolution of up to 0.3 mm voxel size can be obtained in an acceptable imaging time at 7 T. The high detail of T2- and T1-weighted imaging can be used to investigate the internal morphology of brain tumors. Time-of-flight MRA and SWI at 7 T can depict the arterial and venous intratumoral vasculature. High-resolution structural imaging is a straightforward approach, which is independent of the functional blood-brain barrier. This is important in the monitoring of antiangiogenic therapies, which can alter the blood-brain barrier unpredictably. As a feasible protocol for imaging glioma at 7 T, we recommend a combination of T2 TSE, T2 FLAIR, T1 GRE and TOF angiography before and T1 GRE and SWI after application of contrast media.

Key Words: 7 T MR imaging, angiogenesis, glioma

Purpose
Bevacizumab, a monoclonal antibody targeting the vascular endothelial growth factor receptor, is gaining wide clinical use in the treatment of recurrent glioblastoma multiforme (GBM). The purpose of this study was to determine whether MR imaging (MRI)-derived tumor volume and diffusion-weighted imaging-derived apparent diffusion coefficient (ADC) can predict early treatment failure in recurrent GBM patients undergoing bevacizumab therapy.

Materials & Methods
Twenty-four patients with histopathologically confirmed GBM who were treated with bevacizumab for clinical evidence of recurrence were recruited into this retrospective study. Patients received a pretherapy MRI 2 weeks prior to the first administration of bevacizumab and a follow-up MRI every 6 weeks thereafter. The following data were derived from the pretherapy and first posttherapy MRI exams: 1) anatomical tumor region volumes, including the contrast-enhancing region (CEL) on enhanced T1-weighted images, the peritumoral region (PTL) and the entire T2 region (T2L) excluding the surgical cavity depicted on fluid-attenuated inversion recovery (FLAIR) images; and 2) average, minimum and maximum ADC values within the T2L. The ADC values were normalized against the contra-lateral normal-appearing white matter to reduce interpatient variability and were expressed as a ratio value. All patients had survival data available at the time of analysis. Postrecurrence survival was calculated from time of pretherapy MRI. Postrecurrence survival ranged from 2.5 to 17.5 months (mean 10.2 ± 4.07) in all patients. The average postrecurrence survival was used to divide the patient group into two groups: short-term survival (n = 11, mean 6.7 ± 2.11) and long-term survival (n = 13, mean 13.2 ± 2.55). The anatomical tumor volumes and ADC values were compared between the two survival groups.

Results
A statistically significant decrease in anatomical tumor volume between pre and posttherapy MRI, as measured by CEL, PTL, and T2L, was observed (p < 0.05). The long-term survival group exhibited a statistically significant reduction in mean posttherapy anatomical tumor volume within the T2L (54 cm² vs 11.9 cm² decrease) and PTL regions (42 cm² and 27 cm² decrease) compared to the short-term survival group. The volume of CEL decrease was similar between short- and long-term survival groups (11.9 cm² and 11.5 cm²). The degree of ADC decrease, as defined by T2L volume, was found to be similar between the short- and long-term survival groups (0.19 and 0.17, P > 0.05).

Conclusion
The results of our study suggest that the decrease in tumor volume, especially the volume of nonenhancing FLAIR abnormality, on anatomical MRI following bevacizumab...
therapy were statistically greater in those patients with recurrent GBM who lived greater than 10 months from the initiation of the therapy. Changes in tumor ADC values following therapy did not predict the survival difference.

**Key Words:** Bevacizumab, glioblastoma multiforme, diffusion-weighted imaging

**Paper 100 Starting at 3:46 PM, Ending at 3:54 PM**

**Preoperative Grading Nonenhancing Cerebral Gliomas and Neuronal-Glial Tumors Using MR Perfusion, Diffusion Tensor and Spectroscopic Imaging**

Liu, X. · Tian, W. · Kolar, B. · Ekholm, S.

University of Rochester School of Medicine & Dentistry Rochester, NY

**Purpose**

It is important to add functional techniques besides conventional MR imaging for preoperative grading of nonenhancing supratentorial gliomas and neuronal-glial tumors (NEGGNT) as earlier studies have indicated that up to 45% of the nonenhancing supratentorial gliomas are malignant. The aim of this study was to compare some of the new functional imaging methods, including diffusion tensor imaging (DTI), MR perfusion-weighted imaging (PWI) and MR spectroscopic imaging with regard to their ability in differentiating between low and high-grade NEGGNT.

**Materials & Methods**

A total of 50 patients with histology confirmed NEGGNT were included. Of those, 33 patients had a low-grade tumor (WHO grade 1 and 2) and 17 high-grade (WHO grade 3 and 4). The imaging parameters, including maximal relative cerebral blood volume (rCBV), minimal fractional anisotropy (FA), mean FA and mean FA ratio, minimal trace apparent diffusion coefficient (trace ADC), Choline/Creatine (Cho/Cr) and Choline/N-acetylaspartate (Cho/NAA) ratios in the tumors were compared and the results were tested by Mann-Whitney U test and receiver operating characteristic (ROC) analyses for optimal grading threshold.

**Results**

The mean values of each imaging parameter and the statistical results are summarized in the Table. In general, there were significant differences of mean FA, mean FA ratio and maximal FA between low- and high-grade NEGGNT (p < 0.05), but no significance was found for maximal rCBV, minimal ADC, Cho/Cr and Cho/NAA ratios. Furthermore, an ROC analysis showed that a maximal FA cutoff value of 0.264 differentiated between low- and high-grade tumor with a sensitivity of 91.7% and a specificity of 88.9%, which is better than the other imaging parameters.

**Conclusion**

The study suggests that the maximal FA value is the best of the evaluated parameters for grading of NEGGNT, better than maximal rCBV, and the Cho/Cr and Cho/NAA ratios in MR spectroscopy imaging. The maximal FA value could serve as an adjuvant tool to improve the differentiation between low- and high-grade in nonenhancing supratentorial tumors.

**Key Words:** Gliomas and neuronal-glial tumors, diffusion tensor imaging, MR perfusion imaging

**Paper 101 Starting at 3:54 PM, Ending at 4:02 PM**

**Enhancing Fraction and Survival in Glioblastoma Multiforme**

Mills, S. J. · Soh, C. · Thompson, G. · Buonacorss, G. · McBain, C. · Parker, G. J. M. · Jackson, A.

1Imaging Science and Biomedical Engineering, Manchester, UNITED KINGDOM, 2Salford Royal Foundation Trust Hospital, Manchester, UNITED KINGDOM, 3Christie Hospital, Manchester, UNITED KINGDOM

**Purpose**

Dynamic contrast-enhanced MR imaging (DCE-MRI) has shown prognostic potential in glioblastoma multiforme (GBM). Enhancing fraction (EnF) is a recently described DCE-MRI derived measure (1-3). It quantifies the proportion of a tumor that enhances and in GBM has been shown to correlate with Ktrans (contrast agent transfer coefficient) derived from DCE-MRI (3). The objective of this study was to evaluate the prognostic value of EnF in GBM.

**Materials & Methods**

Fifteen patients with GBM were recruited. All underwent standard radiotherapy with adjuvant and concomitant temozolamide. All imaging was performed prior to surgery on a 3 T MR scanner. Imaging included T2-weighted DCE-MRI and anatomical sequences. Voxel was classified as enhancing if the initial area under the contrast concentration curve (IACUC) was greater than 0 mMol.s (EnFIAUC60<0). A threshold of IACUC > 2.5 mMol.s was used to generate thresholded EnF (EnFIAUC60>2.5). Parametric maps of IACUC, Ktrans, vP, and vE were generated. The prognostic value of patient age, sex, tumor volume, EnFIAUC60<0, EnFIAUC60>2.5, median IACUC, median Ktrans, median vP, and median vE were assessed using a multivariate Cox regression analysis.

**Results**

Examination of survival data from deceased patients demon-
stratified a linear relationship between $\text{EnF}_{\text{IAUC60>0}}$ and patient survival ($p < 0.05$, $R^2 = 0.525$, Figure 1). Only $\text{EnF}_{\text{IAUC60>0}}$ was identified as an independent prognostic factor ($p < 0.05$).

Figure 1. Scatter plot of $\text{EnF}_{\text{IAUC60>0}}$ and patient survival. Linear regression analysis (of deceased patients) shows increased survival with increased $\text{EnF}_{\text{IAUC60>0}}$ ($p < 0.05$).

**Conclusion**

This preliminary study suggests a possible relationship between $\text{EnF}$ and length of survival in patients with GBM. We hypothesized that this relationship reflects the effect of increasing intracranial pressure in the face of failing physiological compensation mechanisms, resulting in a fall in the enhancing proportion.

**References**


**Key Words:** Enhancing fraction, glioma, survival

**Materials & Methods**

Inclusion criterion for this study was presence of new enhancing lesion(s) on contrast-enhanced MR (CE MR) within the radiation field in patients with treated high-grade (WHO grade III/IV) gliomas. Thirty-six enhancing lesions in 33 patients satisfying the inclusion criterion were examined prospectively with DWI, perfusion MR and 3D-MRS on a 1.5 T scanner (Siemens Avanto, Erlangen, Germany). Homogenous restriction of diffusion was the criterion for tumor diagnosis since definite ADC cut-offs were not available in literature. On the other hand, normalized mean rCBV $>1.5$ and normalized metabolite ratios (Cho/NAA and/or Cho/Cr) $>1.7$ were the criteria for tumor diagnosis based on published literature. Composite gold standard consisting of histopathology and clinico-radiologic follow up was used for final categorization. In addition, data were analyzed retrospectively to compute ADC, rCBV and metabolite ratio cut-offs for predicting tumor recurrence.

**Results**

Based on the composite gold standard, 24 lesions in 23 patients were classified as tumor recurrence and 12 lesions in 10 patients were classified as treatment-induced changes. The specificity and positive predictive value (PPV) of DWI as well as of PWI using the aforementioned criteria were 100%. However, sensitivity (67% and 57%) and negative predictive value (NPV) (60% and 52%) and accuracy (78% and 67%) were low. MR spectroscopy had low sensitivity (76%), specificity (45%), PPV (73%), NPV (50%) and accuracy (67%). A analysis of different combinations of modalities revealed highest sensitivity (92%), specificity (100%), PPV (100%), NPV (86%) and accuracy (84%) for the combination of DWI with PWI. On retrospective analysis, rCBV ratios were significantly lower in the recurrent tumor group ($p < 0.05$). However, since area under ROC curves (AUC) was not significant ($<0.8$), AUC thresholds for differentiation between the two groups could not be computed. Normalized rCBV was significantly higher in the recurrent tumor group ($p < 0.05$). Minimal, maximal and mean rCBV thresholds yielding optimal sensitivity (74-78%) and specificity (91%) were 1.5, 1.7 and 1.8 respectively. Although the relatively small sample size of this study cautions against over-interpretation, qualitative analysis of DWI in combination with quantitative analysis of perfusion MR is a promising approach in differentiation of recurrent glioma from treatment-induced changes. MR spectroscopy was found not to contribute significantly to the combination due to frequent overlap of metabolite ratios between the two groups.

**Conclusion**

Qualitative DWI analysis for homogenous restriction, as against quantitative grading in terms of ADC, shows potential in differentiation of recurrent tumor from treatment-induced changes. Perfusion MR is the most suitable of the three modalities for characterizing the inherently heterogeneous new enhancing lesions in patients with treated gliomas. Normalized minimal, maximal and mean rCBV thresholds yielding optimal sensitivity (74-78%) and specificity (91%) were 1.5, 1.7 and 1.8 respectively. Although the relatively small sample size of this study cautions against over-interpretation, qualitative analysis of DWI in combination with quantitative analysis of perfusion MR is a promising approach in differentiation of recurrent glioma from treatment-induced changes. MR spectroscopy was found not to contribute significantly to the combination due to frequent overlap of metabolite ratios between the two groups.

**Key Words:** Glioma recurrence, diffusion, perfusion

**Purpose**

To examine the usefulness of diffusion-weighted imaging (DWI), dynamic susceptibility contrast perfusion MR and multivoxel 3D MR spectroscopy (MRS), alone and in combination, in differentiation of recurrent or progressive glioma from treatment-induced changes.
Conjoint Parameter of Cerebral Blood Volume and Permeability from CT Perfusion: Is It a Better Parameter for Grading and Prognostication of High-Grade Gliomas?

Shankar, J. J. S. · Woulf, J. · Da Silva, V. · Nguyen, T.
The Ottawa Hospital
Ottawa, ON, CANADA

Purpose
The prognosis of patients presenting with a glioma depends on the histologic grade of the lesion. Conventional imaging techniques are not always accurate in differentiating the different histologic grade of the gliomas including higher grade gliomas (HGG). All HGG are known to have poor prognosis. It has been difficult to differentiate the HGG based on imaging so the prognostication of the gliomas on imaging is equally difficult. CT perfusion (CTP) reflects the vascularity and thereby possibly grade of the tumors. The purpose of this study was to assess the accuracy of CTP in differentiating HGG and to assess the perfusion parameters for the prognostication of patients with HGG.

Materials & Methods
Patients with suspected glioma on the routine head imaging were studied prospectively with CT perfusion before undergoing either biopsy or surgery. Images were acquired every second for 99 seconds starting 5 to 10 seconds after injection of 40 cc of Omnipaque 300 (4 cc/s) using 80 kVp, 190 mA, 512 x 512 matrix. Permeability surface area product (PS) and cerebral blood volume(CBV) maps were generated using the CT perfusion 3 software using deconvolution method. Regions of interests were obtained from areas of tumor with highest CBV and PS values and were correlated with the histologic grade of gliomas following biopsy or excision. Cerebral blood volume, PS and CBV+PS were compared between the grades of HGG and between gliomas and normal white matter (NWM). Sensitivity (Sn), specificity (Sp), positive predictive value (PPV), negative predictive value (NPV) were calculated. All the patients were followed up on different forms of therapy. Cox-regression analysis was performed to correlate the different parameters with that of the follow-up period. Hazard ratios were calculated and a Kaplan-Meier survival curve was drawn for the patients with HGG.

Results
Total of 20 (5 grade 3 and 15 grade 4) patients were included in our study. The mean CBV and PS for NWM were 0.947 ml/100 g and 0.57 ml/100 g/min respectively. The mean CBV was 4.17 ml/100 g for grade 4 gliomas and 3.53 ml/100 g for grade 3 gliomas, 0.93 ml/100g. The mean PS was 8.12 ml/100g/min for grade 4 gliomas and 3.82 ml/100g/min for grade 3 gliomas. Cerebral blood volume and PS were significantly different (p < 0.0001) between the gliomas and NWM. The grade 3 and grade 4 gliomas had significantly different PS (p = 0.022) (at PS >= 3.5 ml/100 g/min, Sn-86.67%, Sp-60%, PPV-86.67%, NPV-60%) and CBV + PS (p = 0.019) (at PS + CBV >= 9, Sn-66.67%, Sp-80%, PPV-90.91%, NPV-44.44%) but not significantly different CBV (p = 0.411) (at CBV >= 3.5 ml/100 g, Sn-86.67%, Sp-60%, PPV-86.67%, NPV-60%). Mean follow-up period was 10.2 months (1-44 months). There was significant rela-
tionship between the outcome of patients with age (p = 0.034) and the conjoint parameter of CBV + PS (p = 0.049). Hazard ratio for CBV + PS of more than 9 was 6.009 (p = 0.046) and hazard ratio increased by 7% per year with age.

Conclusion
CT perfusion derived PS and CBV + PS may be a better parameter for differentiating the HGG than CBV. The outcome of the patients with HGG was related significantly to age of the patient and CBV +PS. The CBV and PS may have an additive effect on outcome of patients with HGG.

Key Words: CT perfusion, high-grade glioma, cerebral blood volume

MR qBOLD Measurements of Oxygen Extraction Fraction and PET-Measured Cellular Proliferation Using [18F] Fluorine-Labeled Thymidine in High-Grade Gliomas

Benzinger, T. L. S. · Massoumzadeh, P. · Rich, K. · Christensen, J. · M intun, M. · Jost, S. · Yablonskiy, D. · He, X. · Chen, D.
1Washington University School of Medicine St. Louis, Saint Louis, MO, 2Swedish Hospital, Seattle, WA

Purpose
To evaluate qBOLD MR (1, 2) and FLT-PET (3) measurements in the assessment of high-grade primary glial neoplasms (WHO IV).

Materials & Methods
Five subjects with incompletely resected high-grade gliomas were recruited prospectively to a longitudinal imaging study. Nine imaging visits with both FLT-PET and qBOLD MR (3 T) were obtained. A total of 28 regions of interest (ROI’s) were identified based upon the clinical MR imaging, which included standard imaging pre and postcontrast, diffusion tensor imaging (DTI), and dynamic susceptibility contrast perfusion (DSC). Regions of interest were classified as representing (1) enhancing tumor, (2) nonenhancing tumor, (3) vasogenic edema, or (4) normal tissue, based upon clinical interpretation of the MR images, including all available follow-up data. A fter offline postprocessing in M atlab, both the OEF and FLT maps were registered to the clinical MR using a semiautomated technique. Quantitative values of OEF and FLT were measured for each of the regions; for each measurement, ratios of activity in tumor vs normal white matter in the contralateral hemisphere were obtained.

Results
Within areas of residual enhancing tumor, both OEF and FLT ratios were elevated: mean (SD) OEF 1.33 (0.36); FLT 4.86 (3.6). FLT uptake in vasogenic edema was elevated [FLT 1.6 (0.37)] but was lower than that of residual nonenhancing tumor (FLT 6.52). Conversely, the highest areas of OEF corresponded to vasogenic edema [1.90, (1.56) max 5.0] and no OEF elevation was identified in areas of postsurgical enhancement. FLT uptake varied from tumor to tumor; within a given scan, FLT values for tumor and postsurgical enhancement were not different (p > 0.05). OEF varied from tumor to tumor. Within a given scan, OEF values for enhancing and nonenhancing tumor were not different (p > 0.05).
CONCLUSION

This study compares two distinct properties brain tissue in the setting of high-grade glioma - OEF measured by qBOLD MR and cellular proliferation measured by FLT-PET. Both techniques demonstrated elevations in nonenhancing residual tumor, but gave divergent results for vasogenic edema and postsurgical enhancement. This approach may be helpful for distinguishing between nonenhancing tumor and vasogenic edema. Additional subjects and continued longitudinal follow up is needed to fully evaluate the potential of these techniques.

REFERENCES

KEY WORDS: Glioma, FLT-PET, qBOLD

RESULTS

All biopsies (13 enhancing regions and 12 nonenhancing regions) were infiltrated with malignant tumor cells. Quantitative CE (mean; 170 vs 93), rCBV (4.0 vs 1.27), and microvascular density (4.0% vs 0.8%) measurements were found to be elevated significantly within enhancing regions compared to nonenhancing regions (P<0.01). Relative PSR measurements were found to be reduced within enhancing regions compared to nonenhancing regions (71% vs 94%; P 0.01). Given that histopathologic and MRI characteristics of angiogenesis were regionally differentially expressed; we prospectively assessed six distinct biological pathways (57 genes; VEGF, HIF, PDGF, FGF, HGF, EGFR) previously implicated in the up-regulation of GBM angiogenesis. Twenty-five of the 57 identified genes (4 of 6 biological pathways; VEGF, PDGF, HIF, FGF) were differentially expressed between enhancing and nonenhancing regions (Adj P < 0.05). Regression analysis showed statistically significant correlation (P < 0.04) between VEGF expression and microvascular density (R = 0.41), rCBV (R = 0.51), rPSR (R = 0.48), and qCE MRI measurements (R = 0.70) (Figure 1C).

CONCLUSION

In this preliminary study regional cellular and molecular biomarkers of GBM angiogenesis were found to strongly correlate with DSC perfusion and qCE MRI measurements. These findings provide biological evidence that may account for GBM’s heterogeneous morphologic appearance on MRI and may prove beneficial to clinicians when noninvasively selecting regions of highest GBM malignancy for diagnostic biopsy sampling.

KEY WORDS: Glioblastoma, MR imaging, angiogenesis


**Paper 106 Starting at 4:34 PM, Ending at 4:42 PM**

**MR-Based Imaging Biomarkers in the Assessment of Bevacizumab Efficacy in Symptomatic Radiation Necrosis of the Brain**

Jackson, E. F. · Levin, V. A. · Hou, P. · Bidaut, L. M. · Bekele, N. · Kumar, A. J.

M. D. Anderson Cancer Center
Houston, TX

**PURPOSE**

To evaluate MR-based imaging biomarkers as a means for assessing the effects of bevacizumab in the treatment of symptomatic radiation necrosis of the brain.

**MATERIALS & METHODS**

A placebo-controlled randomized double-blind study of bevacizumab for the treatment of CNS radiation necrosis was conducted. Fourteen patients were enrolled in the study and each patient had imaging or biopsy proof of radiation necrosis. Patients were randomized to receive iv saline or bevacizumab at 3-week intervals. Clinical signs and symptoms and MR imaging data obtained three weeks after the second treatment were used to define response or progression. All baseline and each 3-week follow-up interval, contiguous thin section (3 mm) T2 FLAIR MR images (axial and coronal planes) and dynamic contrast agent enhanced MR imaging (DCE M R I) data (fourteen 5 mm contiguous sections with ~10 second temporal resolution) were obtained using a GE 3.0 T Excite HDx scanner. Two compartment pharmacokinetic modeling of the DCE M R I data was performed on a pixel-by-pixel basis from regions of interest defined by the study radiologist. Median $K_{trans}$ (volume transfer constant, 1/min), $K_{ep}$ (contrast agent reflux rate, 1/min), and $v_e$ (extravascular, extracellular volume fraction, unitless) measures were computed and compared across time points. To account for the substantial increase in the volume of enhancing tissue following bevacizumab administration, the $K_{trans}$ and other imaging biomarker measures also were computed after weighting the measures by the number of pixels demonstrating contrast enhancement.

**RESULTS**

All bevacizumab-treated patients (5/5 randomized and 6/6 cross-over) demonstrated decreases in $T_2$ FLAIR volumes (median: -59%, p-value 0.015), $T_1$ gadolinium-enhanced volumes (median: -63%, p-value 0.006), and normalized $K_{trans}$ measures (median: -99%, p-value 0.023). No patient receiving placebo (0/7) demonstrated such decreases and, in fact, all measures increased in this cohort ($T_2$ FLAIR volumes: +14%; $T_1$ gadolinium-enhanced volumes: +17%; normalized $K_{trans}$ measures: +49%). All patients receiving bevacizumab, and none receiving placebo, demonstrated improved neurologic symptoms or signs. At 8 months (median) after last dose of bevacizumab, only one patient experienced recurrence of radiation necrosis, based on radiologic evaluation, and this patient received only two treatments of bevacizumab.

**CONCLUSION**

While bevacizumab has been shown previously to have a profound effect on CNS tumors, as reflected by the volume of contrast enhancement, this study provides the first evidence of bevacizumab efficacy in the treatment of radiation necrosis. Both anatomical ($T_2$ FLAIR and $T_1$ gadolinium-enhanced volumes) and functional (DCE MRI K-trans) imaging biomarker measures compared favorably with neurologic symptoms and signs assessments, thereby reinforcing the potential of image-derived parameters as valid biomarkers for disease characterization and therapy response assessment.

**KEY WORDS:** Radiation necrosis, treatment assessment

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**Paper 107 Starting at 4:42 PM, Ending at 4:50 PM**

**Tumor Vascular Leakiness and Blood Volume Estimates in Oligodendrogliomas Using Perfusion CT: Can These Perfusion Parameters Help Further Characterize Genetic Subtypes as well as Differentiate from Astroglial Tumors?**

Narang, J. · Jain, R. · Schultz, L. · Scarpace, L. · Saksena, S. · Patel, S. C. · Mikkelsen, T.

Henry Ford Hospital
Detroit, MI

**PURPOSE**

Oligodendrogliomas are characterized by typical histopathologic characteristics, a relatively benign course, better response to treatment and favorable outcome in terms of survival as compared to astroglial tumors. The purpose of the study was to determine the usefulness of perfusion CT (PCT) parameters and particularly tumor vascular leakiness estimates [permeability surface-area product (PS)] in the evaluation of oligodendrogliomas (OG), and comparison with astroglial tumors as well as correlation with genetic subtypes of OGs [with or without loss of heterozygosity (LOH) at 1p/19q].

**MATERIALS & METHODS**

Preoperative PCT done in 21 patients (12 females, 9 males; mean age 46.61 years) with histopathology proved OGs was correlated retrospectively with our previously published PCT data for 24 patients with astroglial neoplasms (1). All OGs also were analyzed for genetic subtypes with or without LOH. Perfusion CT parameters PS and cerebral blood volume (CBV) were obtained for the entire lesion and a statistical analysis done to correlate various histopathologic variants.

**RESULTS**

OG subgroups: Low-grade OGs (n = 13) showed slightly lower CBV (1.42 vs 1.72 ml/100 g; p value 0.391) and PS (0.56 vs 0.95 ml/100g/min; p value 0.099) as compared to high-grade OGs (n = 9), though not statistically significant. LOH positive OGs (n = 13) showed higher mean CBV (1.59 vs 1.45; p value 0.712) and slightly lower PS (0.68 vs 0.75; p value 0.718) as compared to LOH negative OGs (n = 8), although not statistically significant. OGs vs astroglial tumors: Low-grade OGs (n = 13) showed slightly higher mean CBV 1.42 ml/100 g as compared to low grade astroglial tumors (n = 8) 0.95 ml/100 g (p value = 0.08), however no statistically significant difference was noted for PS (0.56 vs 0.52 ml/100g/min, p value 0.695). Statistically significant differences were observed in CBV and PS values of high-grade OGs and high-grade astroglial tumors with the high-grade glial tumors showing higher mean CBV (2.79 vs 1.72; p value 0.03) as well as higher PS (2.37 vs 0.95; p value <
0.01), however, these differences were because of disproportionate number of grade IV lesions in both groups.

CONCLUSION
In conclusion, PCT perfusion parameters including PS values could not differentiate OGs into low- and high-grade, even though high-grade OGs showed slightly higher CBV and PS. Similarly LOH positive OGs did show slightly higher CBV as has been reported previously in the literature, but again failed to reach any statistically significant level. Low-grade OGs did show slightly higher CBV as compared to low-grade astroglial tumors as have been described in the literature. This could be explained by the fact that most oligodendroglial tumors are located in cortical areas involving the gray matter and have a rich vasculature of branching capillaries resembling a "chicken wire" pattern. However, the present study did show that despite having slightly higher CBV, most of the OGs do not have high PS values. This could substantiate previous pathology literature which has shown little or no VGEF expression in oligodendroglial tumors irrespective of the grade.

REFERENCES

KEY WORDS: Oligodendroglioma, CT perfusion, astroglial

Paper 108 Starting at 4:50 PM, Ending at 4:58 PM
3D PC Arterial Spin Labeling Outperforms Dynamic Susceptibility Contrast Techniques in the Surveillance of Primary Brain Neoplasms

Velayudhan, V. · Parag, Y. · Tanenbaum, L. N. · Delman, B. · Pawha, P. · Fatterpekar, G. · Naidich, T. P.
Mount Sinai School of Medicine
New York, NY

PURPOSE
Dynamic susceptibility contrast-enhanced (DSC) first pass gadolinium-based perfusion techniques are used routinely in the surveillance of primary brain neoplasms and are of value in differentiating residual or recurrent tumor from treatment-related changes. Dynamic susceptibility contrast-enhanced techniques require the rapid bolus infusion of intravenous gadolinium, which may not be well tolerated by debilitated patients and can be contraindicated in patients with compromised renal function. Interpretation of DSC studies and quantification of perfusion parameters also can be confounded by blood-brain barrier breakdown and capillary leakage. Susceptibility artifact related to bony structures at the skull base and convexity also can interfere with interpretation of EPI-based DSC techniques. Arterial spin labeling (ASL) can visualize and quantify cerebral perfusion via magnetic labeling of water protons in arterial blood without the need for an exogenous contrast agent. The purpose of our study was to establish the practical equivalence of ASL-CBF to DSC and evaluate its performance against DSC in surveillance and characterization of brain neoplasms before and after treatment.

MATERIALS & METHODS
A retrospective study of 30 patients referred for MR imaging of primary brain neoplasms was performed. Whole brain 3D fast spin-echo-based pseudo-continuous ASL studies were added to our established brain tumor imaging protocol, including routine pre and postcontrast imaging as well as DSC. In some cases dynamic contrast-enhanced (DCE) permeability imaging was performed as well. All images obtained were evaluated with knowledge of the clinical circumstances and prior examinations and evaluated by two experienced neuroradiology readers with respect to relative agreement and clinical contribution.

RESULTS
Arterial spin labeling perfusion studies offered equivalent information to that obtained with DSC with superior dynamic range/contrast resolution and reduced artifacts.

CONCLUSION
3D PC ASL provides a useful and noninvasive method for determination of CBF in the routine surveillance of brain neoplasms, offering information equivalent, and in some circumstances superior to contrast-based DSC techniques. Arterial spin labeling provides a suitable substitute for DSC studies in those who are unable to tolerate gadolinium-based contrast agents.

KEY WORDS: Arterial spin labeling, dynamic susceptibility contrast, brain neoplasms

Monday Afternoon
3:30 PM - 5:00 PM
Room 302-304-306

(11b) Adult Brain: Epilepsy and Other (Scientific Papers 109 - 116)

See also Parallel Sessions
(11a) Adult Brain: Neoplasms I
(11c) Pediatric: Functional Imaging
(11d) Head and Neck: New Techniques

Moderators: William P. Dillon, MD
Patrick J. Oliverio, MD
RESULTS
TPMA were associated with several types of seizures/SE and the EEG patterns, most commonly focal epileptiform discharges. On imaging, TPMA were mostly focal unilateral (78.9%), cortico-subcortical (84.2%), hyperintense on long TR sequences, 93.7% with diffusion restriction and 66.6% showing cortico-pial gadolinium enhancement. All type 1 and 2A patterns were focal and unilateral, while 2C presented with CPSE. Sixty percent of type 2B and C had previous and 2A patterns were focal and unilateral, while 2C present-

CONCLUSION
In this study we show that TPMA have a broad electroclinical-imangiological spectrum, attributable to the time-lag between seizures and the studies, seizure dynamics, etiology and cerebral reserve; and that the brain damage induced by them was responsible for a high incidence of clinical sequela. TPMA are best detected in DWI/ADC studies, which may help predict the long-term outcome. Our results may contribute to a better definition and comprehension of TPMA electroclinical-imangiological spectrum, pathophysiology and prediction of long-term outcome.

REFERENCES

KEY WORDS: Status epilepticus, MR imaging

MATERIALS & METHODS
Electrophysiologic-connectivity data were obtained in epilepsy patients with surgically implanted stereotactic electroencephalography (SEEG) electrodes and subdural grid electrodes. Various measures of EC connectivity can be derived from (1) functional arrests after stimulation, (2) seizure propagation patterns, (3) inter-ictal correlations, and (4) direct stimulation of one cortical electrode while recording all other cortical electrodes (CCEP). Prior to implantation, patients underwent preprocedural imaging at 3 T, including HARDI and rsMRI. All electrode positions were coregistered to anatomic imaging. Post-processing for HARDI data included probabilistic tracking between all electrode pairs containing a stimulus, with a similar parallel analysis for rsMRI. Scalar connectivity between electrodes were developed and computed, and compared to EC.
RESULTS
Preliminary results focused on several SEEG probes in one patient, each with up to 12 contacts. On one probe a trigger contact was identified as coinciding with a seizure focus, which then was stimulated electrically while recording all other 92 electrode-contacts. The top figure shows connectivity tracks from the trigger to all 12 contacts on a different probe about 3-4 cm away. Electrode #1 is against the midline, and #12 is around the pial surface. Each pathway is color coded representing the magnitude of a HARDI connectivity score derived from probabilistic tracking. The bottom graphs show three connectivity scores to the same electrodes: EC for CCEP is greatest on cortex adjacent to electrodes #9-10, while HARDI connectivity is greatest at #10 and #11 (5 mm apart). Resting-state functional connectivity showed greatest correlation at electrodes #6 and #7.

CONCLUSION
We present a comparison of EC to IC in the living human brain, and preliminary results show strong concordance. Further data will be presented from all remaining SEEG electrodes, and other patients. Testing of both EP and IC scoring methods complement each other, providing in vivo validation for connectivity. There is substantial clinical benefit for presurgical evaluation of epilepsy patients with multiple candidate foci, which could be rank-ordered by their connectivity.

KEY WORDS: Epilepsy, connectivity, HARDI

Paper 111 Starting at 4:12 PM, Ending at 4:20 PM
Functional Connectivity: MR Imaging of Language Network in Patients with Drug-Resistant Epilepsy

Pravatà, E. · Briganti, C. · Colicchio, G. · Colosimo, C. · Mantini, D. · Sestieri, C. · Tartaro, A. · Caulo, M.
1Università Cattolica del Sacro Cuore, Rome, ITALY
2Università G. d’Annunzio, Chieti, ITALY

PURPOSE
Subtle linguistic dysfunctions and reorganization of the language network have been described in epileptic patients, suggesting plasticity changes across brain regions. Functional connectivity (FC) – MR imaging is a newly developed technique able to study brain connectivity, by evaluating correlations between spontaneous BOLD signal fluctuations. This study investigates the plasticity effects induced by epilepsy on the FC network of the main language-related brain regions and correlates them with patients’ verbal IQ scores.

MATERIALS & METHODS
We retrospectively evaluated FC in 22 right-handed patients with drug-resistant, non-tumoral epilepsy [11 with left and 11 with right-lateralized epilepsy (LE)] and in 14 healthy volunteers. Patients and controls underwent BOLD fMRI to lateralize language functions in the cerebral hemispheres. Six common seed regions related to the language network [(Inferior Frontal Gyrus (IFG), Superior Temporal Sulcus (STS) and Temporo-Parietal Junction (TPJ) of both hemispheres)] were defined from previous studies and verified to fit with individual fMRI activations. BOLD signals fluctuations cross-correlation graphs and corresponding whole-brain connectivity maps corrected with false discovery rate, were calculated for each subject and group. Group-level analyses were performed by independent-samples t-tests and ANOVAs. Pearson’s test was used to correlate FC values with verbal IQ scores in 17 out of 22 patients.

RESULTS
Both correlation graphs (Figure) and connectivity maps showed an overall reduced and rearranged connectivity pattern in all patients compared to controls. In both groups with left and right-LE, mean FC was found significantly reduced within the left (dominant) hemisphere (intrahemispheric FC), between the two hemispheres (interhemispheric FC) and when originating from the left-TPJ and right-IFG nodes (p < 0.05); significant FC correlations with brain areas that were not found in the control group, also were observed in patients. In patients with left-LE, Pearson’s test showed a positive correlation between the verbal IQ and the left intra-
hemispheric FC (r = 0.7; p = .03), while in patients with right-LE, a negative correlation was found with the inter-hemispheric FC (r = -0.7; p = 0.04) and with the right-IFG node FC (r = -0.7; p = .03).

CONCLUSION
In epileptic patients, FC-MR imaging was able to assess disruption and reorganization of different connectivity links among six cortical regions for language, thus confirming a remote influence of epileptogenic lesions, especially for particular nodes of the network. Functional connectivity correlation with the verbal IQ scores was in agreement with linguistic performance in patients with left-LE, whereas suggested an unfavorable effect of nondominant homologous regions recruitment in patients with right-LE.

KEY WORDS: Epilepsy, language, functional connectivity

Paper 112 Starting at 4:20 PM, Ending at 4:28 PM
Diffusion Tensor Imaging with Tract-Based Spatial Statistics Reveals Widespread White Matter Degeneration in Unverricht-Lundborg Disease: Translational Study in Humans and Cstb-Deficient Mice

Koskenkorva, P.1 · Manninen, O.2 · Lehtimäki, K.1 · Kopra, O.2 · Lehesjoki, A.2 · Kälviäinen, R.1 · Gröhn, O.3 · Vanninen, R.1
1Kuoopio University Hospital, Kuopio, FINLAND, 2University of Helsinki, Helsinki, FINLAND, 3University of Eastern Finland, Kuopio, FINLAND

PURPOSE
Unverricht-Lundborg disease (ULD), progressive myoclonic epilepsy type 1, caused by mutations in the Cystatin B (CSTB) gene, is a rare autosomal recessive neurodegenerative disorder characterized by onset from 6-16 years, stimulus-sensitive myoclonus, and tonic-clonic epileptic seizures. In volumetric MR imaging, cortical motor areas are affected in ULD, correlating with the motor symptoms. However, the possible effects of ULD on white matter (WM) tracts have not been evaluated quantitatively. A Cystatin B-deficient mouse model (Cstb/-) has been generated for studying ULD. The aims of this translational study were 1) to assess and characterize the possible WM changes in fractional anisotropy (FA) and directional diffusivity in ULD patients, 2) to evaluate the congruence of those changes between Cstb/- mice and human patients, and 3) to use imaging data to guide histopathologic analysis.

MATERIALS & METHODS
Nineteen patients with ULD and 18 matched controls underwent diffusion tensor imaging (DTI) (1.5 T, Siemens Avanto). Voxelwise analysis with tract-based spatial statistics (TBSS, cluster-level inference at t > 2.2, p < 0.05) was used to compare FA, axial, radial and mean diffusion (AD, RD and MD) among patients and controls. Paraformaldehyde (4%) perfused brains from nine 6-month old Cstb/- mice and four wild type controls were imaged at 9.4T MRI (Varian, DirectDrive) ex vivo. The DTI data of the mice were analyzed with TBSS using the same approach as applied for human data. Paraffin-embedded brain slices from ten 6-month old animals (Cstb/- n = 5, Cstb+/- n = 5) were stained with rat anti-myelin basic protein (anti-MBP, 1:200, Chemicon).

RESULTS
Tract-based spatial statistics revealed significantly reduced FA in all major WM tracts of ULD patients compared with healthy controls. There was no change in AD, but RD and MD were increased (Table).

<table>
<thead>
<tr>
<th>Location</th>
<th>FA</th>
<th>AD</th>
<th>RD</th>
<th>MD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corpus callosum</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ULD</td>
<td>0.68</td>
<td>1.52</td>
<td>0.42</td>
<td>0.78</td>
</tr>
<tr>
<td>Control</td>
<td>0.77</td>
<td>1.51</td>
<td>0.30</td>
<td>0.70</td>
</tr>
<tr>
<td>Posterior limb of internal capsule</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ULD</td>
<td>0.65</td>
<td>1.33</td>
<td>0.40</td>
<td>0.71</td>
</tr>
<tr>
<td>Control</td>
<td>0.70</td>
<td>1.34</td>
<td>0.36</td>
<td>0.69</td>
</tr>
<tr>
<td>Hand knob, subcortical WM</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ULD</td>
<td>0.34</td>
<td>1.05</td>
<td>0.63</td>
<td>0.77</td>
</tr>
<tr>
<td>Control</td>
<td>0.40</td>
<td>1.03</td>
<td>0.55</td>
<td>0.71</td>
</tr>
</tbody>
</table>

Data presented as mean of right and left hemispheres except for corpus callosum. Axial, radial and mean diffusion (×10^-3 mm²/s)

In Cstb/- mice, FA was significantly reduced in cerebellum, corpus callosum, external capsule and several thalamic nuclei. Immunostaining of brain tissue for MBP showed myelin loss in Cstb/- mice in areas highlighted in the TBSS analysis.

CONCLUSION
As a novel finding, TBSS analysis of DTI data revealed extensive changes consistent with a pattern of chronic WM degeneration in ULD patients. Interestingly, very similar alterations were detected in Cstb-deficient mice, providing further validation of this animal model. Immunohistochemistry from Cstb/- mice indicated that myelin loss is likely to contribute to decreased FA. These data provide a novel view for further dissection of the pathogenesis of ULD.

KEY WORDS: Unverricht-Lundborg disease, diffusion tensor imaging, TBSS
RESULTS

cephalography and clinical findings. The findings were correlated with electroencephalograms (EEG), structural imaging, and neuropsychological assessments.

**MATERIALS & METHODS**

Fourteen patients with clinical diagnosis of TLE and 15 healthy volunteers were evaluated. Images were acquired using a 1.5 T MR scanner (Achieva, Philips Medical Systems, Best, The Netherlands) with a SENSE 8-channel head coil during a single MR imaging session. All sequences were acquired orthogonal to hippocampal body axis using a prone orientation of temporal lobes. For hippocampal volumetry and DTI studies coronal planes were positioned parallel to the posterior commissure-obex (PC-OB) line. Single voxel 1-H MR spectroscopy (MRS) of hippocampus was acquired in axial plane perpendicular to PC-OB line. All measurements were done for bilateral hippocampi. Special attention was paid to patients for being seizure free for at least 24 hours prior to MR scan. Standart qualitative imaging protocol for epilepsy patients included an axial and sagittal T1-weighted turbo spin-echo (TSE) (TR/TE = 450/9 ms, slice thickness: 5 mm), and T2-weighted TSE (TR/TE = 5000/100 ms, slice thickness: 5 mm), and a coronal FLAIR (TR/TE = 6000/120 ms, IR:2000 ms, slice thickness: 2 mm) sequences. For volumetry, T1-weighted 3D gradient-echo sequence (TR = 7.2 ms, TE = 3.3 ms, NSA = 1, FOV = 256 mm, slice thickness: 1 mm, gap = 0 mm, flip angle = 8°, matrix = 256x256 pixels) through 160 slices of the entire brain was acquired. For single voxel 1-H MRS each hippocampus voxel of interest (V01, 20 x 20 x 20 mm) placed on hippocampus on sagittal, axial and coronal orientations using point-resolved spectroscopic (PRESS) sequence (TE =144 ms, TR = 2000 ms). Hippocampal metabolic concentrations were measured at 2.0 ppm (NAA), 3.0 ppm (Cre) and 3.2 ppm (Cho). Metabolites were assessed as ratios to Cr [NAA/Cr, Cho/Cr, and NAA/Cr(Cho+Cr)] and in absolute units. Diffusion tensor imaging data were acquired using a single-shot spin-echo echo planar image (SE-EPI) sequence. The diffusion sensitizing gradients were applied simultaneously along 6 non-orthogonal directions (b= 1000s/mm²). All scans were reviewed by two experienced neuroradiologists in consensus. The findings were correlated with electroencephalography and clinical findings.

RESULTS

Individually volumetric measurements on T1-weighted 3D-dataset provided accurate lateralization in 85% of the patients, spectroscopy in 57% and DTI in 57%. Higher lateralization ratios were acquired combining volumetry-spectroscopy (85%), spectroscopy-DTI (85%) and finally volumetry-DTI (100%). Significant increased NAA/(Cho+Cr) ratios and increased FA values were obtained ipsilateral to epileptogenic hippocampus. A ge at onset and response to antiepileptic drugs did not correlate with any result. Duration of epilepsy and FA values showed a significant positive correlation. Furthermore the history of febrile convulsion was associated with increased mean diffusivity values and reduced NAA/(Cho+Cr) ratios at the eliptogenic hippocampus.

CONCLUSION

Volumetry, MRS and DTI studies provide complementary information of hippocampal pathology. For lateralization of epileptogenic focus and preoperative examination, volumetry-DTI combination represents maximal accuracy.

**KEY WORDS:** Temporal lobe epilepsy, MR imaging, MRS, DTI, volumetry
CONCLUSION
Higher relaxivity contrast agents have both a competing higher R1 and R2 effect. This study demonstrates the efficacy of demonstrating contrast enhancement using T2-weighted FLAIR imaging with a HRCA. Normal anatomical structures with intact BBB demonstrated decreased SNR suggesting more of an R2 effect. Normal anatomical structures without a BBB demonstrated increased variability of SNR, suggesting a difference in timing of contrast delivery as well as wash in and wash out. In a small subset of patients with leptomeningeal processes, acute SAH may be distinguishable from tumor or infectious leptomeningeal based on the SNR enhancement pattern using postgadolinium T2-weighted FLAIR imaging and a HRCA.

KEY WORDS: Contrast, leptomeningeal disease, FLAIR

Paper 115 Starting at 4:44 PM, Ending at 4:52 PM
Sinking Skin Flap Syndrome: Imaging Characteristics of an Unfamiliar Entity

Chin, B. M. • Osborn, A. G. • Wiggins, R. H.
University of Utah
Salt Lake City, UT

PURPOSE
Sinking skin flap syndrome (SSFS), or “syndrome of the trephined,” is a rare cause of neurologic deterioration in patients who have undergone decompressive craniectomies. Sinking skin flap syndrome typically presents weeks to months following a large craniectomy with symptoms such as decreased consciousness and hemiparesis and an associated skin flap depression. Only case reports and small case series of SSFS have been published in the neurosurgical literature. To our knowledge, SSFS has not been reported in the radiologic literature. Given the importance of accurately diagnosing this syndrome, the purpose of this study was to characterize the incidence and radiologic spectrum of SSFS in a large tertiary care center.

MATERIALS & METHODS
A retrospective search of imaging and operative databases using keywords “craniotomy” and “craniectomy” and associated CPT codes was performed at the primary institution for the period from January 2000 to October 2009. Data were abstracted from the medical record, and cases of possible SSFS identified.

RESULTS
A total of 5176 craniotomies and craniectomies were identified. Seven hundred nineteen (7.2%) had undergone large frontotemporal, pterional, or hemicraniectomies with subsequent cranioplasty. Of the 719 craniectomies, SSFS developed in 12 (1.7%). The mean age at presentation was 40 years (range 18-60). Six of 12 (50%) had surgery for intractable intracranial hypertension and six of 12 (50%) for extraaxial collections status posttrauma. All patients had sinking of the skin flap of at least 1 cm. All had mass effect as evidenced by gray-white interface buckling and depression and sulcal obliteration. Ten of 12 (83%) had midline shift of the lateral ventricles away from the sunken skin flap.

CONCLUSION
Sinking skin flap syndrome is an uncommon, yet important cause of secondary neurologic deterioration following a large decompressive craniectomy. The radiologic findings are straightforward, and knowledge of how this syndrome presents and its imaging appearance is imperative for optimal patient outcomes.

KEY WORDS: Sinking skin flap syndrome, craniectomy
Accuracy of Brain Imaging in the Diagnosis of Idiopathic Intracranial Hypertension

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University of Ottawa
Ottawa, ON, CANADA

PURPOSE

Idiopathic intracranial hypertension (IIH) is diagnosed traditionally based on clinical presentation, oculary and neurologic examination and lumbar puncture. Neuroimaging is used primarily to rule out alternate causes of raised intracranial pressure such as mass lesions, hydrocephalus or sinus thrombosis. Certain MR findings, however, have been described to be associated with IIH. We aimed to investigate the accuracy of MR imaging in the diagnosis of IIH.

MATERIALS & METHODS

Forty-three patients that fulfilled modified Dandy criteria for IIH and had available MR imaging of the brain and venography were identified retrospectively. Forty-four patients were included in the control group based on availability of MR venography and normal MR brain imaging performed between 2008 and 2009. Control patients were referred for neuroimaging to rule out sinus thrombosis (10 controls) or to investigate pregnancy-related headache (10 controls), non-specific headache (12 controls), optic disk swelling (9 controls) or other miscellaneous symptoms (3 controls). MR images were anonymized and reviewed by three neuroradiologists blinded to clinical data. Imaging studies were evaluated for the presence or absence of findings previously described to be associated with IIH. The parity of each transverse sinus was evaluated and graded as 0 (aplastic or discontinuous), 1 (severe, >75% stenosis relative to the diameter of the lumen of the distal superior sagittal sinus), 2 (moderate, 50-75% stenosis), 3 (mild, 25-50% stenosis) or 4 (normal or very mild, <25% stenosis). A combined stenosis score was calculated from the sum of the right and left transverse sinus stenosis grades. Characteristics and imaging details for this cohort, reviewed by a single neuroradiologist, are summarized in Table 1. Fisher’s exact test was used for statistical analysis.

RESULTS

MR findings in cases and controls are described in Table 1. Sensitivity, specificity, positive and negative predictive values and positive and negative likelihood ratios are summarized in Table 2.

CONCLUSION

A combination of any two of the following MR findings has a high sensitivity and specificity for a diagnosis of IIH: partial empty sella, intraocular protrusion of the optic nerve head, optic nerve enhancement at the attachment with the globe or a low combined transverse sinus stenosis score. No single MR finding was very sensitive for a diagnosis of IIH.

KEY WORDS: Idiopathic intracranial hypertension, MR imaging, venography

Monday Afternoon
3:30 PM - 5:00 PM
Room 311

(11c) Pediatric: Functional Imaging
(Scientific Papers 117 - 127)

See also Parallel Sessions

(11a) Adult Brain: Neoplasms I
(11b) Adult Brain: Epilepsy and Other
(11d) Head and Neck: New Techniques

Moderators: Nancy K. Rollins, MD
Arastoo Vossough, PhD, MD

Paper 117 Starting at 3:30 PM, Ending at 3:38 PM
Language Impairment in Autistic Spectrum Disorder

Nagae, L. M. · Zarrow, D. · Dell, J. · Zimmerman, R. A. · Roberts, T. P. L.
The Children’s Hospital of Philadelphia
Philadelphia, PA

PURPOSE

Increase in mean diffusivity (MD) in the superior longitudinal fasciculus (SLF) previously has been found in the children with autism spectrum disorders and, especially, in autistic patients with clinical language impairment (ASD+LI) when compared to typically developing children and adolescents (TD). Herein, we sought to extend evaluation to the temporal lobe component of the SLF (tSLF) and compare against cortico-spinal tracts (CST) to verify if this effect is specific to language-related tracts or an epiphenomenum
which occurs in other tracts, nonlanguage related, in autistic patients’s brain white matter.

**Materials & Methods**

Eighteen ASD-LI (mean age: 11.4 years; range: 6.7-17.5 years), 8 ASD+/LI (mean age: 8.2 years; range: 6.9-10.1 years), and 25 TD (mean age: 11.8 years; range: 6.5-18.7 years) were further evaluated with diffusion tensor imaging (DTI). All subjects had neuropsychologic testing, which included Clinical Evaluation for Language Fundamentals-4th edition (CELF 4) and Wechsler Intelligent Scale for Children-IV (WISC-IV). Diffusion tensor imaging parameters were: isotropic 2 mm contiguous acquisition of the whole brain at a 3.0 T magnet (Siemens Verio™, Siemens Medical Solutions, Erlangen, Germany); FOV 25.6 cm; matrix of 128 x 128; TR/TE 14000/70 ms; a scheme with 30 diffusion-encoding gradient directions, 1 b0, b max 1000 s/mm2; Parallel imaging (GRAPPA) with an acceleration factor of 2.0; postprocessing was performed using DTISTudio (H. Jiang, S. Mori; Department of Radiology, Johns Hopkins University). Tractography of the right and left SLF, ISLF and CST was performed by two raters, blind to the clinical data and following guidelines of previously reported tractography protocol (2), with an FA threshold of 0.25 and an angle cutoff of 70°. As an interrater intraclass correlation coefficient (ICC) of > 0.9 was obtained for each of left and right hemisphere mean diffusivity (MD) measures in the SLF, results were averaged across raters. Diffusion tensor imaging parameters considered for analysis were: the number of fibers represented, number of voxels occupied by fibers, MD, FA, and tensor eigenvalues \( \lambda_1 \), \( \lambda_2 \) and \( \lambda_3 \) along the tracts. Statistical evaluation comprised ANOVA with diagnosis (TD vs ASD-LI vs ASD+/LI) and hemisphere as factors. Secondary analyses considered +/- language impairment as a factor.

**Results**

Increased MD along the SLF associated with increased axial diffusivity (\( \lambda_1 \)) bilaterally and a trend to increase in radial diffusivity on the left side is seen in ASD. ASD+/LI presented with a strong effect of increase in MD for the left tSLF (p = 0.006), mainly due to increase in axial diffusivity (p = 0.003). The CST presented with increased MD bilaterally in ASD+/LI (p = 0.09, left and p = 0.035, right side), but also seen in ASD-LI on the left side (p = 0.01), with a trend for the right side (p = 0.055).

**Conclusion**

Elevated MD appears to be a striking feature of ASD, being evident in bilateral SLF and also in bilateral CST. Of particular note, elevation of MD in the temporal portion of the SLF is only significant in the left hemisphere for the contrast between ASD+/LI and TD, implicating a neurobiologic basis for language impairment.

**Key Words:** Diffusion tensor imaging, autism, language

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**Paper 118 Starting at 3:38 PM, Ending at 3:46 PM**

**Diffusion Tensor Imaging - MR Tractography of the Brain: Cost Study Using Time and Motion Analysis**

M. Medina, C. Bernal, B. Altman, N. Slay, E. Medina, S. Miami Children’s Hospital Miami, FL

**Purpose**

To determine the total direct costs (fixed and variable costs) of diffusion tensor imaging (DTI) with MR tractography reconstruction of the brain.

**Materials & Methods**

The direct fixed and variable costs of DTI with MR tractography were determined prospectively with time and motion analysis. Seventeen patients with mean age of 13 years (age range 2-33 years) were studied. Nine were male and eight were female. All patients had seizure disorders. The labor of all personnel involved was tracked, and involvement times were recorded to the nearest minute. All material items used in the studies were recorded. Cost of labor and materials were determined from personnel reimbursement data and from vendor pricing, respectively. Direct fixed costs were determined from hospital accounting department records. Total direct costs were calculated from all direct fixed and variable costs. Sensitivity analysis between 1.5 vs 3 T MR system; and 15 vs 32 encoding directions were done.

**Results**

The total direct costs of DTI with MR tractography for a 1.5 T system with 15 encoding directions were U.S. $97. Variable cost was $76.80 and direct cost was $20.20. Total direct costs for the same system with 32 encoding directions increased to U.S. $113.7. The total direct costs for a 3 T system with 15 directions decreased to U.S. $94.5 because of the shorter scan time despite the higher cost of the 3 T system. The most costly component of the direct cost was the postprocessing at U.S. $46.00 for all systems.

**Conclusion**

Diffusion tensor imaging with MR tractography has important total direct costs. The variable costs are higher than the fixed costs. The postprocessing labor costs account for 40% to 48% of the total costs depending on the Tesla system used and number of encoding directions. Total direct costs of DTI are about a third of reported fMRI costs.

**Key Words:** Diffusion tensor imaging, cost-effective, time and motion analysis
Further Decreases in Radiation Dose for Pediatric Head CT Imaging Is Made Possible by ASIR Reconstruction Algorithm

Parag, Y. · Tannenbaum, L. · Delman, B. · Pawha, P. · Naidich, T.
Mount Sinai Medical Center
New York, NY

**Purpose**
During the past 30 years, there has been a steady escalation in utilization of diagnostic CT. Pediatric imaging is one of the fastest growth areas and approximating 6 - 11% of scans performed in the U.S. Adaptive statistical iterative reconstruction (ASIR) techniques offer the promise of routine image quality at lower doses than are required with conventional FBP techniques. We describe our experience with ASIR as a method for decreasing radiation dose in pediatric head CT while maintaining diagnostic quality.

**Materials & Methods**
A retrospective review of 14 scans performed on children (4 months to 7 years) who were referred for noncontrast CT of the head were scanned on a GE Discovery CT750 HD CT scanner using a reduced dose protocol (tailored to ASIR capabilities). 5 mm thick axial slices were created with ASIR and FBP techniques. Images were reviewed as to absolute noise by drawing a 50 mm2 ROI in the white matter of the centrum semiovale and gray matter of the thalami. Images also were evaluated as to diagnostic quality by two experienced neuroradiologists. The radiologists were asked to grade the gray-white matter differentiation and overall image quality on a scale of 1-4. We compared the dose length product (DLP) of this group to 14 age-matched controls scanned with the low dose CT protocol in use on a similar GE VCTxt CT scanner with FBP reconstruction capability.

**Results**
The average DLP in our study group was 173.56 vs 202.86 in the comparison group, resulting in a 14% decrease in radiation dose. Adaptive statistical iterative reconstruction reduced image noise by 22 and 16 percent in the white matter and deep gray matter respectively when compared to FBP. There was clear preference for ASIR reconstruction by both reviewing radiologists asked to rate gray-white matter differentiation (2 vs 2.3) and overall image quality (2.25 vs 2.5).

**Conclusion**
A adaptive statistical iterative reconstruction of CT data allows further reduction of radiation dose for pediatric head CT while maintaining diagnostic quality.

**Key Words:** ASIR, CT, radiation

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Progressive Decrease in NAA/Cr Ratio in Two Teenagers with Type 1 Diabetes and Repeated Episodes of Ketoacidosis without Clinically Apparent Cerebral Edema: Evidence for Permanent Brain Injury

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Sacramento, CA

**Purpose**
The long-term adverse cerebral effects of type 1 diabetes are poorly defined. Cognitive impairment has been reported in some studies of children and young adults with type 1 diabetes. Episodes of hypoglycemia in addition to microangiopathy have been suggested as contributing factors, but recent data suggest that diabetic ketoacidosis (DKA) also may be an important contributing factor. N-acetylaspartate (NAA), measured by MR spectroscopy (MRS), is a marker for both neuronal dysfunction and loss.

**Materials & Methods**
We measured the NAA to creatine (Cr) ratio in two teenage boys (14 and 16 years of age), who each underwent sequential MRS during and following two separate episodes of DKA. All DKA episodes apparently were uncomplicated, without clinical signs or symptoms of cerebral edema.

**Results**
The NAA/Cr ratio decreased during each DKA episode and improved following recovery. However, the NAA/Cr level after recovery remained lower after the second episode of DKA than after the first.

**Conclusion**
These data suggest progressive neuronal dysfunction or loss resulting from DKA.

**Key Words:** MRS spectroscopy, brain, Type 1 diabetes

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fMRI of Children with Autism Spectrum Disorder: Music and Language-Related Activation in Wernicke’s and Broca’s Areas with and without the Presence of Propofol Sedation

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**Purpose**
To determine the presence and extent of cortical activation in sedated and nonsedated pediatric patients diagnosed with autism spectrum disorder (ASD).
MATERIALS & METHODS

A retrospective review of functional M R I ( f M R I) data at 1.5 T from 38 children diagnosed with low-functioning language in the A S D spectrum was performed. Patients were assessed clinically and diagnosed with A S D using the Autism Diagnostic Interview-Revised (A D I-R). A standard institutional set of auditory stimuli that included two runs of language narrative and song with vocals was utilized during the f M R I portion of the examination. f M R I data were post-processed and analyzed with FSL 4.2. Sedation in 27 children (mean age = 8.4 years; SD = 3.05; range = 5.4-17.9) occurred as part of a routine brain MR examination. Intravenous sedation was performed by a pediatric anesthesiologist using IV propofol; drug levels were stable throughout the f M R I portion of the examination (mean = 199 mcg/kg/min; range = 125-300). f M R I data from slightly older nonsedated A S D children (mean age = 11.5 years; SD = 3.6; range = 7.0-16.7) also were reviewed.

RESULTS

During passive language stimulation, mild activation in the transtemporal gyrus was detected bilaterally in 66% (18/27) and unilaterally in 33% (9/27) of sedated patients. Wernicke’s area demonstrated activation in all 27 cases, but was more often unilateral (66%) than bilateral (33%). Ventral Broca’s area was activated in 74% (20/27) of sedated patients; dorsal Broca’s area was activated in 52% (14/27). The supplementary motor cortex was activated occasionally (37%). Group statistics, on the other hand, showed no significant language-related activation in Broca’s area in either sedated or nonsedated patients from the same passive language stimulation. Group activation within Broca’s area, however, was observed in both sedated and nonsedated patients during song (with vocals) stimulation (1.6 < Z < 6.0; p < 0.05; cluster corrected). When compared with the slightly older (± 3.1 years) nonsedated group of A S D patients, greater activation generally was present in the nonsedated patients as compared with sedated children, with the exception of Broca’s area, where activation was similar to that of the younger sedated group (1.6 < Z > 1.6; p < 0.05; cluster corrected).

CONCLUSION

Activation in the Wernicke’s and Broca’s areas of pediatric A S D patients can be detected with f M R I, even during propofol sedation. While group activation in Broca’s area during song (with vocals) stimuli was seen in both sedated and older nonsedated A S D patients, language-related stimuli did not produce group activation in Broca’s area in either sedated or nonsedated children. Knowledge of both the presence and absence of activation patterns may be useful in the assessment, diagnosis, and therapy of patients with A S D as well as other developmental and acquired language disorders that may mimic A S D.

KEY WORDS: f M R I, autism spectrum disorder, sedation
CONCLUSION
Quantitative DTI measurements obtained from this study provide valuable information regarding the microstructural integrity of white matter tracts and selective injury to them in CP children. The injury pattern is predominantly loss of fiber volumes, associated with increased diffusivity. We observed that PTR is more profoundly affected than CST, suggesting that disruption of sensory connections outside pyramidal pathways is an important factor in the pathophysiology of CP and associated motor disability.

REFERENCES

KEY WORDS: Diffusion tensor imaging, cerebral palsy, periventricular leukomalacia

MATERIALS & METHODS
We examined eight children (mean age 15.0 ± 2.4 years) with known mild bilateral cerebral palsy (gross motor function measure I-II) caused by PVL and 12 healthy age-matched controls (mean age 14.9 ± 1.8 years). Fractional anisotropy (FA) values of the transcallosal motor fibers (TCMF) and the corticospinal tract (CST) of both sides were calculated by two readers independently. Additionally, interhemispheric inhibitory competence (TMS) and the degree of mirror movements as measured by standardized clinical examination and a computer-based hand motor function test were evaluated.

RESULTS
Fractional anisotropy values were significantly lower in children with PVL as compared to age-matched healthy controls regarding the TCMF (0.382 vs 0.427; p < 0.003) (Table 1). The number of transcallosal fibers was lower in children with PVL (p < 0.02) (Figure 1 A: control and B: child with PVL). Interrater reliability using an intraclass correlation coefficient (Cronbach's alpha) achieved 0.957 for the TCMF, 0.780 for the left CST and 0.750 for the right CST. Resting motor threshold was elevated in children with PVL (45.14 vs 37.16% of stimulator output) whereas measures of interhemispheric inhibitory competence tended to be lower (duration of the iSP: 20.42 vs 24.34 ms, extent of the iSP: 11.48 vs 8.87 qmm). Mirror movements were markedly elevated in the PVL group.

CONCLUSION
Anisotropy values of TCMF are consistent with functional impairment of hand motor function in children with cerebral palsy. The microstructure of the TCMF may serve as a potential predictor for hand motor function in patients with cerebral palsy.

KEY WORDS: Transcallosal motor fibers, motor development, diffusion tensor imaging

PAPER 124 Starting at 4:26 PM, Ending at 4:34 PM
Multimodal Approach Identifies the Anisotropy of Transcallosal Motor Fibers as Potential Marker for Hand Motor Function in Children with Cerebral Palsy

Koert, I.1,2 Pelavin, P. P.2 Kirmess, B.1 Berweck, S.1 Reiser, M.1 Kubicki, M.2 Shenton, M. E.2 Heinzen, F.3 Erdt-Wagner, B.1
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PURPOSE
Patients with periventricular leukomalacia (PVL) are known to have altered white matter structure of motor tracts. We aimed to evaluate the microstructure (DTI), interhemispheric inhibitory competence as measured by transcranial magnetic stimulation (TMS) and hand motor function in children with mild cerebral palsy compared to normal controls.
New Picture-Aided Rhyming Paradigm for Pediatric Patients and Adult Patients with Reading Difficulties

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Cleveland, OH

Purpose
To develop pediatric-level rhyming paradigm to improve pediatric fMRI image quality.

Materials & Methods
Preschool and early-school rhyme-pairs were collected. Rhyme-associated pictures were added. Matching stick figures served as control in the resting phases. A control sheet was embedded into a computer program to grade patients’ responses via a fiber optic button box response system. Thirty-six patients were included in the study, 18 for tumor evaluations and 18 for epilepsy evaluation. There were 31 adult patients (ages 20 to 83 years) and five pediatric patients (ages 10-15 years). Responses were collected for 32 patients, and automated noise scores were computed for 23 patients.

Results
Good activation was obtained from picture-aided rhyming in 33 out of 36 patients, in addition all five children had robust activation. The percentage of correct responses also improved, to 80% from 72%. Automated noise scores were reduced from 5.9 on the standard rhyme paradigm to 4.4 on the new picture rhyme paradigm, however this did not show statistical significance.

Conclusion
The new simple picture-aided rhyming paradigm is useful for both pediatric and language-impaired adult patients. The new picture-aided rhyming paradigm works well when the adult rhyming paradigm fails, and can be considered a good alternative in a clinical setting where language localization is indicated. Overall this new rhyming paradigm improves the diagnostic quality of fMRI scans.

Key Words: Preoperative language lateralization, fMRI quality, pediatric picture rhyming paradigms

Diffusion Tensor Imaging and Reproducibility Measurements in Pediatric Subjects: Normals and Patients with Spinal Cord Injury


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Purpose
To measure and establish normative diffusion tensor imaging (DTI) parameters of healthy spinal cord tissue in children with idiopathic scoliosis as a means for comparison with children with spinal cord injury (SCI). To establish reliability and validity measures of diffusion tensor imaging in children and to correlate the DTI measures in children with SCI with the International Standards for the Neurological Classification of SCI (ISNCSCI).

Materials & Methods
Five control subjects with thoracic and lumbar idiopathic scoliosis and five subjects with spinal cord injury (SCI) were imaged twice using single-shot echo-planar diffusion-weighted imaging sequence at 1.5 T. A 3D-MR imaging was performed to cover the entire cervical spinal cord (C1-C7) in control subjects. For the SCI subjects, two vertebral bodies above and below the injury were imaged. The DTI parameters included: 6 diffusion directions; b = 700 sec/mm², TR = 6000 ms, TE = 60 ms, FOV = 240 mm, 128 x 128, and 4 acquisitions. The total imaging time to collect the DTI images was approximately 8 minutes. In order to test reproducibility of the DTI scans, the subjects returned within a mean of 34.3 days to the MRI center and imaged a second time. Fractional anisotropy (FA) and diffusivity (D) values (average, axial and radial) were obtained at different levels of the spinal cord by drawing regions of interest (ROIs) by a board certified pediatric neuroradiologist between the two different scans at the same locations. All SCI subjects had undergone ISNCSCI clinical exams. Statistical analysis was performed to assess for significant differences of the DTI indices between the controls and SCI, and reproducibility measurements. Spearman correlation coefficients were calculated to assess for correlations between the diffusion indices and ISNCSCI exams in children with SCI.

Results
For the control population, mean FA = 0.62, sd = 0.11; and mean D = 2.15 x 10⁻³ mm²/sec, sd = 0.52 x 10⁻³; axial D = 1.23 x 10⁻³ mm²/sec, sd = 0.29 x 10⁻³; radial D = 0.44 x 10⁻³ mm²/sec, sd = 0.24 x 10⁻³. Subjects with SCI showed reduced FA values and increased D values compared to control subjects, with mean FA = 0.39, sd = 0.22; mean D = 3.8 x 10⁻³ mm²/sec, sd = 2.02 x 10⁻³; axial D = 1.65 x 10⁻³ mm²/sec, sd = 0.65 x 10⁻³; radial D = 1.06 x 10⁻³ mm²/sec, sd = 0.69 x 10⁻³. Test-retest reproducibility showed excellent interclass correlation (ICC) in all the control group DTI index values (> 0.9) while the SCI group showed moderate ICC in all the DTI index values measured (> 0.7) (Table 1). There were statistically significant correlations between the various DTI indices and several ISNCSCI scores.
Table 1. Interclass correlation (ICC) results of test-retest DTI reproducibility measured in control and the SCI groups.

<table>
<thead>
<tr>
<th></th>
<th>FA</th>
<th>D</th>
<th>Axial</th>
<th>Radial</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>0.9006</td>
<td>0.9688</td>
<td>0.9650</td>
<td>0.9379</td>
</tr>
<tr>
<td>SCI</td>
<td>0.7852</td>
<td>0.7691</td>
<td>0.7958</td>
<td>0.7688</td>
</tr>
</tbody>
</table>

CONCLUSION

Preliminary normative DTI indices were determined for the pediatric population. Reduced FA and increased diffusivity values for injured spinal cord were seen in children with SCI in comparison with control subjects. Test-retest showed excellent reproducibility of the DTI indices in their repeat sessions. Clinical correlation with standard ISNCSCI exams showed good correlation with DTI indices.

KEY WORDS: DTI, spine, spinal cord injury

Paper 127 Starting at 4:50 PM, Ending at 4:58 PM

Correlation between FSIQ and FA in School-Aged Children

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PURPOSE

Diffusion tensor imaging (DTI) provides information about white matter architecture. Preliminary studies suggest fractional anisotropy (FA) values in certain portions of the brain correlate with full-scale IQ. We undertook a prospective study to evaluate this possible association.

MATERIALS & METHODS

Forty-eight English-speaking children; (33M, 15F); 6.2 - 18.1 years; mean 10.6 years +/- 2.7 were recruited from the local community. Subjects were prescreened using telephone interviews of parents; potential subjects with medical, surgical, or pervasive developmental problems, sensory and motor deficits, or preterm birth were excluded. Cognitive testing was performed by trained personnel supervised and/or administered by a licensed psychologist with the Two Subtest Form of the Wechsler Abbreviated Scale of Intelligence (WASI). All subjects had T-scores < 70 on the Syndrome Scales of the Child Behavior Checklist indicating no significant parent concerns with behavioral and emotional functioning and scaled scores > 5 on selected subtests from the Clinical Evaluation of Language Fundamentals (CELF IV) indicating no significant language concerns. Diffusion tensor imaging was acquired at 3 T (image matrix 128 x 128 voxel 2 mm3, TR/TE: 9000/74, b = 700; SENSE = 2; 3 acquisitions; 30 directions). Fractional anisotropy data were analyzed using TBSS. Data from all subjects were aligned to a 9-year-old control brain using non-linear registration and affine transformed into MNI152 standard space. The mean FA image was used to create a mean FA skeleton; FA threshold > 0.20. Voxel-by-voxel statistical analysis was performed to detect correlation between FA and FSIQ differences using the randomization tool (5,000 permutations) and corrected for multiple comparisons using TFCE; p corrected < .05 was considered significant. The FA skeleton also was interrogated manually using ROI analysis software written in IDL.

RESULTS

The mean FSIQ was 113.7 (+/- 14.1); median 112 (78 - 140). There were no regions in which FA correlated with FSIQ. A single region of statistically insignificant correlation (p = 0.2) was seen adjacent to the right frontal horn (Figure 1).

Figure1. FA vs FSIQ in right frontal white matter.

CONCLUSION

Using an operator-independent methodology and whole brain analysis, there was no correlation between FSIQ and FA in school-aged children who are cognitively intact suggesting DTI is insensitive to large differences in FSIQ across a wide range of normal.

KEY WORDS: FSIQ, DTI, fractional anisotropy

Monday Afternoon

3:30 PM - 5:00 PM
Room 312

(11d) Head and Neck: New Techniques
(Scientific Papers 128 - 137)

See also Parallel Sessions
(11a) Adult Brain: Neoplasms I
(11b) Adult Brain: Epilepsy and Other
(11c) Pediatric: Functional Imaging

Moderators: Jenny K. Hoang, MBBS
Richard H. Wiggins, III, MD, CIIP

Paper 11d Starting at 3:30 pm, Ending at 3:40 pm
State-of-The-Art in Head and Neck New Developments and Questions

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Phase-Contrast MR Imaging and 3D CISS vs Contrast-Enhanced MR Cisternography for the Evaluation of Spontaneous Third Ventriculostomy

Ağın, O.1 · Zan, E.1 · Kalcıoğlu, B.2
1 Atatürk Training and Research Hospital, Ankara, TURKEY · 2 Zonguldak Karaelmas University, Zonguldak, TURKEY

Purpose
To compare the diagnostic efficacies of phase-contrast MRI (PC MRI) and three-dimensional constructive interference in steady-state (3D CISS) sequence over detection of spontaneous third ventriculostomy (STV) on the basis of contrast-enhanced MR cisternography (MRC).

Materials & Methods
Eleven obstructive hydrocephalus patients with clinically-radiologically suspected STV and ten controls were examined by PC MRI, 3D CISS and MRC. Phase-contrast MRI and 3D CISS sequence were applied to view the third ventricle and basal cisterns. Following injection of 0.5-1 ml intrathecal Gd-DTPA injection, postcontrast MRC images were obtained in three planes. Presence of STV was scored as follows: grade 0, no existence of STV; grade 1, STV present. Results of PC MRI and 3D CISS were compared with the MRC findings.

Results
In PC MRI five patients were assessed as grade 0 and six cases grade 1. As a result of 3D CISS sequence, eight cases were evaluated as grade 0 and three cases grade 1. Based on MRC, nine cases were assessed as grade 0 and two cases grade 1. False positivity was found in four cases by PC MRI and in one case by 3D CISS. The sensitivity, specificity and accuracy of PC MRI and 3D CISS sequence regarding demonstration of STV, were 100%, 100%; 56%, 89% and 64%, 91% respectively.

Discussion
Phase-contrast MRI and 3D CISS are helpful in confirming the STV. Phase-contrast MRI and 3D CISS should be the first preference. If PC MRI and 3D CISS give negative results, then MRC is not required. MR cisternography should be performed on patients who demonstrate suspected STV findings on PC MRI and 3D CISS sequences. MR cisternography may prevent false positive results.

Key Words: Hydrocephalus, MR cisternography, PC cine MR

Signal Characteristics of Carotid Intraplaque Hemorrhage at 3 T

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Purpose
The increased susceptibility of paramagnetic substances at higher field strengths may alter signal features of intraplaque hemorrhage (IPH) and diminish its detection. We sought to determine the characteristics of IPH in carotid plaque at 3.0 T by contrast-enhanced MR imaging.

Materials & Methods
Fourteen subjects (11 males, age range 58-86 years) scheduled for carotid endarterectomy (CEA), were scanned on a 3.0 T Philips Achieva system (Philips Healthcare, Best, Netherlands) with bilateral carotid coils. The following high-resolution axial images were acquired: (1) 3D time-of-flight MR angiography (3D TOF MRA), (2) ECG gated T2*-weighted turbo field-echo (TFE), (3) ECG gated, double-inversion-recovery T1-weighted turbo spin-echo (DIR TIWTSE) before and after gadolinium administration (0.05-0.1 mmol/kg, Magnevist, Schering). Black blood images were obtained with the following parameters: Field-of-view, 14 x 14 cm; matrix size, 400 x 400; slice thickness, 2 mm. Contrast-enhanced angiography specimens were stained with H&E and Movat’s Pentachrome. Glycophorin A and Iron (hemosiderin markers) were identified using Immunohistochemistry and Mallory’s stain. Data were analyzed using Vesselmass software (Leiden University, Netherlands). Regions of interest representing each plaque component were selected by referencing the matched histology. Contrast enhancement was defined as the percent change in signal intensity of a region from the pre to postcontrast images. The data were presented as mean ± SEM.

Results
Fifty-eight MR images from eight patients (3 symptomatic) contained IPH confirmed by histology. The iron stain was positive in 15 of 58 corresponding histology sections from six patients. Compared to TIWTSE and TOF, hemosiderin deposition was observed more readily on T2*WTFE, owing to the pronounced susceptibility effects yielding dark signal. Percent enhancement was calculated at 58 locations where IPH was identified (Figure 1). No significant enhancement (± 3.4% ± 1.6%) was observed for IPH. The enhancement increased significantly for fibrous tissue (28% ± 3.6), adventitia (43% ± 3.2%) and muscle (13% ± 1.3%) (P < 0.05 compared to IPH, respectively). Enhancement was greater for the fibrous tissue than the nonhemorrhagic part of the necrotic core (p < 0.05). Enhancement was detected in the nonhemorrhagic portions of the lipid cores (5.9% ± 4.0%; n = 19 slices, including two additional cores without IPH) but not found to be significantly higher than that measured in IPH (p = 0.12) likely because of the small sample.
CONCLUSION

3 T MR imaging can identify hemosiderin containing IPH using T2*-weighted images. The lack of enhancement might be useful for identifying IPH within the core.

KEY WORDS: Carotid, intraplaque hemorrhage, MR imaging

Paper 130 Starting at 3:56 PM, Ending at 4:04 PM
Homogeneous Fat Suppression and Decreased Susceptibility Artifacts on T2-Weighted MR Imaging of the Face and Orbits by Single-Scan FSE Triple Echo Dixon Technique

Guha-Thakurta, N. · Debnam, J. M. · Mahfouz, Y. M. M. · Kumar, A. J. · Ma, J. · Ginsberg, L. E.
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PURPOSE
Inadequate fat suppression and susceptibility artifacts may limit detailed evaluation of the facial and orbital tissues on FSE T2-weighted MR images acquired with conventional chemical shift selective suppression (CHESS). The purpose of our study was to evaluate and compare fat suppressed T2-weighted MR images of the face and orbits acquired with a novel single-scan FSE triple echo Dixon technique (fTED) to those using conventional FSE with CHESS fat suppression.

MATERIALS & METHODS
Thirty patients who underwent MR imaging of the face and orbits from Dec 1, 2008 to Jan 14, 2009 at our institution included T2-weighted sequences with both CHESS and fTED fat suppression. Two neuroradiologists evaluated the T2-weighted images from the two techniques for uniformity of fat suppression, degree of susceptibility artifacts and overall image quality. Regions of interest included scalp, maxillofacial soft tissues, orbits, sinonasal and oral cavities.

RESULTS
Homogeneous fat suppression was better in the fTED fat suppressed T2-weighted images predominantly in the maxillofacial soft tissues (N = 26), scalp (N = 18), and orbits (N = 17). Susceptibility artifacts were decreased in the sphenoid sinuses (N = 19), and in the presence of dental amalgam in the oral cavity (N = 10). Imaged brain parenchyma had decreased signal-to-noise ratio on the fTED fat suppression T2-weighted images compared to the CHESS fat suppressed images. In three cases with motion artifacts on fTED fat suppressed images the overall image quality was comparable between the two techniques.

CONCLUSION
The fTED technique provided better fat suppression than CHESS in the MR imaging of the face and orbits in certain areas improving the overall image quality. Decreased susceptibility artifact also enabled better visualization of the sinonasal and oral regions.

KEY WORDS: Fat suppression, MR face, orbits

Paper 131 Starting at 4:04 PM, Ending at 4:12 PM
Adaptive Statistical Iterative Reconstruction Allows Lower Radiation Dose Neck CT

Stein, E. G. · Som, P. M. · Pawha, P. S. · Tanenbaum, L. N.
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New York, NY

PURPOSE
Adaptive statistical iterative reconstruction (ASIR) is a recently available reconstruction technique that, compared to filtered back projection (FBP) methods typically used in CT, provides a reduction in image noise and improvement in low contrast detectability. We performed a retrospective review of dose-reduced images obtained with ASIR compared with images generated using FBP reconstruction from the same low radiation dose data set. A quantitative and qualitative assessment of the images generated was performed. The degree of radiation dose provided by use of the ASIR reconstruction technique also was determined.

MATERIALS & METHODS
Twenty patients referred for contrast-enhanced neck CT were scanned on a Discovery CT750 HD clinical CT scanner using a noise index of 23 between April and September 2009. The images were reconstructed using both conventional FBP and ASIR techniques. Twenty different randomly selected patients referred for contrast-enhanced neck CT performed on a Lightspeed VCT using the clinical protocol with a noise index of 16 were compared for radiation dose. The ASIR and FBP reconstructed images were assessed quantitatively for noise. Qualitative assessment was performed by three ENT radiologists blinded to the reconstruction method.

RESULTS
Radiation dose was reduced 47% from 5.1 mSv (FBP) to 2.7 mSv (ASIR), p = 0.0001. Noise was reduced 10-15% using the ASIR reconstruction. Adaptive statistical iterative reconstructed images scored 3.8 v. 3.5 (out of 4) for FBP (p = 0.02). Adaptive statistical iterative reconstructed images were preferred 82% of the time.

CONCLUSION
Adaptive statistical iterative reconstruction allows a nearly 50% reduction in radiation dose while maintaining diagnostic image quality for routine clinical neck CT imaging. The continued high satisfaction with the filtered back projection reconstruction warrants further reduction in X-ray technique.

KEY WORDS: ASIR, neck, radiation reduction
PURPOSE
World Health Organization (WHO) criteria for measuring and reporting tumors has been replaced gradually by the Response Evaluation Criteria for Solid Tumors (RECIST) for purposes of treatment decision-making. The major difference between WHO and RECIST criteria was unidimensional vs bidimensional measurement of lesions. Several problems with RECIST criteria had been pointed out, and a new RECIST (nRECIST), version 1.1, was published in January 2009. The major changes of nRECIST in response evaluation using CT imaging include: Lymph nodes are measured and recorded in short axis, not long axis, whereas tumor lesions are measured in longest axis; Measurable lymph nodes are defined as ≥ 15 mm in short axis; Lymph nodes ≥ 10 mm up to 15 mm are considered as pathologic but not measurable; Nodes that reduce in size down to < 10 mm in short axis are considered normal. The purpose of this study is to assess the impact of the nRECIST criteria on assessment of neck tumor response.

MATERIALS & METHODS
Neck CT scans obtained between July 1, 2005 and June 30, 2006 for head and neck cancers at our institution were reviewed. Only patients without surgery, who had CT scans both before and after chemotherapy and/or radiation treatment were included. Two blinded board-certified neuroradiologists reviewed the scans and measured the target lesions using WHO, RECIST and nRECIST criteria. Changes in measurements between the pre and posttreatment scans were categorized by each radiologist into one of four treatment response categories: complete response (CR), partial response (PR), stable disease (SD), progression of disease (PD). Weighted kappa values were calculated between the radiologists for RECIST, nRECIST and WHO criteria, and between RECIST vs nRECIST, RECIST vs WHO and nRECIST vs WHO for each radiologist.

RESULTS
A total of 47 patients (94 scans) were reviewed. By switching from RECIST to nRECIST, seven of 47 cases (15%) by radiologist 1 and 16 of 47 cases (32%) by radiologist 2 were categorized differently. Most of these cases were moved from PR to CR. For RECIST, nRECIST, and WHO criteria, weighted kappa were 0.56, 0.39 and 0.62 respectively between radiologists. For each radiologist, weighted kappa values between RECIST vs WHO, RECIST vs nRECIST, and WHO vs nRECIST were 0.83, 0.79, and 0.59 for radiologist 1 and 0.78, 0.73 and 0.68 for radiologist 2. When using RECIST, nRECIST, WHO criteria, 34 (72.3%), 26 (55%), and 39 (83%) and of 47 cases were concordant (72.3%) between the two radiologists.

CONCLUSION
nRECIST categorizes more tumors as CR than RECIST and shows less interobserver agreement. The degree of interobserver agreement is greatest when utilizing WHO criteria and least when utilizing nRECIST. For all criteria, agreement of intraobserver results is higher than interobserver agreement, suggesting that a more reproducible tumor response assessment can be achieved by having pre and posttreatment CT scans read by the same radiologist.

KEY WORDS: RECIST, tumor response, neck
**CONCLUSION**

Apparent diffusion coefficient values can be used to differentiate benign and malignant neck lesions on both 1.5 T and 3 T field strengths. However, the threshold ADC value that acts as a discriminator between benign and malignant lesions appears to be different on 1.5 T and 3 T studies. Larger sample size is required in further studies to confirm these findings.

**KEY WORDS:** Apparent diffusion coefficient, diffusion-weighted imaging, head and neck cancer

**Paper 134 Starting at 4:28 PM, Ending at 4:36 PM**

**Percutaneous Treatment of Facial Venous Malformations: A Matched Comparison of Ethanol and Bleomycin Sclerotherapy**

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1Faculty of Medicine, Winnipeg, MB, CANADA, 2Toronto Western Hospital, Toronto, ON, CANADA

**PURPOSE**

To compare results and complications of percutaneous sclerotherapy for facial venous malformations (VMs) using alcohol vs bleomycin.

**MATERIALS & METHODS**

Between 2003 and 2006, 18 patients with facial VMs were treated by percutaneous sclerotherapy using alcohol. Of these, 17 were matched individually to lesions treated by bleomycin according to presentation, location, size (measured in three planes) and infiltration on MR imaging. Treatment details and clinical results were obtained from charts and compared.

**RESULTS**

Average number of sclerotherapy sessions was 1.7 for alcohol and 3.4 for bleomycin. Average volume administered was 8.1 cc of alcohol and 9.1 units (1 unit = 1 mg/cc) of bleomycin. Of the 17 treated with alcohol, 2 (11.8%) developed adverse effects and 7 (41.2%) developed complications (Figure 1). None of the matched lesions treated with bleomycin developed adverse effects or complications. Seventeen (100%) patients treated with alcohol improved clinically. Fifteen (88.2%) patients treated with bleomycin improved after treatment and 2 (11.8%) were unchanged.

**CONCLUSION**

Sclerotherapy using alcohol or bleomycin is an effective treatment for craniofacial VMs. Alcohol has a slightly higher success rate than bleomycin and bleomycin usually requires more treatment sessions (see Figure 1). Alcohol has a higher complication rate and inherent postprocedural swelling. We conclude that bleomycin treatment may be better tolerated and therefore be preferred over alcohol sclerotherapy.

**KEY WORDS:** Percutaneous sclerotherapy, venous malformations, head and neck

**Figure 1.** Matched lesions of right cheek treated with bleomycin (A) and alcohol (C). Patient treated with bleomycin (A = pretreatment and B = posttreatment) presented with cosmetic concerns related to vascular malformation of right cheek. Diagnosis of VM was confirmed by T2-weighted MR imaging (A). Lesion was treated over five sclerotherapy sessions, during which a total of 75 units (1 mg/cc = 1 unit) of bleomycin were injected. Imaging follow up (B) demonstrated reduction in size and hyperintensity on T2-weighted sequences. Patient did not experience any complications secondary to treatment. Patient treated with alcohol (C = pretreatment and D = posttreatment) similarly presented with cosmetic concerns related to a lesion that was confirmed by T2-weighted MR imaging (C) to be a large and diffuse VM. One session of percutaneous sclerotherapy using alcohol was performed to treat superficial portion of lesion, with 10 cc of sclerosant injected. Patient developed transient facial nerve palsy, which resolved after 3 months. T2-weighted imaging done postsclerotherapy (D) confirmed clinical response.
Paper 135 Starting at 4:36 PM, Ending at 4:44 PM

CT-Guided Injection of the Anterior and Middle Scalene Muscles: Technique and Complications

M. Ashayekh, A. · Christo, P. J. · Yousem, D. M. · Pillai, J. J.
Johns Hopkins School of Medicine
Baltimore, MD

**Purpose**

A anterior scalene block may serve as a reliable diagnostic test by temporarily blocking or paralyzing the muscle in spasm and reducing symptoms of neurogenic thoracic outlet syndrome (NTOS). A positive response to the block correlates well with good surgical outcomes for NTOS. There are different methods of performing scalene injections, including the use of anatomical landmarks, electromyography, fluoroscopy, ultrasonography, or computed tomography (CT). The purpose of this study is to describe the technique and complications associated with CT-guided injection of the anterior and/or middle scalene muscles (ASM/MSM) in patients being evaluated for NTOS.

**Materials & Methods**

Sixty-eight subjects (mean age 43 ± 11 years), 45 females and 23 males, were identified via a retrospective review of medical records. Patients were positioned supine and a biop- sy strip was placed on the neck. A scout film was obtained from the C4 to T1 levels using 3 mm slices. The ASM/MSM was identified, the neck was prepared in the usual sterile manner, and a 1.5-inch, 22- or 25-gauge needle was inserted into the muscle belly. A focal area of the neck was rescanned on one to two more occasions for evaluation and adjustment of needle position, then 0.1 ml–0.3 ml of radiographic contrast (i.e., Omnipaque 180) was injected to verify both needle placement and spread of material within the muscle. Local anesthetic or botulinum toxin then was injected after negative aspiration for blood followed by rescanning to confirm selective injection into the ASM/MSM. The procedure was evaluated for technical success, described as satisfactory detection of the scalene muscle, intramuscular needle placement, intramuscular injection of contrast, appropriate delivery of medication, and frequency of unintended brachial plexus block or other complications. In addition, findings that may account for the patient’s symptoms, including cervical ribs, apophysomal of and transverse process, degenerative joint disease (DJD), and incidental lesions were also reported.

**Results**

In sum, 82 scalene injections were investigated. One of the patients underwent a scalene injection four times, another patient had the injection performed on three occasions, and 24 patients had the injection performed twice. In all cases, detection of ASM/MSM and intramuscular needle placement was satisfactory using CT guidance. Postprocedure, there was no hematoma, dysphasia, infection, abnormal bleeding, pneumothorax, vascular uptake, neck weakness, or phona- tion problems. Other related findings are reported in the table.

Table: Complications and Findings of the CT-Guided Scalene Muscle Injection

**Conclusion**

CT-guided injection of the ASM/MSM is a safe, fast, and reliable new method to assess or temporarily treat patients with NTOS. Also, accurately avoiding anesthesia of the brachial plexus and having few complications makes it an advantageous diagnostic and therapeutic method for NTOS.

**Key Words:** Scalene block, thoracic outlet syndrome

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Paper 136 Starting at 4:44 PM, Ending at 4:52 PM

Combined Use of Diffusion-Weighted Imaging and PET-CT in Head and Neck Squamous Cell Carcinoma

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Medical University of Vienna
Vienna, AUSTRIA

**Purpose**

The purpose of this prospective study was to correlate the values of the apparent diffusion coefficient (ADC) with diffusion-weighted MR imaging (DWI) and the uptake of 18 FDG (standardized uptake value; SUV) in head and neck squamous cell carcinomas.

**Materials & Methods**

Thirty consecutive patients with biopsy-proved ENT squamous cell carcinomas were examined on a clinical 3T MR scanner. In addition to conventional MR sequences acquired with a 16-channel head and neck coil, two different types of diffusion-weighted sequences were obtained: DWIBS in the axial plane for the whole neck and a navigated EPI in the sagittal plane through the center of the tumor, both using b-values of 0 mm²/s and 800 mm²/s. The ADC maps were calculated automatically. The tumors’ ADC values were measured with three standard-size ROIs and a ROI covering the entire tumor. Two-way repeated measures ANOVA was used for group comparisons. Spearman rank correlation of ADC values was performed.

**Results**

The 30 SCC had a mean ADC value of 0.90 (± 0.14) with standard-size ROI, and 0.94 (± 0.16) with large ROI measurements with the DWIBS sequence. The tumors’ ADC values were significantly higher when measured with the EI: 1.07 (± 0.21) and 1.09 (± 0.2). We observed a high correlation between the measurements of the large ROIs and the mean value of the three standard-size ROIs for both sequences. The mean SUV max (30 ± 12) did not correlate with ADC values on DWIBS or EPI.

**Conclusion**

Our findings suggest that different ADC reference values must be established for different diffusion-weighted sequences. The SUV appears not to be related to the ADC.

**Key Words:** Diffusion-weighted imaging
Dynamic MR Imaging of the Temporomandibular Joint at 3 T Using a Gradient-Echo Sequence

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PURPOSE
Temporomandibular joint (TMJ) dysfunction is a cause of headache, facial pain and referred otalgia, which can be quite debilitating to patients. Broad implementation of an effective protocol to define contours of the articular disk, and to evaluate disk motion has been limited by lack of a dynamic imaging sequence with sufficient temporal resolution. Recent dynamic TMJ studies demonstrated the feasibility of a single-shot spin-echo sequence at 1.5 T (1). In this work, we report our preliminary studies on the feasibility of a real-time gradient-echo (GRE) imaging at 3 T.

MATERIALS & METHODS
Experiments were performed on a GE Signa Excite 3 T scanner using a 6-channel carotid receive coil (NeoCoil). Static and dynamic TMJ imaging studies were performed on eight asymptomatic volunteers. The disk and its surrounding tissue were first identified using spin-echo sequence. Gradient-echo imaging also was performed with several echo times in order to measure T2*. Tissue regions of interest were drawn manually, and T2* was estimated by curve fitting (3). A simulation study was performed to find the GRE imaging parameters (flip angle, TE, and TR) that maximize the CNR efficiency between the disk and surrounding tissue (2). We used T1 = 901 ms for the disk and T1 = 812 ms for the anterior soft tissue based on the literature (2). For a given short TR of 16 ms, the parameters of TE = 8 ms and flip angle = 15° produced the optimum CNR efficiency from the simulation. Dynamic TMJ scans were performed with a 2DFT GRE sequence using custom real-time imaging software (4). Imaging parameters were: TE = 8 ms, TR = 16 ms, flip angle = 20°, slice thickness = 5 mm, in-plane spatial resolution = 0.5 x 0.5 mm2, NEX = 1. Partial k-space data (200 out of 300 phase encodes) were acquired at each frame. The temporal resolution was 3.2 sec. Each subject was instructed to open their jaw incrementally and sustain each posture for about 6 seconds (i.e., self-paced). Final images were obtained by performing sum-of-squares of all three coil images after Homodyne reconstruction.

RESULTS
In three of eight volunteers, static GRE imaging did not provide sufficient contrast between disk and surrounding tissue, likely due to variations in tissue relaxation properties between subjects. Despite this challenge, motion of the disk relative to translation of the condyle was well delineated on dynamic sequences, without the use of a Burnett device to control position. Potentially, continued real-time adjustment of TE and further enhancement of temporal resolution will mitigate these factors.

CONCLUSION
Acquisition of a 2DFT GRE at 3 T using custom-real imaging software has sufficient temporal resolution to capture temporomandibular joint mechanics, without the use of a Burnett device. Such a technique has the potential to improve imaging efficiency and the ability to diagnose temporomandibular joint dysfunction.

REFERENCES

KEY WORDS: TMJ, temporomandibular joint, dynamic imaging

Monday Evening
5:00 PM - 6:30 PM
Rooms 302-304-06

(12) A SFN R Programming:
Multimodality/Functional Neuroimaging

(138) Seizure Disorder
Noriko Salamon, M D, PhD

(139) Traumatic Brain Injury
Karen A. Tong, M D

(140) State-of-the-Art Imaging in Dementia
Jeffrey R. Petrella, M D

Moderator: Michael D. Phillips, M D

Seizure Disorder
Noriko Salamon, M D, PhD

LEARNING OBJECTIVES
Upon completion of this presentation, participants will be able to:
1) Review the multimodality technique available to evaluate epilepsy patients.
2) Illustrate how to combine multimodality technique for presurgical planning.

PRESENTATION SUMMARY
Neuroimaging plays an important role in identifying the cause of epilepsy. The postsurgical seizure control is largely based on the precise identification of the border of the lesion (1). Presurgical evaluation for the epilepsy needs not only morphological but also neurophysiological assessment; so that the
lesion we see is indeed the source of the epilepsy. When the lesion is located in the eloquent area of the brain, functional evaluation is necessary to have a better postsurgical clinical outcome. In this lecture, multiple modalities including M R I, C T, positron emission tomography (P E T), magnetic source imaging (M S I), functional M R I (fM R I), diffusion tensor imaging (D T I) will be demonstrated. The illustration of each of the modalities will be presented. PET-M R I fusion will increase detectability of the subtle type of cortical dysplasia (1-4). When the multiple lesions are seen such as tuberous sclerosis, PET-M R I fusion or M S I will help identifying the epileptogenic tuber (5). In the nonlesional cases, invasive depth electrode or grid placement may be necessary. The importance of the combination of multimodality will be addressed to bring the nonlesional case to surgery.

**REFERENCES**


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**State-of-the-Art Imaging in Dementia**

Jeffrey R. Petrella, MD

**LEARNING OBJECTIVES**

Upon completion of this presentation, participants will be able to:

1) Review the pertinent clinical issues arising in the work up of the dementia patient.
2) Discuss the role of state-of-the-art multimodality imaging, including FDG-PET, serial quantitative volumetric imaging and amyloid imaging for addressing these issues.
3) Describe how fMRI and fcMRI are increasing our understanding of the underlying mechanisms of Alzheimer disease.

**PRESENTATION SUMMARY**

As the therapeutic options for patients with dementia increase, there will be a greater need for accurate and early diagnosis, identification of asymptomatic at-risk populations, and the ability to track disease progression. Consequently, there will be an increased demand for an expanded role of imaging beyond its current requirements for ruling out potentially reversible causes of dementia. In this lecture we will discuss the role of FDG-PET, serial
quantitative volumetric imaging and amyloid imaging as the next generation of clinical imaging tools for evaluation of patients with dementia (1). Finally, using Alzheimer disease as an example, will examine the role of functional MRI (fMRI) and functional connectivity MRI (fcMRI) for bridging the gap between our understanding of the molecular basis of dementia and its clinical phenotype (2, 3).

**References**


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**Monday Evening**

**5:00 PM - 6:30 PM**

**Ballroom ABC**

(13) A SPNR Programming: Seizure Disorder in Children: The Role of Histopathologic and Functional Imaging in Medical versus Surgical Treatment

Audience Response Plus (AR+)*

Self-Assessment Module (SAM)**

(141) Histopathologic Imaging in Seizure Disorders
— P. Ellen Grant, MD

(142) Imaging of Eloquent Areas and Seizure Focus
— Nolan R. Altman, MD

(143) Pediatric Seizure Disorder Outcome: Medical vs Surgical Treatment
— Joseph Madsen, MD

**Questions and Answers**

Moderator: Peter Kalina, MD

*An educational grant was received by Bayer Healthcare Pharmaceuticals, Inc. in support of the Audience Response Plus+ (AR+) technology in the Maintenance of Certification (MOC) Review Sessions.

**Session is under review as of April 6, 2010 by the American Board of Radiology to meet the criteria for self-assessment toward the purpose of fulfilling requirements in the ABR Maintenance of Certification. To obtain current SAM credit information, visit www.asnr.org.

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**Histopathologic Imaging in Seizure Disorders**

P. Ellen Grant, MD

**Learning Objectives**

Upon completion of this presentation, participants will be able to:

1) Outline the role of structural imaging in the evaluation of a child with epilepsy
2) Review common imaging findings
3) Discuss optimal imaging protocol
**Presentation Summary**

Malignations of cortical development (MCD) are the most frequently identified pathologic substrate in pediatric patients undergoing epilepsy surgery. Pre-operative identification of a localized structural lesion is an important prognostic factor in the surgical management of medically refractory partial epilepsy. In fact, for the most common of these lesions, focal cortical dysplasia (FCD), complete excision of dysplastic cortex is the most important determinant of seizure-free outcome. Diagnostic modalities that can detect, define and delineate the extent of these lesions are therefore crucial to optimal management of patients with MCD. The progress in lesion detection, definition and delineation are primarily the result of improving MRI technologies. Imaging findings of CDs include thickening of the cortex, blurring of the gray-white matter junction, abnormal cortical signal (on one or all imaging sequences) and increased T2/FLAIR and/or T1 hypointense signal extending from the ependymal surface to the cortical surface. A ditional imaging features that have been described include focal hypoplasia, a deep sulcus with malformations at the depths of the sulci, broadening of the gyri and white matter atrophy. Many of these features can be seen on both T1 and T2 weighted images, although the cortical dysplasia for a given patient may be more apparent on any one of these imaging sequences. FLAIR, especially volumetric FLAIR at 3T, is very sensitive for identifying white matter involvement, but in our experience is less sensitive for evaluation of the cortical extent, making T1 and T2 weighted images superior for cortical lesion boundary definition. Improvements in MR technology, when used in conjunction with optimized imaging protocols, can dramatically increase the signal-to-noise ratio (SNR). In particular, increases in SNR obtained using phased array (PA) coil technology are most dramatic at the cortex, with obvious implications for MCDs. The use of PA coils has been shown to improve diagnostic yield using a 12-channel array at 3 Tesla (T). In our anecdotal experience, a 32-channel array further improves the ability to detect and characterize MCDs at 3T. In addition, preliminary studies at 7T suggest that the improved cortical visualization may push our abilities to even higher levels. For further discussion please refer to Madan and Grant 2009.

**References**


**Imaging of Eloquent Areas and Seizure Focus**

Nolan R. Altman, MD

**Learning Objectives**

Upon completion of this presentation, participants will be able to:

1. Define what imaging methods are available for seizure localization and how they are used.
2. Discuss how language mapping is performed and utilized in pediatric neuroimaging.

**Presentation Summary**

Modern neuroimaging facilitates precise presurgical mapping of eloquent regions of the brain. This is best done with fMR and DTI exams. The WADA test has been replaced in most cases. Examples of pre and postoperative exams will demonstrate the utility of the exams. This may be performed on sedated children. Epileptogenic regions can be searched for either ictally or interictally. Ictal SPECT, WADA and fMR studies are performed ictally. Interictal PET, SPECT and fMR are used and are obtained more easily. Fusion of these studies is critical and various methods are available and will be demonstrated.

**References**

Monday Evening
5:00 PM - 6:30 PM
Room 311

(14) General Session: Spine Imaging

(144) Diffusion-Weighted Imaging of the Spine and Spinal Cord
— Majda M. Thurnher, MD

(145) Vascular Imaging of the Spine
— Mary E. Jensen, MD

(146) Pre and Postnatal Imaging of Spinal Anomalies
— Erin Simon Schwartz, MD

Moderator: Ori A. Glenn, MD

Diffusion-Weighted Imaging of the Spine and Spinal Cord
Majda M. Thurnher, MD

Learning Objectives
Upon completion of this presentation, participants will be able to:
1) Illustrate current and future clinical applications of the DWI and DTI in the spine.
2) Review the technical difficulties in obtaining DWI and DTI in the spine.

Presentation Summary
The application of advanced MR imaging techniques, such as MR spectroscopy, perfusion, and diffusion-weighted imaging in the spine and spinal cord has been limited by a number of physical, physiologic, and technical factors. With improvement in coil technology, hardware, and pulse sequences it now is becoming possible to obtain biochemical, physiologic, and hemodynamic information about the human spinal cord in vivo. Despite the general lack of optimism about the usefulness of clinical 3 T MR imaging in evaluation of the spine, the initial gap between promises and clinical reality of 3 T spine imaging has been partially bridged in the last years. High-resolution images of the spinal cord, diffusion and diffusion tensor imaging (DTI) and even tractography of the spinal cord is now the reality. Changes in DTI metrics were found in the cervical spinal cord of multiple sclerosis (MS) patients, in the absence of spinal cord signal abnormality at conventional MR sequences. The measurement of DTI metrics in the spinal cord in MS patients may aid in monitoring the disease progression and therapeutic effect. Fiber tractography was used for differentiation of spinal cord tumors, showing displacement of the fibers in ependymomas and infiltration of fibers in diffuse astrocytoma. The preliminary data suggest that DTI and FT can be used for visualization of fibers in different spinal cord tumors. Recently published data have shown that the evaluation of major (E1) and minor (E2, E3) eigenvalues, may assist in identifying subgroups of patients with compressive myelopathy and triaging patients who will benefit from decompression surgery. This lecture will concentrate on various aspects of DWI and DTI in the evaluation of the diseases of the spine and spinal cord, especially emphasizing their practicality in everyday imaging, as well as the potential for future clinical applications.

Vascular Imaging of the Spine
Mary E. Jensen, MD

Learning Objectives
Upon completion of this presentation, participants will be able to:
1) Identify the vessels that comprise the arterial and venous supply to the spinal cord and column.
2) Rate the usefulness of non-invasive imaging techniques for diagnosis of spinal vascular lesions.
3) List the common vascular malformations that affect the spinal cord or column.

Presentation Summary
In order to evaluate and treat spinal vascular lesions, a thorough understanding of the arterial supply and venous drainage of the spinal cord and column is necessary. Traditionally, the spinal cord vascular anatomy has been evaluated using digital subtraction angiography. However, technical developments in noninvasive imaging such as computed tomographic angiography (CTA) and magnetic resonance angiography (MRA) has made it possible to visualize the spinal axis vasculature in a noninvasive manner. This lecture will cover the arterial and venous supply of the spinal cord and column, with emphasis on classic vascular anatomy as demonstrated on digital subtraction angiography, supplemented by images from CTA and contrast-enhanced MRA. Examples of normal vessels and distorted vasculature due to pathologic conditions will be included.

Pre and Postnatal Imaging of Spinal Anomalies
Erin Simon Schwartz, MD

Learning Objectives
Upon completion of this presentation, participants will be able to:
1) Recognize the more commonly encountered spinal anomalies with prenatal imaging.
2) Rank the more commonly encountered spinal anomalies with postnatal imaging.
3) Utilize the reviewed clinical-radiologic classification to aid in the diagnosis of spinal anomalies.
Encountering the fetal or pediatric patient with a spinal anomaly can be daunting for radiologists. The clinical-radiologic classification system proposed by Tortori-Donati, Rossi, and Cama serves as a useful tool in reaching the correct diagnosis when presented with the anomalous spine prenatally or postnatally.

**References**


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**Monday Evening**

5:00 PM - 6:30 PM
Room 210

(15) PQI: Getting Started with Baby Steps

(147a) Introduction to the MOC Process
— David Laszakovits, MBA

(147) Rationale, Requirements Reality of Practice Quality Improvement
— David M. Yousem, MD

(148) A Simplified Approach to Developing PQI Projects
— Pina C. Sanelli, MD, MPH

(149) Examples of PQI Projects Performed
Reducing Radiation Exposure in Aneurysmal Subarachnoid Hemorrhage by Implementing Utilization Guidelines: A Practice Quality Improvement Project
— Michael L. Loftus, MD

(150) Reducing the Need for Sedation in Pediatric Patients
— Bernadette L. Koch, MD

(151) Streamlining Interventional Radiology Practice
— Sanjay Misra, MD

Panel Discussion
Moderators: David M. Yousem, MD, MBA
David Laszakovits, MBA

**Introduction to the MOC Process**
David Laszakovits, MBA

**Rationale, Requirements, Reality of Practice Quality Improvement**
David M. Yousem, MD, MBA

**Learning Objectives**
Upon completion of this presentation, participants will be able to:
1) List the steps needed in completing a PQI project.
2) Identify web sites that assist in formulating and completing a PQI process.
3) State the purported value in the PQI component of MOC.

**A Simplified Approach to Developing PQI Projects**
Pina C. Sanelli, MD, MPH

**Examples of PQI Projects Performed**
Reducing Radiation Exposure in Aneurysmal Subarachnoid Hemorrhage by Implementing Utilization Guidelines: A Practice Quality Improvement Project
Michael L. Loftus, MD

Michael Loftus is a radiology resident at Weill Cornell - New York Presbyterian Hospital in New York and the resident representative on the departmental Practice Quality Improvement committee and Housestaff Quality Council. He has an MBA background from Columbia Business School and an interest in developing operations management innovations that result in overall healthcare quality improvement and specifically increased radiation safety.

**Learning Objectives**
Upon completion of this presentation, participants will be able to:
1) Recognize the increasing radiation exposure that patients receive with current CT utilization practices.
2) Review opportunities to improve current practice in ways
that reduce cumulative radiation exposure.

**Presentation Summary**
Since the introduction of computed tomography, its utilization has increased dramatically. Furthermore, the development of new imaging techniques such as CT angiography (CTA) and CT perfusion (CTP) have improved the diagnostic ability of CT, but have further increased radiation exposure to patients because of their technical parameters, thin slice acquisition, and extended field of view. Our department implemented a Practice Quality Improvement (PQI) imaging protocol designed to limit CTA and CTP exams and reduce cumulative radiation exposure from head CT for patients with aneurysmal subarachnoid hemorrhage (A-SAHI). Our structured imaging algorithm resulted in a 12.1% decrease in cumulative radiation exposure and a 25.6% decrease in the number of head CT exams performed by defining appropriate imaging time-points and clearly defined termination points. Application of these methods to other high CT-utilization patient populations may reduce patient radiation exposure while maintaining the clinical benefits of CT imaging.

**Reducing the Need for Sedation in Pediatric Patients**

Bernadette L. Koch, MD

**Learning Objectives**
Upon completion of this presentation, participants will be able to:
1) Describe a PQI project designed to reduce the need for sedation in imaging pediatric patients.
2) Describe the use of certified child life specialists and distraction devices to decrease the need for sedation.

**Presentation Summary**
Producing high quality CT and MR imaging in children, can be a challenge to perform without sedation or anesthesia. The process of sedation or anesthesia for imaging children requires time, money and resources (MDs, RNs, PCAs, space, etc.), and is not entirely without complications. Advantages of avoiding sedation include, but are not limited to, elimination of potential medication errors and reactions, decreased time away from home/work/school, decreased personnel required to care for the children before, during and after imaging, and elimination of recovery time. In addition, the sedation process itself can be anxiety provoking for children and their families. Therefore, when possible, the best choice is to obtain high quality images without the need for sedation. This presentation will describe a multifaceted program to decrease the need for sedation, while maintaining high quality images. This includes distraction devices (DVD/VCR, MRI compatible video goggles, and video projectors), the use of oral sucrose solution in infants, infant immobilizer and the integration of a child life specialist into the imaging team.

**References**


Streamlining Interventional Radiology Practice
Sanjay Misra, MD

**Learning Objectives**
Upon completion of this presentation, participants will be able to:
1) Define what a PQI project is.
2) Cite the steps needed to create a PQI.
3) Review how to define and measure the outcomes of a PQI project.

**Presentation Summary**
Describe the steps needed to develop a practice quality improvement (PQI) project in Vascular and Interventional Radiology. A PQI project was developed in which standardization of the interventional radiology supply process was performed. The presentation will describe the background and steps which were required for the improvement in the supply process which led to a improved supply usage, less supply outages, decrease in the amount of expired product, and better work flow. At the end of the presentation, the participant should be able to define the steps needed to create a PQI project in their own work place.

**Monday Evening**
5:00 PM - 6:30 PM
Room 312

(16) Advanced Imaging Seminar: MRSpectroscopy for the Neuroradiologist

(152) Spectroscopic Imaging: Approaches to Standardization — Andrew A. Maudsley, PhD
(153) MRSpectroscopy - Clinical Applications — R. Gilberto Gonzalez, MD, PhD
(154) MRSpectroscopy - GABA Editing and Neuroscience — Richard A. Edden, PhD

Moderator: Timothy P. L. Roberts, PhD
Spectroscopic Imaging: Approaches to Standardization
Andrew A. Maudsley, PhD

Dr. Maudsley completed a PhD in physics in 1976 that included the early development of MRI. In 1979 he took a research position at Columbia Presbyterian Medical Center, New York, where he worked on the construction of the first 1.5 T superconducting magnet system located in a clinical setting. Over the next several years Dr. Maudsley and colleagues published several early papers in the area of technique developments for MRI and in vivo spectroscopy, including the development of spectroscopic imaging methods and the first sodium and phosphorus imaging in animals and humans. He is currently a Professor of Radiology at the University of Miami, where he continues the development of spectroscopic imaging methods and their application for diagnostic studies of the brain in humans, including areas such as epilepsy, traumatic brain injury, and neurodegenerative diseases. Dr. Maudsley's publications include 126 papers and book chapters, and eight patents. He has received grant awards from the National Institutes of Health, is a Fellow of the International Society for Magnetic Resonance in Medicine, and has served on the Medical Imaging study section of the National Institutes of Health.

Learning Objectives
Upon completion of this presentation, participants will be able to:
1) Review current MRS methods, clinical applications, and limitations.
2) Describe new approaches to integrating MRI and MRS acquisition protocols with comprehensive data processing and analysis methods.
3) Recommend approaches for improving standardization of MRS methods.

Presentation Summary
Magnetic resonance spectroscopy (MRS) provides information on tissue metabolism that can be of diagnostic value and complimentary to structural imaging findings. However, MRS methods have not become incorporated widely into standard imaging protocols, in part because of the requirement for specialized data acquisition and analysis methods, as well as by the wide-ranging differences in implementations between sites. This presentation will describe newer MR spectroscopic imaging approaches that map distributions of tissue metabolites throughout the brain, and which simplify interpretation by presenting alterations in metabolite concentrations relative to normal values. By taking advantage of higher speed acquisition methods and newer high-field MRI instruments, MRS imaging methods can be implemented in a routine manner and in clinically viable acquisition times. Examples of MRS imaging studies implemented on 3 T MR instruments from multiple manufacturers will be presented.

MR Spectroscopy - Clinical Applications
R. Gilberto Gonzalez, MD, PhD

MR Spectroscopy - GABA Editing and Neuroscience
Richard A. Edden, PhD

Dr. Edden received his BA, MSci, MA, PhD from Cambridge University, United Kingdom in Natural Sciences (Chemistry) in 1996-2005. He received his Postdoctorate at The Johns Hopkins University, Russell H. Morgan Department of Radiology and Radiological Sciences in 2005-2007. Dr. Edden was an RCUK Academic Fellow, Schools of Biosciences and Chemistry, Cardiff University, United Kingdom from 2007 to 2009. He is an Assistant Professor, Russell H. Morgan Department of Radiology, The Johns Hopkins University, from 2009 to the present.

Learning Objectives
Upon completion of this presentation, participants will be able to:
1) Describe the experimental basis of edited MR spectroscopy.
2) Illustrate novel combined approaches of edited MRS, functional neuroimaging and behavioral psychophysics.

Presentation Summary
This presentation will cover the use of edited magnetic resonance spectroscopy for studying the inhibitory neurotransmitter GABA. An explanation of editing methods, with specific reference to GABA, will be followed by a summary of recent experiments relating GABA concentration to functional neuroimaging signals (both fMRI and MEG) and psychophysical measurements of behavior.
Tuesday Morning

7:45 AM - 8:45 AM
Ballroom ABC

(17) Maintenance of Certification (MOC) - Review Session (AR+)
Vascular
Audience Response Plus (AR+)*

(155) Vascular
— Frank C. Tong, MD

(156) Neurovascular Diagnosis and Intervention
— Jacqueline A. Bello, MD

Moderators: Jacqueline A. Bello, MD
Frank C. Tong, MD

*An educational grant was received by Bayer Healthcare Pharmaceuticals, Inc. in support of the Audience Response Plus+ (AR+) technology in the Maintenance of Certification (MOC) Review Sessions.

NOTE ABOUT SCANNED IMAGES: Scanned images are included in the proceedings book. Some submitted images were reduced during the printing process, thereby decreasing clarity. The images as originally submitted can be viewed within the abstract on the ASNR website at www.asnr.org/2010.

Vascular
Frank C. Tong, MD

LEARNING OBJECTIVES
Upon completion of this presentation, participants will be able to:
1) Describe normal spinal vascular anatomy and differentiate between vascular and nonvascular etiologies for spinal cord pathology.
2) Distinguish between aggressive and nonaggressive vascular shunting conditions and diagnose unusual causes of SAH.
3) Discuss the causes and work up of venous and arterial occlusive disease of the brain.
4) Review the anatomy and physiology of the collateral circulations.

PRESENTATION SUMMARY
Through a case presentation format, this session will review various topics in vascular neuroradiology. The diagnosis, differential diagnosis and treatment of vascular pathology of the brain, spine and head and neck will be covered in an interactive program employing the audience response system. This problem-based strategy will include a discussion of appropriate imaging techniques and implications for treatment.
Tuesday Morning

8:45 AM - 10:15 AM  
Ballroom ABC

(18) Socioeconomic Programming: 
Overview of Healthcare Reform Legislation

(157) J. Arliss Pollock MD 2010 Memorial Lecture  
Building a Bridge from Fragmentation to Accountability: Prometheus Payment Model  
— Meredith B. Rosenthal, PhD

(158) Healthcare Reform: Implications for Neuroradiologists  
— Gerard Anderson, PhD

Questions and Answers
Moderator: David J. Seidenwurm, MD

J. Arliss Pollock, MD 2010 Memorial Lecture  
Building a Bridge from Fragmentation to Accountability: Prometheus Payment Model
Meredith B. Rosenthal, PhD

Dr. Rosenthal is Associate Professor of Health Economics and Policy in the Department of Health Policy and Management at the Harvard School of Public Health. Dr. Rosenthal received her PhD in health policy at Harvard University in 1998. Her research examines the design and impact of market-oriented health policy mechanisms, with a particular focus on the use of financial incentives to alter consumer and provider behavior. She currently is working on a body of research that examines alternative models for reforming physician and hospital payment. Specific empirical projects include evaluations of several Patient-Centered Medical Home pilots, pay-for-performance initiatives, and an episode-based payment system. Dr. Rosenthal’s work has been published in the New England Journal of Medicine, the Journal of the American Medical Association, Health Affairs, and numerous other peer-reviewed journals. Based on her work, Dr. Rosenthal has been called to testify before the U.S. Congress and the California and Massachusetts legislatures. In 2006, Dr. Rosenthal was awarded an Alfred P. Sloan Industry Studies Fellowship in recognition of her field-based research on physician incentives. Dr. Rosenthal is member of the Massachusetts Public Health Council, which promulgates regulations and advises the Commissioner of Public Health on policy matters.

Learning Objectives
Upon completion of this presentation, participants will be able to:
1) Review the advantages and disadvantages of episode-based payment.
2) Describe the elements of Prometheus Payment and its implementation in multiple pilot sites across the country.

Presentation Summary
There is general consensus that fee-for-service payment for health care in the U.S. has contributed to fragmentation of the delivery system, poor quality, and high costs. Proposed reforms would introduce more prospective payment approaches including episode-based payment. This session will cover episode-based payment in concept and describe the design and implementation of a specific example, Prometheus Payment.

Healthcare Reform: Implications for Neuroradiologists
Gerard Anderson, PhD

Learning Objectives
Upon completion of this presentation, participants will be able to:
1) Create awareness of health reform initiatives
2) Review payment reform implications for neuroradiologists

Presentation Summary
Next steps in health reform and provider payment. This presentation will provide an overview of changes in health reform and provider payment that will affect neuroradiologists. Both the public and private sectors are initiating a series of reforms that could affect both the healthcare system and method of payment for neuroradiologists. This presentation will focus on system changes such as medical home, accountable health plans and other system designs that will affect how neuroradiologists interact with other healthcare providers. It also will examine how payment reforms such as bundled payments will affect who will be distributing the money from the health insurers and how this is likely to affect neuroradiologists.
Tuesday Morning
10:45 AM – 12:30 PM
Ballroom ABC

(19a) Adult Brain: Functional Imaging
(Scientific Papers 159 - 171)

See also Parallel Sessions
(19b) Interventional: New Devices And Techniques
(19c) Pediatric: Developmental/Congenital Malformations and Demyelinating/ Degenerative and Neonatal Imaging
(19d) Head and Neck: Pharynx, Larynx, Soft Tissue Neck, Sinonasal and Temporal Bone

Moderators: John L. Ulmer, MD
Sriini Mukundan, Jr., MD, PhD

Paper 159 Starting at 10:45 AM, Ending at 10:53 AM
Precision and Accuracy of Two Projection-Based Pulse Sequences for Measurement of Brain Cell Fraction and Tissue Sodium Concentration Bioscales with Quantitative Sodium MR Imaging

Thulborn, K. R.1 · Lu, A.1 · Atkinson, I. C.1 · Claiborne, T.1 · Ganin, H.1 · Stainsby, J. A.1,2
1University of Illinois at Chicago, Chicago, IL, 2GE Healthcare, Mississauga, ON, CANADA

PURPOSE
The precision and accuracy of the flexible twisted projection imaging (flexTPI) and 3D cones (3DC) pulse sequences were evaluated for quantitative sodium MR imaging of normal human brains.

MATERIALS & METHODS
Healthy adults (N = 8) were recruited into an IRB-approved protocol for quantitative sodium imaging measurements (N = 5) with one or both of the pulse sequences on a clinical 3.0 T scanner with broadband capabilities (GE Healthcare, WI). Proton and sodium imaging was performed with single-tuned quadrature RF coils. Separate sessions were used for each pulse sequence. Human subjects underwent shimming and B0 mapping with proton imaging followed by B1 mapping and spin density measurement with sodium imaging. The imaging procedure was repeated on a calibration phantom of similar coil loading to the human. Mapping was performed with B0 and B1 corrections to human and phantom sodium images with conversion to tissue sodium concentration (TSC) maps and cell volume fraction (CVF) maps.

RESULTS
Calibration curves after B0 and B1 corrections were linear ($R^2 = 0.999$) with signal to noise performances of 18:1 at 40 mM. Tissue sodium concentration (TSC) values in gray (GM) and white (WM) matter for each of five subjects with each sequence (flexTPI: WM 28.5±0.6, 26.9±0.9, 29.1±0.7, 26.3±0.6, 27.0±0.4; GM 36.8±0.7, 36.3±0.9, 37.3±0.9, 35.9±1.2, 36.7±0.7 and 3DC: WM 30.4±0.4, 29.2±0.5, 30.1±0.2, 30.2±0.2, 28.6±0.5; GM 37.3±0.5, 36.3±0.6, 37.1±0.5, 37.6±0.4, 36.4±0.5 unit: µmol/g wet weight) show little difference between sequences. Standard deviations are small with little variance across subjects. These TSC values estimate the cell fraction around 80% in agreement with published values (1). As accuracy cannot be confirmed directly, accuracy was inferred using TSC values from skeletal muscle at the base of skull (26.2±3.3 µmol/g wet weight) and in the vitreous humor [133.6 ± 6.3 µmol/g wet weight] in agreement with literature values (muscle 28.4±3.6 µmol/g wet weight (2), vitreous humor 131.8±3.8 mM (3)).

CONCLUSION
Equivalent precision of human brain TSC measurement has been demonstrated for both pulse sequences for quantitative sodium imaging incorporating correction of B0 and B1 inhomogeneities. Equivalent accuracy for both sequences is inferred from the linear calibration and comparable TSC values in muscle and vitreous humor to published values. Sodium images, TSC maps, CVF maps and calibration are shown below, respectively.

REFERENCES

KEY WORDS: Sodium MR imaging, projection imaging, cell density
Impact of Tumor Location on Morbidity and Mortality: A Retrospective fMRI Study

Wood, J.1 · Kundu, B.1 · Utter, A.1 · Gallagher, T.1 · Voss, J.2 · Sanamandra, S.1 · Nair, V. A.1 · Kuo, J. S.1 · Field, A.1 · Moritz, C.1 · Meyerand, B.1 · Prabhakaran, V.1

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PURPOSE
Motor and language deficits are particularly debilitating functional deficits and thus a major neurosurgical concern in the preoperative or postoperative setting of brain tumor patients. A critical parameter for predicting deficits is the distance from brain tumor to functioning cortex (1, 2). We tested the hypothesis that there is an association between distance of tumor lesion to motor cortex (MC) or language areas (Broca’s and Wernicke’s areas) and existence of functional deficits of weakness or aphasia respectively. We also tested for a relationship between these distances and postoperative mortality.

MATERIALS & METHODS
Our study included patients who underwent either primary or metastatic brain tumor resection at the University of Wisconsin Madison or Madison VA hospital. Preoperative fMRI language and motor maps of 83 and 73 subjects respectively were reviewed retrospectively (see Table 1a). The distance parameters were calculated for each subject by finding the minimum distance from tumor to cortical activation. Morbidity information in terms of weaknes and aphasia as well as mortality information was examined. Statistical analysis was done using chi-squared test and multivariate ANOVA.

RESULTS
See Table 1b for results. We found a significant association between distance from the tumor to MC and the existence of weakness/paresis (p < 0.001); however no significant relationship was found between this distance and mortality (p = 0.652). Similarly, a significant association was found between distance of the lesion from either language area and the existence of aphasia (p = 0.001) but no significant relationship between this distance and mortality (p = 0.857). Moreover, we found a proportional relationship between distance and motor deficit. Incidence of weakness decreases approximately by 30% from less than one centimeter to between one and two centimeters, and then decreases again by approximately 30% for distances greater than two centimeters. This differs from the relationship describing tumor location and aphasia. Here, incidence of aphasia was much higher for distances less than one centimeter and then does not vary beyond this cutoff point.

REFERENCE

KEY WORDS: fMRI, motor deficits, aphasia

Paper 161 Starting at 11:01 AM, Ending at 11:09 AM
Reorganization of Functional Connectivity MR Imaging in Patients with Brain Tumors

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1Institute of Advanced Biomedical Technologies, Chieti, ITALY, 2Catholic University, Rome, ITALY

PURPOSE
Functional connectivity MR imaging (FCMRI) measures the spontaneous and synchronous fluctuations of the BOLD signal between spatially remote brain regions. Modifications of FC produced by the presence of brain tumors were demon-
strated only using magnetoencephalography (1). The present study aims at investigating modifications of FCMRI within the language network in patients with a left hemisphere brain glioma.

**MATERIALS & METHODS**

We retrospectively evaluated FCMRI in 40 right-handed patients with a left hemisphere brain glioma and in 14 healthy subjects. Patients were classified into four subgroups considering the malignancy of the tumors (low grade/high grade), the volume of the tumors (small/large) and the position of the tumors in respect to a plane orthogonal to the anterior commissure (anterior/posterior) and in respect to the distance from the left Broca and Wernicke areas (“in”/”out”). Patients and controls underwent fMRI to lateralize language functions in the cerebral hemispheres. For each subject, whole-brain connectivity maps were created positioning a seeding in the left inferior frontal gyrus (left Broadman 45) using the region with maximum BOLD signal as reference and accounting for any eventual anatomical derangement due to the presence of the tumor. Five seed regions (right Broadman 45, Superior Temporal Sulcus and Temporo-Parietal Junction of both the hemispheres) were derived from connectivity maps. Cross-correlation matrices of BOLD signals fluctuations were calculated for each subject and correlated with behavioral tests related to language. Group-level analyses were performed by independent-samples t-tests and ANOVAs.

**RESULTS**

The global FCMRI was reduced significantly in tumor patients compared to controls (p < 0.001). Functional connectivity MR imaging was significantly reduced within seed regions of the affected hemisphere (left intrahemispheric FC) and within the right hemisphere (right intrahemispheric FC) (p < 0.05); interhemispheric FC also was reduced significantly in patients (p < 0.001). Patients with posterior tumors showed a greater reduction of the left intrahemispheric FC compared to patients with anterior tumors (p < 0.05). Patients with high-grade tumors showed a greater reduction of the right intrahemispheric FC than patients with high-grade tumors (p < 0.01). In the whole brain connectivity maps, patients show a more complex spatial distribution of the FC between the language-related regions (p < 0.01).

**CONCLUSION**

The presence of a brain tumor in the left hemisphere significantly reduces the FC between language-related brain regions; this effect is more significant considering low-grade tumors localized near the left Wernicke area. Modification of the FC is not restricted to the area surrounding the tumor; remote and contralateral areas also are influenced.

**REFERENCES**


**KEY WORDS:** Functional connectivity, MR imaging, brain tumors

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**Paper 162 Starting at 11:09 AM, Ending at 11:17 AM**

**Eighteen-Month Follow Up of Radiation-Induced Metabolic Alterations in Normal Brain: An MR Spectroscopy Study**

Chapman, C. H.¹ · Sundgren, P. C.²,² · Tsien, C. I.¹ · Elias, A.¹ · Junck, L.¹ · Gomez-Hassan, D. M.¹ · Chenevert, T. L.¹ · Lawrence, T. S.¹ · Cao, Y.¹

¹University of Michigan, Ann Arbor, MI, ²Lund University Hospital, Lund, SWEDEN

**PURPOSE**

Irradiation of the brain can cause late neurologic complications in long-term survivors. Few longitudinal studies of long-term changes in normal-appearing brain have been published. We hypothesized that two-dimensional chemical shift imaging MR spectroscopy (2D CSI MRS) could detect late changes in irradiated normal-appearing white matter not evident on other MRI modalities.

**MATERIALS & METHODS**

Eleven patients with primary low-grade brain neoplasms treated with radiation therapy (RT) participated in an IRB-approved prospective study in which MR imaging and MRS were performed on a 1.5 T scanner (LX EchoSpeed, GE Medical Systems) prior to RT and 1, 6, and 18 months after the completion of RT. Eight of the 11 patients completed the study up to 18 months (prescribed dose 50.4-59.4 Gy, median 55.8 Gy). The MR protocol included T1- and T2-weighted pre- and postcontrast images. Two-dimensional CSI MRS was performed with the following parameters: TE/TR 144/1500 ms, FOV 23, thickness 10 mm, matrix 16 x16, scan time 1NEX 4:20 minutes. Volumes of interest (VOIs; 100 mm³) were placed systematically to cover normal-appearing white matter and the metabolic ratios NAA/Cr, Cho/Cr and NAA/Cho were calculated in VOIs matched across time points (NAA = N-Acetyl Aspartate; Cr = Creatine; Cho = Choline.) The metabolic spectra were analyzed using the individual vendor software (Funtool 2, GE) with manual adjustment of metabolic peak boundaries. Two-tailed Student’s T-test (P < 0.05) was used for statistical comparison between values obtained at the preradiation study and those obtained postradiation.

**RESULTS**

A significant decrease in the mean Cho/Cr ratio compared to pre-RT persisted at 18 months post-RT from 1 and 6 months post-RT. At 18 months post-RT, there were significant increases in NAA/Cho and NAA/Cr compared to the values obtained pre-RT (Figure). No patient had disease progression.

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**Figure 1:** Changes in mean metabolic ratios. Error bars are standard error. All changes are significantly different (P < 0.05) from pre-RT except NAA/Cho at 1 month and 6 months.
CONCLUSION
Our data suggest that MRS is sensitive for detection of radiation-induced metabolic changes in normal-appearing white matter. Persistent Cho/Cr reduction could represent unrepaired oligodendrocyte damage. The parallel increase in NAA/Cho and NAA/Cr ratios at 18 months most likely represent a predominant increase in NAA levels, which might be explained by a late neuronal repair processes even if interval changes in the Cr levels exist. Future studies should continue follow up and correlate metabolite changes to delayed white matter MR signal abnormalities.

Acknowledgment: Grant support provided by NIH 1 R01 NS 064973.

KEY WORDS: Spectroscopy, radiation therapy, metabolic

Paper 163 Starting at 11:17 AM, Ending at 11:25 AM
Using Active Listening Paradigm to Improve fMRI Language Activation

Mahmoud, S. Y. M. · Jones, S. E. · Phillips, M. D.
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Cleveland, OH

PURPOSE
To improve image quality of fMRI from the passive listening paradigm with introduction of a listening prompt-guided/active listening. Functional MR imaging has low SNR for higher cognitive functions, such as language. Typically three different language paradigms are performed to increase signal-to-noise ratio for single-patient clinical applications. Of these, passive listening often has the lowest SNR, but can show reliable localization and lateralization. Therefore there is value in mechanisms to improve SNR in the paradigm. Pervious work has shown increase in extent and magnitude of activation from the active response story processing task compared to the passive listening task, which likely related to involvement of memory and attention resources engaged across acquisition intervals (Vannest, JJ et al. 2009). We extend these findings to a clinical environment, using a simple clinical paradigm. Most patients are imaged for presurgical planning for either epilepsy or brain tumor. For this we modified our passive listening paradigm to include a more active component, by asking the comprehension questions before scanning as well.

MATERIALS & METHODS
Nineteen patients prospectively underwent clinical fMRI examinations, which included a modified listening paradigm, which comprised the same paradigm with additional prescan introduction to the same four multiple-choice comprehension questions that is going to be asked in the postscan evaluation. This differed from earlier standard paradigm which was performed using a short story composed of 32-second nine blocks of alternating backward forward narration with a postscan four multiple choice comprehension questions from the group of 60 subjects were randomly selected (GroupN). The principal eigen-vector (e1N), FA (FAN) and trace (traceN) values were estimated. The same procedure was repeated 100 times. Maps of the standard devia-

tively from 197 patients examined over the past 2 years using the standard listening paradigm. T test was used to compare the average/maximum activation from the two groups.

RESULTS
Location of the activation from both techniques was similar. The average/maximum activation was significantly higher from the new active listening method. The strength of activation was improved by 35% for the active listening. Mean left activation = 10.7 for the new method vs 7.3 for the old method, with a significant p value = 0.031. Mean right activation = 7.5 for the new method vs 5 for the old method, with a p value of 0.016. Noise scores were lower in the new guided/active listening method (5.8 vs 6.8), however this did not show statistical significance, p value = 0.57. Behavioral performance improved from average of 75% to 95% from the guided/active listening technique.

CONCLUSION
Robust fMRI activation can be obtained from the passive listening paradigm by using an active listening technique, incorporating the use of prescan questions that guide attention during acquisition. This technique is clinically practical and simple and it improves the overall diagnostic quality of the listening paradigm for clinical fMRI scans using the same paradigm.

KEY WORDS: fMRI, language lateralization, listening paradigm

Paper 164 Starting at 11:25 AM, Ending at 11:33 AM
Effect of the Number of Subjects Used for the Development of a Diffusion Tensor Brain Template on the Variability of the Template’s Tensor Properties

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PURPOSE
Development of a diffusion tensor (DT) template that is representative of the diffusion characteristics of the healthy human brain, and is not biased by the properties of a single subject, requires spatial normalization and averaging of the DT information from multiple subjects. The purpose of this study was to evaluate how the number of subjects used for the development of a DT template affects the variability of tensor characteristics in the final template.

MATERIALS & METHODS
Turboprop-DT data were acquired on 60 healthy subjects using a 3T MR scanner (1). The DT data from all subjects were spatially normalized using high-dimensional elastic registration [DTI-GUI (2), SBIA, U Penn, PA]. N datasets from the group of 60 subjects were randomly selected (GroupN). The tensors from GroupN were averaged voxel-wise to construct a brain template (Tn). The principal eigenvector (e1Ni), FA (FANi) and trace (traceNi) values were estimated for all voxels in Tn. Additional templates based on N subjects were produced following a bootstrap approach. More specifically, N datasets from GroupN were randomly selected with replacement. A template Tn, and the corresponding e1Ni, FANi, traceNi were estimated. The same procedure was repeated 100 times. Maps of the standard devia-
tion of FA (FAstd) and trace (tracestd), and the 95% cone of uncertainty (COU) were produced from the 100 templates. The N then was modified (between 10-60) and the whole process was repeated. Finally, the percentage of white matter voxels with FAstd<0.05*FAN, trace std<0.05*traceN, and COU<5º were plotted as a function of N.

RESULTS
As N increased, the FAstd, tracestd, and COU declined throughout the brain. The FAstd values in white matter (WM) and gray matter (GM) were similar when N was low, while the FAstd in WM was lower than that in GM for large N. Tracestd was lower in WM compared to GM for low N, and became similar for WM and GM for large N. Cone of uncertainty was lowest in WM with high FAN, and increased for decreasing FAN. In general, for large N, the behavior of FAstd, tracestd, and COU in different types of brain tissue was similar to that in single-subject DT data. The percentage of WM voxels with FAstd<0.05*FAN, trace std<0.05*traceN, and COU<5º increased for increasing N. At least 60 subjects were required to build a template in which more than 95% of voxels with 0.4<FA N≤1 had an FAstd<0.05*FAN, more than 99% of voxels with 0.4<FA N≤1 had a trace std<0.05*traceN, and more than 82% of voxels with 0.4<FA N≤1 had a COU<5º.

CONCLUSION
The variability of tensor properties in DT templates decreased as the number of subjects used in the development of these templates increased. Furthermore, when considering voxels with a wide range of FA values (e.g., 0.4-1), more than 60 subjects were necessary in order to develop a template in which more than 95% of these voxels had FAstd<0.05*FAN, trace std<0.05*traceN, and COU<5º.

REFERENCES
4. Carew JD, et al. ISMRM 2007;1598

KEY WORDS: Brain template, diffusion tensor

Paper 165 Starting at 11:33 AM, Ending at 11:41 AM
Arrival Time Demonstrates Active Cerebral Autoregulation in Normal Subjects Using Lower Body Negative Pressure and Arterial Spin Labeling MR Imaging

Cain, J. R. · Parkes, L. M. · Jackson, A.
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PURPOSE
Cerebral autoregulation is a complex homeostatic mechanism which maintains constant cerebral blood flow (CBF) throughout a wide range of cardiac outputs. Disease processes such as diabetic autonomic neuropathy may affect the mechanism leading to postural hypotension (1). Investigation of cerebral autoregulation using MR imaging is challenging because orthostatic challenges which illicit an autoregulatory response such as tilt table tests are incompatible with MR imaging. Lower body negative pressure (LBNP) of -20 mm Hg has been shown to be an equivalent stimulus to 700 tilt table test (2). We have constructed a LBNP chamber which is MR imaging compatible and investigated the effects of LBNP on CBF using arterial spin labeling (ASL) and phase contrast angiography (PCA).

MATERIALS & METHODS
Four healthy male volunteers, aged 24-31 years, underwent imaging with a 3 T Achieva MR scanner (Philips, The Netherlands) with their legs and lower torso within a LBNP chamber. Imaging consisted of an ASL sequence followed by a quantitative PCA acquisition both in control state and during -20 mm Hg LBNP. Arterial spin labeling imaging consisted of STAR labeling and EPI collection (20 slices; TR: 3000 ms; TE: 21 ms; FOV: 224 x 224 mm; Voxel size: 3.5 mm x 3.5 mm; Slice thickness: 5 mm with 1 mm gap; Label thickness: 150 mm; 10 mm label gap; 20 dynamic scans) collected at 4 inversion times: 800 ms, 1200 ms, 1600 ms and 2000 ms. Phase contrast angiography acquisition was collected using sagittal 2D cine phase-contrast images. Cardiac gating was used to cover the entire cardiac cycle. Sixteen phase images were calculated over the cardiac cycle from 256 acquisitions. For each subject a 2D PCA slice was collected at a level of skull base containing both internal carotid arteries and basilar artery. Phase contrast angiography results were analyzed using Q flow software (Philips, the Netherlands). Cerebral blood flow was calculated from the sum of the average flow over the cardiac cycle in each vessel. Arterial spin labeling images were analyzed using house code written in MATLAB (Mathworks, USA) assuming a single blood compartment model (3). Control and labeled images were subtracted and a two-parameter fit for arrival time (time from label region to imaging region) and CBF was performed on a voxel-by-voxel basis. Cerebral blood flow was calculated for gray matter, which was segmented based on T1 values.

RESULTS
There was no difference between ASL gray matter perfusion values (mean 46.7 ml/100 ml/min and 43.7 ml/100 ml/min respectively) or PCA cerebral blood flow values between control and -20 mm Hg. The arrival time of the labeled bolus was delayed in all 4 subjects, during -20 mm Hg LBNP compared to control (mean 879 ms and 769 ms respectively, p = 0.04 two-tailed paired t-test).

CONCLUSION
In young healthy males cerebral autoregulation is able to compensate for -20 mm Hg LBNP and maintain constant cerebral perfusion. The observed delay in bolus arrival suggests that the LBNP stimulus causes dilation of pial vessels. Arrival time may prove to be an important biomarker in detecting cerebral autoregulation. This experiment demonstrates that normal cerebral autoregulation is observable using MR imaging, giving promise for future studies of subjects with abnormal cerebral autoregulation.

REFERENCES

KEY WORDS: Arterial spin labeling, cerebral autoregulation, lower body negative pressure
**Paper 166 Starting at 11:41 AM, Ending at 11:49 AM**

**One-Year Longitudinal Evaluation of Gray and White Matter Disease in a Cohort of Clinically Isolated Syndrome Suggestive of Multiple Sclerosis**

Raz, E.¹ · Cercignani, M.² · Totaro, P.¹ · Sbardella, E.¹ · Pozzilli, C.¹ · Bozzali, M.² · Pantano, P.¹

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**PURPOSE**

In patients with multiple sclerosis (MS), diffuse MR imaging abnormalities have been described in both white matter (WM) and gray matter (GM). Notwithstanding, the relationship between WM and GM damage evolution is not fully understood. In a transversal study on clinically isolated syndrome (CIS) patients, voxel-based morphometry (VBM) analysis did not show volume loss in gray matter structures whereas tract-based spatial statistics (TBSS) analysis revealed widespread FA decrease in most WM tracts. In this study we aimed at evaluating longitudinally the WM and GM damage in the same cohort, after 1-year follow up and VBM and TBSS have been used in combination.

**MATERIALS & METHODS**

Thirty-four consecutive CIS patients [F/M = 21/13; mean age = 31.7 years (SD = 7.7)] were evaluated longitudinally. At baseline and 12 months later, all patients underwent a neurologic examination and an MR scan at 1.5 T, including: axial dual-echo turbo spin echo (TSE), axial 3D T1-MPRAGE, axial diffusion tensor imaging (DTI) with gradients applied along six noncollinear directions. T2-lesion volumes (LV) were assessed using a semiautomatic technique. Voxel-based morphometry and TBSS were used for longitudinal analyses of GM and WM, respectively.

**RESULTS**

At 1-year follow up, 33/34 patients with CIS converted to MS. At 1-year follow-up, global brain volumetric assessment showed a significant (p follow up) showed GM volume reduction in MS patients (p < 0.05, corrected for family wise error), located bilaterally in ten clusters: the thalamus, cuneus, paracentral lobule and insula. Longitudinal TBSS of MS patients did not reveal areas of decreased FA over time (p > 0.05).

**CONCLUSION**

While WM damage is detectable early and widely involves most WM tracts, it shows little changes over 1-year of follow up. Conversely, GM damage is not detectable early, but a significant decrease in cortical and deep GM volume is observed at 1-year follow-up evaluation.

**KEY WORDS:** Multiple sclerosis, TBSS, VBM

**Paper 167 Starting at 11:49 AM, Ending at 11:57 AM**

**Spectroscopic Imaging of the Human Brain at 7 T**

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¹The Ohio State University, Columbus, OH, ²Toshiba America Medical Systems, Inc., Tustin, CA, ³Brigham and Women’s Hospital, Boston, MA

**PURPOSE**

The purpose of this in vivo feasibility study was to evaluate the potential of spectroscopic imaging (SI) at 7 T.

**MATERIALS & METHODS**

Spectroscopic imaging of the human brain was performed in five volunteers on a 7 T whole body MR scanner (Achieva, Philips, Cleveland, OH, USA) using a transmit-receive head coil. After a second order shim SI with transverse spin-echo slice localization was performed with the following parameters: TR = 1500 ms, field of view = 250 mm; 28 x 28 matrix; slice thickness = 20 mm; 1 average; 8 REST slabs and two different echo times: a long echo time of TE = 144 ms and a short echo time of TE = 26 ms. STEAM CSI was performed with: TR = 1500 ms; TE = 18 ms; TM = 22 ms; 16 x 18 matrix, 1 average and 10 x 10 x 15 mm voxels. CSI data were postprocessed, spectra were curve fitted and integral peak areas were calculated.

**RESULTS**

Spin-echo slice excitation and STEAM for SI imaging at 7 T allows acquisition of highly resolved brain MR spectra. STEAM SI excitation pulses with larger bandwidth reduce chemical shift displacement. PRESS localization is not applicable for SI at ultra-high fields due to a large chemical shift displacement. In all volunteers the resonances of Choline, Creatine, N-Acetylaspartate and Myo-Inositol could be identified readily in different SI voxels. CSI with short-echo time resolved additional resonances in the spectra like Glutamate and Glutamine.

**CONCLUSION**

Spectroscopic imaging at ultra-high magnetic fields increases the sensitivity and spectral resolution in MRS. Higher-order shimming is necessary for in vivo MRS at ultra-high fields.
field strengths as well as distortion correction of the data to improve the noninvasive characterization and quantification of molecular markers with clinical utility of improved detection. The tremendous gain in signal to noise ratio at 7 T compared to the lower field strengths of today’s clinical MR scanners facilitates more robust and advanced clinical applications of ultra-high field MR spectroscopy. Ultra-high field spectroscopic imaging of the brain is feasible and improves substantially the assessment of molecular markers to detect and monitor a variety of neurologic diseases.

**KEY WORDS:** Spectroscopic imaging, brain, 7 T

**Paper 168 Starting at 11:57 AM, Ending at 12:05 PM**

A fMRI Study Showing Neuroanatomical Correlates of Medical Image Interpretation and Effects of Art Instruction in Radiology Education

Dickerson, E.1 · Babaian, C.2 · Curby, K.1 · Hershey, B.1 · Faro, S.1 · Mohamed, F.1

1Temple University School of Medicine, Philadelphia, PA, 2Bucks County Community College, Newtown, PA

**PURPOSE**

Art instruction often is viewed as an important adjunct to conventional medical education; over half of U.S. medical schools offer electives in fine art. The purpose of this study was to demonstrate how cortical functional activation during the interpretation of medical imaging relates to artistic ability. This study also tracked changes in functional activation following an art course consisting of instruction on illustration and fine art appreciation.

**MATERIALS & METHODS**

Functional MR imaging of nine healthy medical student subjects conducting a medical imaging interpretation task was obtained both before and after a 5-week course of instruction in illustration, fine art appreciation. Students also covered topics in negative space, gray scale, and shape and pattern recognition within radiographs. Functional imaging data came from a medical imaging interpretation task in which subjects were presented with a series of head CT images selected by a board-certified neuroradiologist for 5 seconds in pseudorandom order and asked if each scan represented normal anatomy or pathology. The task was presented in a block design composed of five 30-second task blocks alternating with five 30-second control blocks for a total functional scanning time of 5 minutes. Functional MR imaging parameters: BOLD T2* EPI; FOV: 220 mm, ST: 5 mm, TR: 2000 ms, 64 x 64 voxels, ET: 30 ms. SPM8 software was used to locate the brain region(s) where functional activation correlates with artistic illustration skill. Functional activation within this brain region was compared both before and after a 5-week course of instruction.

**RESULTS**

The analysis revealed a 19-voxel region in the superior portion of the postcentral sensory cortex in the right parietal lobe (Brodmann Area 3) where functional activation during the medical imaging interpretation task correlated with artistic proficiency in creating an illustration demonstrating, “Accurate rotation of object in space” as judged by three blinded raters (Pearson’s r²: 0.837) (See figure). This relationship was substantiated by examining the correlation of functional activation and the independently rated artistic quality: “Object has illusion of volume” (Pearson’s r²: 0.842). This region of interest demonstrated greater activation following the art instruction course (p-value: 0.021) whereas functional activation within the visual cortex (regions V1, V2, and V3) was unchanged between scanning sessions (p-value: 0.125).

**CONCLUSION**

These results suggest neuroanatomical substrates and cognitive resources are shared between medical image interpretation and artistic illustration. A relatively brief (15 hours over 5 weeks) course of fine art and illustration instruction may yield improved competence in both realms.

**KEY WORDS:** Art education, medical education, fMRI

**Paper 169 Starting at 12:05 PM, Ending at 12:13 PM**

Measuring Perfusion and Permeability in High Grade Gliomas: Dynamic Contrast Enhanced MRI in 3D at 3T

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**PURPOSE**

The objective of our study was to investigate the feasibility of simultaneously measuring perfusion and permeability in high grade gliomas using Dynamic Contrast Enhanced MRI in 3D.

**MATERIALS & METHODS**

Ten previously untreated patients suffering from histologically proven high grade glioma were examined in our study. MRI was performed using a 3 T scanner acquiring perfusion images with rapid Dynamic Contrast Enhanced Perfusion MRI. The regions of interest were positioned in perfusion maps into tumor center, tumor periphery, peritumoral region depicted by abnormal T2-weighted images and in contralateral normal appearing white and grey matter. Lesion and white and grey matter curves were analyzed with a 2-compartment uptake (2CU) model and a 2-compartment...
exchange (2CX) model, yielding cerebral blood flow (CBF), cerebral blood volume (CBV), permeability surface product (PS) and, in case of the 2CX model, extracellular, extravascular volume VEE. The best model was chosen according to the Akaike information criterion.

RESULTS
All contrast-enhancing (CE) lesions visible on post-contrast T1w images could be identified on PS maps. All CE lesions were found and analyzed with the 2CU- and 2CX-models. The 2CX model was, according to the Akaike information criterion, the best model for all lesions. CBV and PS were significantly higher (p < 0.01 and p < 0.001) in lesions than in normal appearing white and grey matter. CBV and PS were significantly higher (p < 0.01 and p < 0.001) in lesions than in normal appearing white and grey matter.

CONCLUSION
In contrast to dynamic susceptibility studies, T1w perfusion imaging in combination with advanced modeling provides quantitative parameters with an unambiguous interpretation. Simultaneous quantitative assessment of perfusion and permeability is feasible with a rapid 3D-sequence. The large spatial coverage allows for characterization of lesions scattered throughout the whole brain, the spatial resolution allows for detection even of small lesions. CBF and CBV values are in good agreement with literature values. Contrast enhancing lesions show significantly increased CBV and PS values and a heterogeneous distribution. Assessment of permeability and perfusion might allow for lesion characterization and therapy monitoring. DCE-perfusion MRI of high-grade gliomas can identify tumor occurrence and may identify disease relapse and may be helpful in evaluating antiangiogenic therapies.

KEY WORDS: MRI, perfusion, glioma

REFERENCES

PAPER 170 STARTING AT 12:13 PM, ENDING AT 12:21 PM
Early Magnetic Resonance Spectroscopy Renormalized of Prefrontal Cortex and Anterior Cingulated Cortex Metabolites in Hepatic Encephalopathy after Liver Transplantation

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PURPOSE
Neurologic complications are common in patients with decompensated chronic liver disease before solid organ transplantation. Specific pattern at localized proton MR spectroscopy of the brain exists when short echo times are used in patients with hepatic encephalopathy. The results of spectroscopy reveal decreased amplitudes of myo-inositol (mI) and choline (Cho) combined with increased levels of glutamine and glutamate (Glx). Preliminary data indicate that liver transplantation may completely reverse the spectral abnormalities in hepatic encephalopathy. We focus our investigation in the prefrontal cortex (PFC) and anterior cingulated cortex (ACC) in spectroscopic findings after liver transplantation. And we also evaluated the characteristic changes of brain metabolites at early stage.

MATERIALS & METHODS
In this study, 12 patients (9 male, 3 female, mean age: 46±5.2 years) with hepatic cirrhosis proved by pathology underwent complete MR imaging and 1H spectroscopic examination before liver transplantation and at 2-3 week follow up after liver transplantation. Spectrum was performed by using 3.0-T whole body tomography (Achieva, Philips, Holland) and a commercially available circularly polarized head coil. For the followup examinations, exact reproducibility of the spectral localization was achieved by acquiring three orthogonal (sagittal, transverse and coronal) gapless, we used short TE (TE=9ms) STEAM protocol and placed the volume of interest in the PFC and ACC. This area contains gray and white matter and allows measurement of 2x4x3.5 cm³ and 6x3x2 cm³ volume of interest respectively.

RESULTS
Two-3 weeks after liver transplantation, 'H spectroscopic changes elevated Cho/Cr ratio (t=-3.113, p=0.006<0.05) and decreased Glx2.11/Cr ratio (t=2.439, p=0.025<0.05) were found in all patients in ACC region. Simultaneously, MR spectroscopic measurements reveal a characteristic decreased in Glx2.11/Cr ratio (t=3.397, p=0.004<0.05) in PFC region. Other metabolite ratios (mI, NAA and Glx3.75) reveal no statistical difference after liver transplantation. Figure 1 graph illustrates the comparison of metabolite ratios before and after liver transplantation. The patients have a significantly elevated Cho/Cr and decreased Glx2.11/Cr ratio (a,b) in the ACC region. Also, they have a characteristic decreased Glx2.11/Cr ratio (c,d) in PFC region, (b,d after liver transplantation).

CONCLUSION
After successful liver transplantation, renormalization of hepatic encephalopathy specific brain metabolite changes is detected at 1H spectroscopy and precedes the imaging abnormalities. Cho and Glx2.1 may be an early and sensitive index strongly indicating the recovery of amino acid metabolism.

KEY WORDS: Magnetic resonance spectroscopy renormalized, liver transplantation, prefrontal cortex and anterior cingulated cortex
**Pulsed Arterial Spin Labeling Evaluation of Cerebral Blood Flow in Multiple Sclerosis**

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**PURPOSE**
Perfusion abnormalities in the cortex and basal ganglia have been described in multiple sclerosis (MS) possibly related to decreased metabolic activity. We sought to determine if pulsed arterial spin labeling (PASL) perfusion can detect these abnormalities.

**MATERIALS & METHODS**
The study was performed under IRB approval. A retrospective analysis was performed on known MS patients imaged on a 3.0 T Trio (Siemens, Erlangen, Germany) scanner. Thirteen normal volunteers also were recruited as a part of this study. Other clinical information, including MS subtype, treatment regimen, and disease status were recorded also. A standard PASL based on PICORE-Q2Tips with TR = 2500, TE = 16, 8 mm, 2 mm skip, 64 x 64, TI1 = 700, TI = 1800, and 91 measures with flow limit of 100 cm/sec was included as a part of the standard clinical protocol. Perfusion-weighted images were transferred offline for analysis using custom software (nDive - n-Dimensional Volume Explorer). A neuroradiologist drew regions-of-interest (ROIs) in cortical gray matter, basal ganglia and thalami bilaterally. Cortical gray matter ROIs were drawn on a single slice to include regions in the frontoparietal lobes. Basal ganglia and thalami on associated anatomical (T2-weighted images) were identified and appropriate voxels were marked for each patient, bilaterally. The average value for each region was recorded for each patient.

**RESULTS**
A total of 35 MS patients were identified. Average patient age was 40.2 +/- 11.6 years; average volunteer age was 35.2 +/- 10.9 years. There were 24 female and 11 male patients and, 8 females and 5 male normal volunteers. Fifteen patients had active disease based on clinic notes. The resulting perfusion values are reported in Table 1. A Tukey’s multiple comparison procedure was used to test for statistical significance.

<table>
<thead>
<tr>
<th></th>
<th>Cortical GM</th>
<th>Basal Ganglia</th>
<th>Thalami</th>
</tr>
</thead>
<tbody>
<tr>
<td>MS patients</td>
<td>371.3 +/- 76.7</td>
<td>207.0 +/- 42.8</td>
<td>266.0 +/- 66.2</td>
</tr>
<tr>
<td>Normal</td>
<td>383.3 +/- 101.5</td>
<td>221.7 +/- 54.3</td>
<td>279.6 +/- 67.4</td>
</tr>
<tr>
<td>P value</td>
<td>0.6617</td>
<td>0.3311</td>
<td>0.5312</td>
</tr>
</tbody>
</table>

There was no statistical difference between the average ages of the two groups (p > 0.1843). The MS patients’ perfusion values trended lower than those of the controls for all ROIs. Statistical significance was not identified between the two populations for any of the three ROIs.

**CONCLUSION**
We identified a trend of reduction in CBF in cortical gray matter, basal ganglia and thalami in the patients vs controls. These results are consistent with other studies of perfusion in MS. Lack of statistical significance with this sample size and technique suggests that further study is warranted.

**KEY WORDS:** Arterial spin labeling, multiple sclerosis, brain perfusion
Luna Aneurysm Embolization Device

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PURPOSE
To evaluate in the rabbit elastase-induced aneurysm model a self-expanding, intrasaccular flow diverter.

MATERIALS & METHODS
Elastase-induced aneurysms were created in 12 New Zealand White rabbits. At least 3 weeks following aneurysm creation the aneurysms were treated using the Luna Aneurysm Embolization Device (NFocus Neuromedical, Inc, Palo Alto, CA). The Luna is a self-expanding, ovoid metallic device. Single Luna devices were placed within the aneurysm cavity through a 5Fr Envoy catheter (Cordis Neurovascular, Miami Lakes, FL). Digital subtraction angiography (DSA) was performed preimplantation, 5, 10, and 30 minutes postimplantation, and at 1 month. Early postimplantation intraaneurysmal flow was graded as unchanged, moderately diminished, or completely absent. Parent artery compromise was assessed at all time points. One-month DSA was graded using a 3-point scale (complete, near-complete, or incomplete occlusion). Four aneurysms were harvested for gross and microscopic histologic evaluation. Tissue within the aneurysm dome and across the aneurysm neck were assessed qualitatively using hematoxylin and eosin staining.

RESULTS
Luna devices were placed successfully in all cases. No case of substantial parent artery compromise was noted at any time point. Ten (83%) of 12 aneurysms demonstrated complete cessation of flow by 30 minutes after device implantation; 2 had small neck remnants. At follow up 10 (83%) of 12 aneurysms were occluded completely; the 2 aneurysms with small remnants early after implantation were nearly completely occluded at follow up. Gross examination demonstrated membranous tissue completely covering the device in 3 subjects; a single subject showed that the aneurysm cavity was open to the parent artery through the bare holes of the device. This latter subject demonstrated near-complete occlusion angiographically, while the other 3 subjects showed complete angiographic occlusion. Microscopic examination showed that two aneurysms had completely organized loose connective tissue filling the entire aneurysmal cavity. Organized loose connective and unorganized thrombus both were present and filled the aneurysm cavity in the remaining two aneurysms.

CONCLUSION
The Luna Aneurysm Embolization Device achieved, with a single device, complete, near-immediate aneurysm occlusion in the majority of cases. Most cases were occluded completely at follow up. Complete angiographic occlusion was associated with complete neointimal coverage across the aneurysm neck.

KEY WORDS: Aneurysm, embolization, device
58%, vs 52% in the group “coils alone” (p = 0.87, ns). No case of recanalization was observed in the patients treated by flow diverter stents (n = 2).

CONCLUSION
Complication rate observed in patients retreated for an intracranial recanalized aneurysm by stent +/- coils is not significantly higher than in the group treated by coils alone. Recanalization rates were not significantly different in the two groups. Nevertheless, no recanalization was observed in patients treated with flow diverter stents.

KEY WORDS: Stent, recanalization, retreatment

Paper 174 Starting at 11:01 AM, Ending at 11:09 AM
Silk Stent Placement for Cerebral Aneurysm Repair: A Case Series with Early Angiographic Follow Up

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PURPOSE
To describe our experience with Silk® (Balt Extrusion, Montmorency, France), a novel nitinol braided self-expandable vascular reconstruction device, in the treatment of intracranial aneurysms.

MATERIALS & METHODS
A total of 11 patients with cerebral aneurysms (7 saccular, 4 fusiform) were treated with Silk stent placement. All patients were pretreated with full dose aspirin and clopidogrel. In eight of the 11 patients, Silk stent use represented the primary treatment. In the remaining three patients, Silk was used for aneurysmal recurrence: after coils; after coils and Enterprise® stent; and after coils and Leo stent placement. Patients underwent imaging follow up at 2-6 months post-procedure. One patient was treated in the acute phase of aneurysmal subarachnoid hemorrhage.

RESULTS
Stent deployment was achieved in 10 of the 11 patients. One stent did not open (7.5 cm) and the procedure was abandoned. During the procedure several technical issues were encountered, including: difficulty negotiating curves/difficulty deploying stent on curves; poor apposition between stent and arterial wall; and initial difficulty with deployment within an existing Enterprise stent. The radiographic visibility of the first generation stent was poor but improved with subsequent modifications. The Vasco® delivery catheter occasionally proved difficult to navigate. Despite this, immediate angiography showed improved aneurysmal occlusion in nine of the ten patients. One patient with IV and VI cranial nerve palsy was intact at 2 months. One patient suffered fatal aneurysmal rupture 5 days poststent deployment and one patient had transient, asymptomatic carotid occlusion related to incomplete stent opening. Follow-up imaging at 2 to 6 months on ten patients where the stent was deployed successfully demonstrated improved appearances in 9/10 and unchanged appearance in one compared with the immediate posttreatment angiogram. Two patients achieved complete endovascular aneurysm occlusion and one patient progressed to asymptomatic parent artery occlusion.

CONCLUSION
The use of Silk stents in the treatment of complex and large cerebral aneurysms represents a fundamental advance in endovascular technology. Early angiographic results are encouraging and longer term follow up is required. However, the device can be difficult to deploy and the cause of the fatal rupture needs to be ascertained before these devices can be recommended for routine use as primary treatment for large saccular intradural aneurysms.

KEY WORDS: Cerebral, aneurysm, stent

Paper 175 Starting at 11:09 AM, Ending at 11:17 AM
Woven EndoBridge as an Intraaneurysmal Flow Diversion Device

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PURPOSE
The Woven EndoBridge (WEB) device (Sequent Medical, Inc.) is an intrasaccular, ellipsoid, braided-wire embolization device designed to provide flow disruption along the aneurysm neck. The purpose of this study was to evaluate in an in vivo aneurysm model the acute and chronic performance of the WEB device regarding immediacy, degree, and durability of aneurysm occlusion.

MATERIALS & METHODS
The WEB device was implanted in 24 elastase-induced aneurysms in the New Zealand white rabbit model and followed for 1 (n=6), 3 (n=6), 6 (n=6), and 12 months (n=6). Devices were placed through 0.027” microcatheters (Rebar 027, eV3, and High-Flo Renegade, Boston Scientific). Degree of intraaneurysmal flow disruption was graded on a 4-point scale based on digital subtraction angiography...
(DSA) within 10 minutes following device implantation. Chronic aneurysm occlusion was rated using a 3-point scale. All aneurysms were harvested for histologic analysis.

RESULT
Grade 1 (complete, immediate cessation of intraaneurysmal flow) was noted in 9 (45%) of 20 available cases. Grade 2 (near complete cessation of flow) was noted in 4 (20%) of cases, while Grades 3 (persistent flow with moderate to marked stasis) and 4 (persistent flow with no or minimal stasis) was noted in 4 (20%) and 3 (15%) cases, respectively. At follow up complete occlusion was noted in 10 (42%) of 24 cases. Near-complete aneurysm occlusion was noted in 9 (38%) of cases, while incomplete occlusion was noted in 5 (20%) cases. Stable or progressive aneurysm occlusion as compared to early post-implantation DSA was present in 20 (83%) of 24 cases; and increased aneurysm filling with contrast was seen in 4 (16%) cases. Histologic evaluation showed contiguous neo-intima in cases with complete angiographic occlusion at follow up, with absence of unorganized thrombus in the dome. Cases with incomplete occlusion angiographically at follow up typically did not have a contiguous neo-intima and also had areas of unorganized thrombus within the dome.

CONCLUSION
The WEB device is trackable through microcatheters and readily placed in experimental aneurysms in rabbits. Complete or near complete disruption of flow was seen early after implantation in the majority of cases. High rates of complete or near complete occlusion were seen in chronic implants. In cases of good long term angiographic occlusion, histologic healing was typified by neo-intimal formation and robust intraaneurysmal thrombus organization.

KEY WORDS: Aneurysm, embolization, device

Paper 176 Starting at 11:17 AM, Ending at 11:25 AM

NFocus Luna, a Neurovascular-Directed Device for Large Artery Vessel Occlusion: A Comparative Study in a Canine Model

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PURPOSE
Parent vessel occlusion of the carotid or vertebral arteries occasionally is required as a deconstructive technique for the treatment of vascular lesions. To date there are no devices directed for neurologic use. The purpose of this study was to evaluate the Nfocus Luna PVO Device and Amplatzer Occlusion Device for large vessel occlusion in a canine animal model.

MATERIALS & METHODS
The subclavian arteries were targeted for occlusion in seven canines. One Amplatzer and one Luna device were rotated sequentially and placed into the subclavian arteries for vessel occlusion. Serial angiographic assessment was performed after device placement until vessel occlusion was seen and then at 1 or 2 months when the study was terminated. Three (3) subjects were euthanized at one month and four (4) subjects were euthanized at 2 months postimplantation. At study conclusion the native artery segments containing the implanted device were harvested and histologic analysis subsequently was performed.

RESULTS
The Luna and Amplatzer devices were positioned accurately and deployed in all cases. The Luna device occluded on average in 18.9 ± 9.4 minutes while the Amplatzer device occluded in 14.7 ± 5.7 minutes. The Luna devices had better occlusion scores than the Amplatzer device at all follow-up periods. In no instance was there any evidence of device migration. At 28 days the Luna implants showed near complete occlusion with small recanalization channels while the Amplatzer devices were associated with low occlusion levels and large residual vascular channels within the occluder. The 55 (± 1) day samples showed a similar trend characterized by full to nearly full occlusion of the Luna-implanted vessels and incompletely occluded to widely recanalized vessels implanted with the Amplatzer. Both devices showed good local toleration characterized by low inflammatory scores and modest adventitial fibrous response.

CONCLUSION
Based on this animal study, the Luna device and delivery system can be placed accurately to occlude vessels without migration and with a performance that is similar to the Amplatzer Vascular Plug in the canine model. The Luna device on average provided a higher degree of occlusion durability (lower incidence of recanalization channels) at both 1- and 2-month time periods.

KEY WORDS: Vessel occlusion, aneurysm, animal model

Paper 177 Starting at 11:25 AM, Ending at 11:33 AM

Percutaneous Biopsies through the Ovale Foramen

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PURPOSE
Various tumors can affect the parasellar area. Their histologic diagnosis and treatment is quite complex, requiring major surgical interventions in many instances to expose the tumor, to obtain a biopsy and subsequently to dissect the lesion, in an attempt to obtain its complete eradication. Some cases require additional treatment (or can only be treated) with radiation therapy and/or chemotherapy. Knowing the histologic diagnosis before the therapeutic surgical intervention allows for better therapeutic planning. We are presenting a series of cases, which demonstrate that with the appropriate technique it is possible to perform percutaneous biopsies through the ovale foramen, in order to obtain a histologic diagnosis.

MATERIALS & METHODS
Between the years 2005 and 2009, eight percutaneous images-guided biopsies were performed at our center, in different regions of the parasellar area including both the medial and lateral portions of Meckel’s cave. To reach the lesions we used a route that is similar to the glization of the trigeminal nerve. In order to do this, the patient needs to be in a supine position with head inclined backward and if the lesion is on the left side then the head is tilted to the right.
This procedure is performed under fluoroscopy and with multidetector tomography to introduce the needle perpendicularly two centimeters lateral, to the labial comisure through the ovale foramen. Six (6) procedures were performed under angiographic suite using the tandem technique. Two (2) biopsies were obtained under CT guidance. One case required both CT and fluoroscopic guidance. A 22G needle was inserted first to identify the safest pathway and choose the biopsy site. Subsequently, a 20G or 18G biopsy needle with automatic firing was placed to obtain the core biopsy.

RESULTS
Tissue samples were obtained in eight lesions and a diagnosis was possible in all cases. The histologic diagnosis included: chordoma, chondrosarcoma, rhabdomyosarcoma, carcinoma, metastasis, lymphoma, meningioma and schwannoma.

CONCLUSION
Percutaneous biopsy through the ovale foramen is possible. It is a safe procedure, and allows histologic diagnosis to plan for appropriate surgical, radiation or chemotherapy treatment and it is a new development in neuroradiology.

KEY WORDS: Percutaneous, biopsies, ovale foramen

Paper 178 Starting at 11:33 AM, Ending at 11:41 AM
4D Digital Subtraction Angiography and 4D (Omni-Plane) Fluoroscopy: Early Experiences

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PURPOSE
To evaluate the application of novel reconstruction algorithms which embed temporal resolution into standard rotational 3D digital subtraction angiography (3D DSA) volumes and, to then assess the utility of these reconstructions for visualization of complex flow patterns as well as for creation of roadmaps that allow visualization of device manipulation from any chosen angle without a need for movement of the C-arm gantry.

MATERIALS & METHODS
Rotational 3D DSA data are acquired using either intraarterial or intravenous injections of contrast medium using typical C-arm rotation times of 5-20 seconds. Temporal information is embedded in the reconstructed 3D vascular volume using multiplicative projection processing (MPP) of time-resolved data obtained either from a separate conventional 2D DSA acquisition or by employing the time-resolved data present in the intrinsic projections that form the 3D volume. Whereas conventional reconstruction from projections typically requires a number of projections dictated by the Nyquist theorem, due to the sparsity of angiographic datasets, in our method, only one or two projections are sufficient to embed temporal information into a 3D volume. 4D fluoroscopy also is implemented using MPP such that a selected 4D DSA time frame is combined with information from biplane real-time fluoroscopy to create arbitrary fluoroscopic views over selectable subvolumes without need for C-arm gantry movement.

CONCLUSION
The application of multiplicative projection processing using a constrained reconstruction of a 3D DSA rotational data set embedded with temporal information from either a separate 2D DSA acquisition or the intrinsic projections used to create the volume provides a means to derive 4D DSA and 4D fluoroscopy. It seems likely that these developments will enhance the ability of interventionalists to diagnose and treat complex vascular abnormalities.

KEY WORDS: 4D DSA, DSA

Paper 179 Starting at 11:41 AM, Ending at 11:49 AM
Intraarterial Contrast Injections for C-Arm CT Measurements of Cerebral Blood Volume in Acute Brain Stroke: Preliminary Canine Study

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PURPOSE
Our purpose was to evaluate the feasibility of using intraarterial contrast injections to measure global and regional cerebral blood volume (CBV) using C-arm CT.

MATERIALS & METHODS
Eight dogs were studied. Cerebral blood volume measurements were performed in two normal dogs using C-arm CT after injection into one common carotid artery (CCA) and one vertebral artery (VA). Perfusion CT (PCT) also was per-
formed using standard techniques. In six dogs, an embolic stroke was created in one middle cerebral artery (MCA) territory. Three to 4 hours after creation of the stroke, animals underwent PCT using a 64-slice volume GE scanner (GE Medical Systems, Waukesha, WI) with intravenous (iv) injection of contrast. Animals then were immediately brought back to the angiography suite where C-arm CT measurement of CBV was performed using prototype software (Siemens HealthCare AX, Forchheim, Germany). Measurements were made using a 10-second acquisitions after an iv injection of contrast as well as after injection into one CCA and one VA. Four of these animals also had CBV measured in conjunction with an aortic arch injection (AA). All injections were made using a protocol that ensured a steady state of contrast during the CBV measurement. After postprocessing two slices, centered on the frontal horns of the lateral ventricles, were selected from each modality for each of the two normal dogs; as closely as possible slices were matched anatomically from animal to animal using image registration. (Siemens HealthCare AX, Forchheim, Germany). For the six stroke animals, the same technique was employed except that the slices selected for analysis were centered as closely as possible on the area of ischemia. Qualitative review of the PCT images was used as a determiner as to whether or not an infarct had been created. The C-arm CBV maps from each of the injection protocols were compared to those from PCT.

RESULTS
Cerebral blood volume maps from C-arm CT matched well with those from PCT when iv injections were used. C-arm CT maps after AA injections also matched well to those from iv injection in all animals. C-arm CT maps made in conjunction with VA injections did not match consistently well with those done with either iv or AA injections. This reflected an inability to obtain homogenous contrast filling of the MCA territory using a VA injection. In no case did a CCA injection provide filling of the contralateral hemisphere or a hemisphere with an infarct, that was adequate to obtain a CBV map. C-arm CT CBV maps of the ipsilateral hemisphere made in conjunction with a CCA injection in the two normal animals matched well with those made with iv injections. Because of the small sample size accurate measurement of CBV values in regions of interest was not possible.

CONCLUSION
Global and regional measurement of CBV using C-arm CT and intraarterial injections of contrast is feasible. When there is an arterial occlusion, however, valid measurement requires that all arterial inputs to a region in question be fully and equally opacified. Further work is required to determine the usefulness of this technique in humans with ischemic stroke.

KEY WORDS: C-arm CT CBV, intraarterial injection, ischemic stroke

Paper 180 Starting at 11:49 AM, Ending at 11:57 AM
Transcranial Access Using Fluoroscopic Cone-Beam CT Navigation

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PURPOSE
Cone-beam CT (CBCT), 3D image overlay, and navigation software on contemporary fluoroscopic units generate less radiation dose while performing imaging of comparable quality to conventional CT. They provide superimposition of MR and CT datasets and can accurately guide percutaneous procedures providing live instrument visualization and the capability to re-image without patient transfer. These techniques, however, have been minimally used for accessing the head and neck and not used for percutaneous transcranial access.

MATERIALS & METHODS
Using an Allura Xper FD20 unit (Philips Healthcare) accuracy measures were performed on a custom head model in combination with the Hennig instrument guide frameless stereotactic system (Elekta Inc., Stockholm, Sweden). Conebeam CT navigation was used in placement of a ventricular drain in a 62-year-old female for subarachnoid-related hydrocephalus using otherwise standard bedside technique. 3D image overlay and CBCT navigation were used for percutaneous n-butyl cyanoacrylate (nBCA) embolization of an intraorbital mass in a 69-year-old male.

RESULTS
Head model measures demonstrated 3.5 mm error in targeting using CBCT navigation. Ventriculostomy catheter placement was technically successful without complication with catheter at the foramen of Monro. Percutaneous nBCA was technically successful without complication with no significant bleeding encountered during operative resection.
CONCLUSION
Cone-beam CT navigation and 3D image overlay provide accurate instrument guidance and spatial resolution comparable to current neuronavigation systems while also providing real time instrument position and the ability to re-image without moving the patient. These are features not available with other types of neuronavigation.

KEY WORDS: Interventional, brain, percutaneous

Paper 181 Starting at 11:57 AM, Ending at 12:05 PM
Long-Term Angiographic and Clinical Outcome following Stenting under Flow Reversal by Proximal Flow Control Technique for Chronic Total Occlusions of the Cervical Vertebral and Carotid Arteries

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PURPOSE
Because there may be a large amount of thrombi in chronic total occlusions (CTOs) of the cervical arteries, an expected risk associated with endovascular recanalization is high. The aim of the retrospective study was to investigate the feasibility, safety and effectiveness of stenting under flow reversal by proximal flow control for CTOs of the cervical vertebral and carotid arteries.

MATERIALS & METHODS
Included for analysis were patients (1) who were admitted to our institution from March 2005 to January 2007, (2) with recurrent TIAs, (3) modified Rankin scale of ≤ 2, (4) with angiographic total occlusion of the cervical vertebral or carotid arteries, (5) duration of occlusion > 3 months, (6) with estimated occlusion length of 150 mm or shorter in the affected arteries and (7) who underwent stenting for CTOs of the cervical vertebral and carotid arteries.

RESULTS
During the study period, six patients underwent stenting for cervical CTOs; carotid arteries in four cases and vertebral arteries in two cases. In all six cases, CTOs were penetrated successfully with hard-type guidewires and dilated sufficiently with stents. Although the median estimated occlusion length was 115 mm (range from 50 to 130 mm), the median real occlusion length was approximately 29 mm (range from 10 to 38 mm). No complications occurred during the periprocedural period, no TIAs have recurred for 3 years after stenting, and no restenosis occurred for 3 years angiographic investigation.

CONCLUSION
Long-term angiographic and clinical outcomes were favorable. Stenting under flow reversal by proximal flow control for CTOs of the cervical vertebral and carotid arteries may be feasible, safe and effective in improving hemodynamic symptoms.

KEY WORDS: Chronic total occlusions, stenting, cervical vertebral and carotid arteries

Paper 182 Starting at 12:05 PM, Ending at 12:13 PM
Complete and Incomplete Multisegmental Spinal Arterial Trunks: Angiographic Anatomy and Clinical Implications

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PURPOSE
The normal components of a segmental artery are (i) a paravertebral stem (originating from the aorta), (ii) an anterolateral branch (intercostal or lumbar artery), and (iii) a dorsospinal branch. A multisegmental trunk is defined as one segmental artery supplying the expected corresponding vertebral (primary) level, as well as a second, immediately adjacent (secondary) level. This report describes the angiographic characteristics of complete and incomplete multisegmental trunks, and discusses their implication for the conduct of a spinal angiogram and the diagnosis of spinal vascular disorders.

MATERIALS & METHODS
Ten angiographic observations are reported, covering the following variants: (1) Complete multisegmental trunks (2 cases), with single or multiple vertebral body branches replacing the missing paravertebral stem at the secondary level (Figure). (2) Incomplete multisegmental trunks with isolated dorsospinal artery (3 cases). (3) Incomplete multisegmental trunks with isolated paravertebral stem (3 cases). (4) Incomplete multisegmental trunks with an isolated dorsospinal artery providing the artery of Adamkiewicz (1 case), or with an isolated paravertebral stem feeding a spinal vascular malformation (1 case).

RESULTS
A complete multisegmental trunk entirely supplies two adjacent vertebral levels; there is therefore no segmental branch stemming from the aorta at the secondary level. The absence of a hemivertebral blush at the secondary vertebral level is a reliable angiographic characteristic of an incomplete multisegmental trunk. In such case, the missing component can be found at its expected site of origin from the aorta, as an isolated paravertebral stem alone, or as an isolated paraverte-
bral stem continuing as a dorsospinal artery. In either case, the isolated branch can provide an anterior or posterior spinal contributor, which may be the sole supply to a vascular malformation, as shown in one of our examples.

**CONCLUSION**

Complete and incomplete multisegmental trunks can and must be recognized during spinal angiography. Overlooking an isolated paravertebral stem or a dorsospinal artery can potentially result in a falsely negative study.

**Key Words:** Spinal angiography, vascular anatomy, spinal vascular malformations

**PAPER 183 STARTING AT 12:13 PM, ENDING AT 12:21 PM**

Access to the Epidural Space Using the Sacral Hiatus in Cadavers

Riascos-Castaneda, R. F. · Firouzbakht, F. · Layer, L. · Amole, A. · Von Ritschl, R. · DiPatre, P. L.

The University of Texas Medical Branch

Galveston, TX

**Purpose**

This study aims to use this caudal access to prove the feasibility of catheter advancement to the cervical recess of the epidural space.

**Materials & Methods**

Two cadavers were used in our study of sacral hiatus epidural catheterizations. The cadaver was placed in the prone position and the sacral cornua were palpated and used as a landmark to find the hiatus. A 13-gauge needle then was inserted into the sacral hiatus with the guide of fluoroscopy. The stylet was removed and exchanged for a guidewire which was placed into the needle and advanced under fluoroscopy to level of L1. The needle then was replaced with a catheter that was advanced over the guidewire. The catheter was advanced to the superior recess of the spinal epidural space. Epidural confirmation was done with injection of contrast medium and autopsies performed by the pathology department.

**Results**

Epidural space catheterization was confirmed initially by injecting contrast and visualizing the epidural space at the level of the cervical recess. X-ray images confirmed that the catheter had been advanced to the epidural space at the level of the cervical recess. No dural puncture was evident during the procedure as confirmed by the lack of CSF flow in the catheter. The ability to manipulate the position of the catheter tip within the epidural space was maintained, which implies that torque on the catheter is sufficient to allow selective guidance of the catheter. The autopsy performed displayed an intact thecal sac with our catheter adjacent all the way from the hiatus to the furthest extent of the cervical recess.

**Conclusion**

We concluded that caudal needle techniques can be used for the advancement of endovascular catheters and guidewires through the sacral hiatus. We have proved this by displaying that catheterizing and navigation of the epidural spinal canal is feasible through a caudal approach. We have found that the use of hydrophilic guidewires, aid the nontraumatic passage of the catheter through the epidural space. A caudal access point aids percutaneous epidural navigation, by decreasing the angulation of the catheter, improving torque, and allowing changes of position of the tip of the catheter for selective placements. Clinical Relevance/Application: Multiple epidural therapeutic injections using only one access, obtain biopsies along the epidural spinal canal, using small endovascular scopes as a means of diagnosis and treatment of cord lesions.

**Key Words:** PIN, epidural, sacral hiatus

**PAPER 184 STARTING AT 12:21 PM, ENDING AT 12:29 PM**

Assessment of Catheter Skills Training on a Synthetic Vascular Model with Pulsatile Flow and Fluoroscopy

Small, E. A. · Thakur, Y. · Drangova, M. · Leung, A.

‘University Hospital, London Health Sciences Centre, London, ON, CANADA, ‘The University of Western Ontario, London, ON, CANADA, ‘Robarts Research Institute, The University of Western Ontario, London, ON, CANADA

**Purpose**

Competence to perform endovascular procedures has been determined largely by the number of procedures performed and time in training. Many academic neuroradiology programs have difficulty meeting the minimum number of diagnostic cerebral angiograms for their fellows. Even more concerning, the number of procedures performed does not necessarily equate to expertise. We sought to determine whether trainees could develop catheter skills by training on a synthetic vascular model with pulsatile flow and fluoroscopy.

**Materials & Methods**

Seven physicians participated in the study, including three novices with little or no endovascular experience, two fellows with intermediate experience, each of whom had performed approximately 100 procedures over 1 year, and two expert staff with over 15 years experience. Catheter skills were tested on a synthetic vascular model which consisted of a maze of multiple segments and branches with a range of lengths, diameters and angles. Each person completed eight different paths through the model. Performance was measured by monitoring path navigation times and tracking errors. The novices were given a 15-minute tutorial on safe wire and catheter handling techniques followed by 2 hours of training on the model. After a 1-week period, trainees were retested. Two of the three novices were given another tutorial and two more hours of training before a third test. The times of the novice angiographers were compared to their baseline times, as well as those of the intermediate and expert angiographers using the Kruskal Wallis test with Dunn’s posttest. Video recording enabled retroactive assessment of catheter handling errors.

**Results**

Training on the model resulted in a statistically significant drop in the time required to navigate the various paths for each of the novices. Mean completion time improved from 258 seconds at baseline to 144 seconds after one training session. This decreased to 90 seconds after a second training session. The intermediate and expert groups by comparison
had baseline mean completion times of 107 seconds and 58 seconds respectively. The number of catheter handling errors also decreased with training.

CONCLUSION

Training on a synthetic model can assist novice angiographers to rapidly and safely acquire basic wire and catheter skills. Simulation also provides an opportunity to objectively measure trainee performance through analysis of task completion-time and catheter handling errors.

KEY WORDS: Cerebral angiography, synthetic model, resident training

Tuesday Morning

10:45 AM – 12:30 PM
Room 311

(19c) Pediatric: Developmental/ Congenital Malformations and Demyelinating/Degenerative and Neonatal Imaging
(Scientific Papers 185 - 197)

See also Parallel Sessions
(19a) Adult Brain: Functional Imaging
(19b) Interventional: New Devices and Techniques
(19d) Head and Neck: Pharynx, Larynx, Soft Tissue Neck, Sinonasal and Temporal Bone

Moderators: Orit A. Glenn, MD
L. Santigo Medina, MD, MPH

Paper 185 Starting at 10:45 AM, Ending at 10:53 AM

Pathognomonic Single-Voxel Proton MR Spectroscopic Findings in 3-hydroxy-3-methylglutaryl Coenzyme A Lyase Deficiency?

Patay, Z. · Lambert, A. N. · Löbel, U. · Sabin, N. D. · Sablauer, A.
St. Jude Children’s Research Hospital
Memphis, TN

PURPOSE

3-hydroxy-3-methylglutaryl coenzyme A lyase (HMG-coA lyase) deficiency is a devastating inborn error of L-leucine catabolism. Conventional MR imaging (MRI) findings are either unremarkable or nonspecific. Since anecdotal reports suggested abnormal proton MR spectroscopic (MRS) profiles in patients with HMG-coA lyase deficiency, we sought to determine the diagnostic value of MRS using a larger patient cohort.

MATERIALS & METHODS

In this retrospective study, we reviewed conventional MRI and single-voxel MRS data of 10 patients (M/F: 5/5, age: 2 weeks - 8 years) with laboratory-confirmed HMG-coA lyase deficiency. All studies were performed on 1.5 T MR scanners, typically during episodes of metabolic decompensation. Conventional MR imaging included sagittal and axial T1-weighted, axial and coronal T2-weighted, and axial echo planar diffusion-weighted imaging sequences. Single-voxel MRS was performed in all patients using point resolved spectroscopy (PRESS) with TE = 135 ms, and occasionally with TE = 270 ms, as well.

RESULTS

In our patients, white matter involvement was common, occasionally associated with abnormalities of cerebral and cerebellar deep gray matter structures. Significant imaging phenotypic variations were identified, even between age and gender-matched patients; therefore no pathognomonic lesion pattern could be identified by conventional MRI in our patient cohort. On MRS, abnormal peaks were identified at 2.4 and 1.2 ppm in all patients, regardless of age and stage of disease (Figure).

CONCLUSION

In agreement with previous investigators, we found that conventional MR imaging findings in HMG-coA lyase deficiency are nonspecific and show significant phenotypic variations. Conversely, our data suggest that the biochemical phenotype of the disease is uniform. Since we are unaware of any other metabolic disease with the above-described spectral pattern, we believe that MRS findings may be pathognomonic for the disease. The MRS pattern we describe may greatly aid the clinical diagnosis of HGM-coA lyase deficiency and help differentiate it from other common inborn errors of metabolism with similar clinical presentation such as organic acidurias, especially during metabolic crisis situations. We speculate that the two consistently present abnormal peaks on MRS of the brain correspond to the HMG-coA and may represent proton-proton interaction between methyl and hydroxyl groups.

KEY WORDS: HMG coenzyme A lyase deficiency, proton MR spectroscopy, inborn errors of metabolism
Alexander Disease Evaluated Using Directional Diffusivity Diffusion Tensor Imaging

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PURPOSE
Patients with Alexander disease present with differing rates of neurologic decline which is suspected to be the result of differing degrees of axonal damage. However, the degree of neurologic disability often correlates poorly with the degree of abnormality on conventional MR imaging. Previously, both spectroscopy and DTI have been suggested to be useful in identifying patients with more severe disease. The purpose of the study was to investigate DTI derived directional diffusivity as a tool to quantitatively measure axonal and myelin injury in Alexander disease and to correlate these findings with disability.

MATERIALS & METHODS
Diffusion tensor imaging derived axial and radial diffusivity were used to evaluate CNS white matter in three patients with genetically confirmed infantile and juvenile forms of Alexander cases and 12 age-matched controls. A histogram approach was used to evaluate diffuse white matter abnormalities. Directional diffusivity measurements were correlated with neurologic disability.

RESULTS
All of the patients with Alexander disease had both elevated radial and axial diffusivity, indicative of chronic demyelination and axonal damage. However, higher axial diffusivity was identified in those subjects with greatest disability, and was found to develop over time in the subject who had serial DTI scans during the course of his disease progression (Figure).

CONCLUSION
Both progressive and severe myelin and axonal damage determine the neurologic deterioration in patients with Alexander disease. Clinically, axonal damage may correlate more with severity of the disease. Axial diffusivity has been suggested previously to be a marker for axonal integrity. Here, we were able to identify elevated axial diffusivity associated with disease severity in Alexander disease. This suggests that DTI-derived directional diffusivity may be a useful MRI biomarker for disease progression in Alexander disease, where conventional MR imaging often fails.

REFERENCES

KEY WORDS: Alexander, leukodystrophy, DTI

Rhombencephalosynapsis and Mesencephalosynapsis: A Spectrum of Severity in Seven Patients

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PURPOSE
Rhombencephalosynapsis (RES) is a rare congenital cerebellar malformation increasingly recognized by prenatal and neonatal imaging. It represents dorsal fusion of the cerebellar hemispheres and fusion of the dentate nuclei due to primary failure of vermian differentiation. It may be isolated or more frequently associated with abnormal development of midline structures, ranging from absent septum pellucidum to telencephalosynapsis. In this study, we seek to describe the imaging findings in seven patients with RES in attempt to understand the embryologic background of RES and associated midline defects.

MATERIALS & METHODS
Clinical findings and MR images of seven patients with RES at our institution (5 boys and 2 girls; age range of 5 days - 12 years) were reviewed retrospectively.

RESULTS
MR findings revealed dorsal fusion of the cerebellar hemispheres and dentate nuclei. Associated anomalies included absence of the septum pellucidum 7/7, severe hydrocephalus and aqueductal stenosis with thinned and dysplastic corpus callosum 5/7, mild ventriculomegaly 1/7, fused fornices 5/7, underdeveloped medial temporal lobes 5/7, hypoplasic mammillary bodies 5/7, absent anterior commissure 3/7, fused tectum 4/7, normal olivary nuclei 7/7, periventricular heterotopia and polymicrogyria 1/7. During the third gestational month, the midline component of the cerebellum begins to grow faster to form the vermis, as well, the alar plates, also referred to as the tectum, thicken and divide to form the colliculi. Four out of our five patients with aqueductal stenosis had fused colliculi, also named mesen-
cephalosynapsis. No patient had diencephalosynapsis (fusion of the thalami). However, fused fornices in 5/7 and absent anterior commissure in 3/7 may be considered a form fruste of telencephalosynapsis. The fornices and the anterior commissure begin to form at about 9 and 10 weeks, respectively.

CONCLUSION
Rhombencephalosynapsis may be isolated or occur in association with mesencephalosynapsis, diencephalosynapsis and telencephalosynapsis. This suggests that embryologic mechanisms responsible for RES are of variable degree of severity and possibly could alter the downstream signalling cascade from the mesencephalo-metencephalic junction at more rostral levels.

KEY WORDS: Rhombencephalosynapsis, mesencephalosynapsis, telencephalosynapsis

Paper 188 Starting at 11:09 AM, Ending at 11:17 AM
Diffusion-Weighted MR Imaging in Fetuses with Congenital Heart Defects

Berman, J. I.1 · Hamrick, S. E. G. · McQuillen, P. S.1 · Studholme, C.1 · Xu, D.1 · Henry, R. G.1 · Hornberger, L. K.4 · Glenn, O. A.1
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PURPOSE
Congenital heart anomalies have been linked with long-term motor, sensory, and cognitive difficulties. This case study uses in utero diffusion MR imaging to detect structural brain abnormalities associated with congenital heart disease (CHD).

MATERIALS & METHODS
Three women were referred for fetal MR imaging after abnormal ultrasound showed congenital cardiac anomalies. Case 1 was a fetus at 32.14 weeks gestational age at MR imaging with transposition of the great arteries. No abnormalities were evident on T1- or T2-weighted MR imaging. Case 2 was a fetus at 34.57 weeks gestational age with hypoplastic left heart. No abnormalities were evident on T1- or T2-weighted MR imaging. Case 3 was a fetus at 35.29 weeks gestational age with hypoplastic left heart. Fetal MR imaging demonstrated a hypoplastic corpus callosum. Diffusion-weighted imaging was performed on a 1.5 T scanner with a b-value of 600 s/mm² applied in 3 orthogonal directions in addition to a single b = 0 s/mm² volume. Regions of interest were placed in the periatrial white matter, thalamus, and basal ganglia and ADC values were measured. Diffusion measurements were compared to measurements from a population of 33 control fetuses (1).

RESULTS
Apparent diffusion coefficient (ADC) values in the periatrial white matter and thalamus were higher for all fetuses with CHD as compared with the control population. The average z-score was 1.26 for the periatrial white matter, 1.38 for the thalamus, and 0.40 for the basal ganglia (Figure). Regression analysis indicated a significant difference between patient and control thalamic ADC values (p < 0.05) and a strong trend not reaching significance between patient and control periatrial white matter ADC values (p = 0.071). Patient and control basal ganglia ADC values were not significantly different (p = 0.53).

CONCLUSION
This study shows that fetal diffusion MR imaging is a feasible method of detecting abnormal brain diffusivity associated with CHD. These in utero results are consistent with a recent neonatal study which also found ADC in the thalamus and posterior white matter to be most affected by congenital heart disease (2). Certain congenital heart lesions cause changes in cerebral perfusion and/or cerebral hypoxia, potentially leading to abnormal patterns of brain development. This study reinforces the hypothesis that brain development is affected in utero by CHD.

REFERENCES

KEY WORDS: Fetus, diffusion, heart

Paper 189 Starting at 11:17 AM, Ending at 11:25 AM
Development and Validation of a Semiquantitative Brain Maturation Score on Clinical Fetal MR Imaging

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PURPOSE
Assessment of fetal brain maturation has potential to provide important prognostic data and facilitate the future study of human brain development in high-risk fetuses. The goal of this study was to develop a valid, yet simple to use semiquantitative scale of fetal brain maturation that can be used in routine clinical fetal MR imaging interpretation.
**Materials & Methods**
A simple semiquantitative scale and scoring system for assessing brain maturation was developed. The model was designed by major modifications and additions to a previously validated ex utero brain maturation score. Six defined visual imaging indices, including specific areas of myelination, presence and locations of the germinal matrix, frontal/occipital cortical folding, insular cortical folding, and sulcal depth of each of the superior and inferior temporal sulci were used. Thirty-one normal fetal brains were assessed via fetal MR imaging by two independent raters. The cumulative maturational score was correlated with gestational age and also manually segmented fetal whole-brain volumes. Regression models of gestational age and brain volume based on the indices was performed. The performance of the predictive model then was cross-validated by the leave-one-out procedure.

**Results**
The two independent raters had a correlation of $r = 0.951$ (p < 0.001) for the maturational score assessment. The correlation of the visual score with gestational age and segmented brain volume was $r = 0.971$ (p < 0.001) and $r = 0.969$ (p < 0.001), respectively. The regression analyses revealed adjusted squared multiple R of 0.938 and 0.932 for predicting gestational age and brain volume, respectively. The analysis also indicated that the scoring system can even be further simplified and yet maintain relative accuracy by stepwise regression. The cross-validation analysis demonstrated excellent validity with R2 = 0.91 for gestational age and R2 = 0.89 for brain volume.

**Conclusion**
The study demonstrated the feasibility of developing a highly accurate, reproducible, and yet simple-to-use clinical scale of brain maturation on routine fetal brain MR imaging. This scoring system has potential to be used in assessment of fetal brain maturation during pregnancy.

**Key Words:** Fetal, brain, maturation

**Paper 190 Starting at 11:25 AM, Ending at 11:33 AM**
**Imaging Features of Associated Abnormalities in Septo-Optic Dysplasia Complex**
Bagg, S.1 · Parmar, H.2 · Ibrahim, M.2 · Gujar, S.2,3 · Joshi, S.2 · Castillo, M.1
1University of North Carolina, Chapel Hill, NC, 2University of Michigan, Ann Arbor, MI, 3Johns Hopkins Hospital, Baltimore, MD

**Purpose**
Classic MR findings in Septo-Optic Dysplasia (SOD) include optic nerve hypoplasia and absent septum pellucidum, but historically there has been debate over whether associated abnormalities such as cortical malformations, hydrocephalus and pituitary abnormalities are also a part of SOD. Polizzi et al. (1) suggested recategorization of SOD as “Septo-Optic Dysplasia Complex” to encompass these associated abnormalities. We performed a retrospective analysis utilizing the MR images of 41 SOD patients from two academic centers and specifically looked for associated abnormalities. We then analyzed the data and described the incidence of associated abnormalities. These associated abnormalities may impact treatment and prognosis and are important to note.

**Materials & Methods**
We compiled a list of 41 clinically diagnosed SOD patients who had MR imaging over the last 10 years. Brain MR images were reviewed for presence/absence, or abnormalities of the following structures: optic nerves, optic chiasm, pituitary stalk, shape of lateral ventricles, schizencephaly, cortical migration abnormalities, septum pellucidum, callosoforniceal continuation, hydrocephalus, pituitary gland, myelination, and hippocampal malformations. Clinical charts then were reviewed and information was entered into data tables and combined for both institutions.

**Results**
In 29 patients (85%), the optic nerves were either small or atrophic. The optic chiasm was abnormal in 31 (82%) of patients. In 20 patients (49%), the pituitary stalk was atrophic. Thirty-five patients (85%) had lateral ventricles that were typical in appearance for SOD demonstrating frontal horns that were “box-like” superiorly and point inferiorly. Schizencephaly was present in six cases (15%) and cortical migration (predominantly polymicrogyria) abnormalities were present in 22 cases (54%). The septum pellucidum was absent in 38 cases (93%). “Callosal-forniceal continuation” was present in 10 patients (24%), enlarged ventricles in 14 cases (34%), and hippocampal malrotation in 12 cases (29%). Only one patient (2%) had abnormal myelination pattern.

**Conclusion**
We found that associated abnormalities such as cortical migration abnormalities, callosoforniceal continuation, enlarged ventricles, and hippocampal malrotation all had relatively high incidences. Thus, there is no simple subgroup or subclassification and it is important for radiologists to search for them because they may have clinical implications as suggested by Miller et al. (2). Furthermore, given the relative incidence of associated abnormalities, we suggest revising the current terminology to encompass these variable associated abnormalities. We agree with Polizzi’s (1) notion of recategorizing the syndrome as “Septo-Optic Dysplasia Complex.”

**References**

**Key Words:** Septo-Optic dysplasia, SOD
Diffusion Tensor Imaging of Neurofibromatosis Bright Objects

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1The Johns Hopkins Medical Institution, Baltimore, MD, 2The Johns Hopkins University, Baltimore, MD

PURPOSE
One of the more curious NF1 lesions that are seen in the brain are the “T2 bright objects”. In this study, we examined the diffusion characteristic of these neurofibromatosis bright objects (NBOs) with diffusion tensor imaging. We hypothesized that the NBOs would show greater reduction in FA in white matter (WM) based lesions than gray matter based lesions and that the greater the deviation from contralateral normal-appearing symmetric structures the higher the likelihood of symptoms. We also believed that lesions would more likely cause disruption of the tract rather than displacement on diffusion tractography.

MATERIALS & METHODS
Fourteen NF1 patients who had high quality MRI/DWI images and DTI data were included in the study sample. Regions of interest (ROI) were placed manually in NBOs and contralateral normal-appearing anatomically identical sites. Apparent diffusion coefficients (ADC), fractional anisotropy (FA) values were measured and used to differentiate quantitatively between NBOs and contralateral normal-appearing anatomically identical sites. Differences in eigenvalues (λ1, λ2, λ3) were calculated to examine microstructural integrity. Apparent diffusion coefficient, FA and eigenvalues (λ1, λ2, λ3) data were compared with age-matched normative data. Differences in ADC, FA and eigenvalues (λ1, λ2, λ3) were analyzed using a paired t-test (a value of p ≤ 0.05 was considered significant). Finally fiber tractography was performed to assess NBOs-induced changes in WM trajectories.

RESULTS
Increased ADC and decreased FA values were found in NBOs located in gray matter and white matter compared to contralateral normal-appearing anatomically identical sites. The ADC values were significantly higher for gray matter NBOs and white matter NBOs than of contralateral normal-appearing site. The FA values were significantly lower only in NBOs and white matter NBOs than of contralateral normal-appearing site. The ADC values were significantly higher for gray matter NBOs located in gray matter and white matter compared to contralateral normal-appearing anatomically identical sites. Differences in eigenvalues were significant for both the gray and the white matter NBOs (Table). When fiber tractography was performed we found that NBOs did not lead to remarkable change in WM trajectories.

Mean and Standard Deviation of ROI Measurements in DTI Data

CONCLUSION
Elevated ADC and decreased FA values might indicate a disintegration of the myelin sheaths and/or axonal disruption. Higher eigenvalues in NF-1 regions with NBOs suggest microstructural integrity loss. Neurofibromatosis bright objects do not lead to remarkable changes in WM trajectories like tract displacement or destructions.

KEY WORDS: Neurofibromatosis bright object, DTI
Preferential Microstructural Injury to the Pulvinar of the Thalamus in Childhood Survivors of Prematurity

Nagasunder, A.1 · Kinney, H. C.2 · Tavare, C. J.1 · Rosser, T.1 · Gilles, F. H.1 · Nelson, M. D.1 · Bluml, S.1,3 · Panigrahy, A.1,3
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PURPOSE
Preterm infants are highly vulnerable to brain injury resulting in subsequent cognitive and motor disability. The diffuse component of perinatal white matter injury is thought to result in disruption of thalamo-cortical connections. Our goal was to test the hypothesis that there is preferential microstructural injury to specific subdivisions of the thalamus in early childhood survivors of prematurity with periventricular leukomalacia (PVL).

MATERIALS & METHODS
Medical records and diffusion tensor imaging (DTI) data were reviewed retrospectively in this IRB-approved study. Seventeen patients with PVL on MR imaging (MRI) were included and compared with 74 controls. Clinical information concerning cerebral palsy, seizures and developmental delay were recorded. Diffusion tensor imaging protocol consisted of echo planar imaging (EPI) sequence using 25 encoded directions and b = 1000 s/mm² on a 1.5 T GE scanner. Thalamic subdivisions such as anterior, reticular (lateral), medial dorsal and pulvinar were traced manually using two methods: a small sized and a large sized region of interest (ROI) on maps generated by DTIStudio (John Hopkins, MD, USA). The subdivision data were compared to the whole thalamic ROI. Student’s t-test, test of two binomial proportions and ANOVA were used for comparison purposes.

RESULTS
Periventricular leukomalacia patients were at gestational ages of 24-36 weeks. One hundred percent PVL patients demonstrated developmental disability. 75% cerebral palsy, 67% seizure and 86% visual function abnormalities. Periventricular leukomalacia patients had significantly reduced fractional anisotropy (FA) (p = 0.003) and increased radial diffusivity (RD) (p = 0.02) in the whole thalamus when compared to controls. The subdivision analysis showed a selective increase in axial diffusivity of the pulvinar nucleus (p = 0.001) in PVL cases in both the small and large ROI approach.

CONCLUSION
Our study is one of the first to show preferential microstructural injury within the parenchyma of the thalamus in childhood survivors of prematurity with PVL. Two major patterns of damage found: (1) global decrease in FA and increased radial diffusivity in the thalamic parenchyma which might reflect loss of myelinated efferent/afferent fibers; this could be related to disruption of the cortical-thalamic connections postulated to occur in PVL; (2) Preferential damage to the pulvinar which also demonstrated an increase in axial diffusivity, suggesting axonal injury. The preferential damage to the pulvinar may underlie deficits in higher level visual integrative function.

Acknowledgments: Grant support: Rudi Schulte Research Institute, NIH NS 063371, CHLA GCRC grant CCI-06-00121.

KEY WORDS: Diffusion tensor imaging, periventricular leukomalacia

Narrowing of the Corpus Callosum as a Biomarker of Acute Profound Hypoxic-Ischemic Encephalopathy at Term

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PURPOSE
Cerebral palsy is a group of disorders attributed to nonprogressive insults to the developing fetal or infant brain. Insults may occur, pre, peri or postnatally. Determination of cause is important in giving prognosis, counselling, prevention and medico-legally. A characteristic “central” pattern of injury is seen in acute-profound term hypoxic-ischemic encephalopathy (HIE) involving the basal ganglia, particularly thalamus and posterior putamen. Variable white matter injury, particularly peri-Rolandic, also is often present. Corpus callosum (CC) thinning previously has been reported anecdotally following hypoxic-ischemic injury. There is a lack of a robust imaging biomarker for term HIE. This pilot study aims to determine whether a simple CC morphologic analysis can be used as a marker for HIE based on fiber radiation to injured regions.

MATERIALS & METHODS
Retrospective review of clinical imaging of 13 children with proved acute profound (AP) hypoxia was performed with 22 control cases selected from a group of children who had had normal MR imaging for assessment of undiagnosed developmental delay. Imaging was performed at 1.5 T and included an isotropic T1 sequence. The corpus callosum was identified on a midline sagittal image and computer software used to divide it into 100 segments along its length, according to a method described by Denenberg. Width of each of the percentile divisions was measured, as well as overall cross-sectional area, length and perimeter. Area of callosal regions, grouped by their projections, as described by Hofer was measured. Principal component analysis (PCA) was used to group the 99 widths into contiguous anatomical regions. The unpaired Student’s t-test was used to compare measures between control and patient groups. The Bonferroni correction was used to correct for multiple comparisons.

RESULTS
No significant difference was demonstrated between patient ages, callosal area, perimeter or centerline length, or between any individual Hofer region. Principal component analysis of widths yielded seven factors corresponding to...
and b = 700 s/mm². Diffusion tensor imaging data were pre-
scanner using an EPI sequence with 25 encoded-directions.
Diffusion tensor MRI data were obtained on a 1.5 T GE
approval was obtained for the retrospective use of those data.
We retrospectively reviewed DTI data for nine neonates (8
MATERIALS & METHODS

Animal studies have demonstrated a loss of corticothalamic
connections early after a focal cortical stroke (1). We were
interested in testing whether a decrease in corticothalamic
(or thalamocortical) connections could be detected in the
thalami of human neonates following a cortical stroke using
diffusion tensor imaging (DTI). Our prediction was that
there would be a decrease in fractional anisotropy (FA) and
an increase in the apparent diffusion coefficient (ADC) in
the thalamus ipsilateral to the cortical infarct due to a loss of
corticothalamic and thalmocortical connections.

MATERIALS & METHODS

We retrospectively reviewed DTI data for nine neonates (8
term/1 preterm at 25 weeks GA; ranging in age from 5 days
to 4 months) who had focal infarcts (3 unilateral left, 3 uni-
lateral right and 3 bilateral) and compared those to a group
of 12 neonates (all term; ranging in age from 1 week to 2
months) who had no evidence of ischemia based on both
conventional MR imaging and clinical history. All neonates
underwent neuroimaging for clinical purposes and IRB
approval was obtained for the retrospective use of those data.
Diffusion tensor MRI data were obtained on a 1.5 T GE
scanner using an EPI sequence with 25 encoded-directions
and b = 700 s/mm². Diffusion tensor imaging data were pre-
processed with DTI Studio (Department of Radiology, Johns
Hopkins University) yielding volumes corresponding to FA
and ADC and then imported into Brainsuite (Department of
Radiology, UCLA) where the ADC and FA volumes were
corendered. Thalami were manually traced on axial slides.
Volume, mean FA and mean ADC were calculated for each slice using Matlab (Mathworks, Inc) and values obtained
from focal lesion patients were compared with normative
values from the comparison group using statistical methods
developed for comparing patients against small normative
samples (2).

RESULTS

Thalamic volumes were at the 5 th percentile or below, bilat-
erally, in four neonates with cortical strokes (2 bilateral, 2
unilateral) and unilaterally in a single neonate (ipsilateral to
a unilateral stroke). Thalamic volumes in the remaining four
patients were in the lower range of normal. Fractional
anisotropy was decreased ipsilateral to the cortical lesion in
five patients (2 bilateral, 3 unilateral), within the average
range in three (all unilateral) and increased in one (bilateral).
Apparent diffusion coefficient values tended to be high (> 80th percentile) in all cases.

CONCLUSION

We were able to demonstrate secondary changes in thalamus
(assessed as change in volume and/or FA) following a focal
perinatal cortical infarct in most of the neonates with focal
infarcts. This indicates that these focal brain lesions, which
are incurred during a period of rapid brain development, are
causing downstream effects on areas outside of, but func-
tionally interconnected with the infarcted cortical areas.

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Acknowledgment: Sponsored by NINDS P01/P50-
NS019632.

KEY WORDS: Neonatal infarct, DTI

CT of the head is the most commonly used radiographic
technique for evaluation of acute pediatric intracranial
abnormalities. While the normal appearance of sutures has
been studied in the past, it has been limited to skull radi-
ographs and ultrasound, both of which are not used com-
monly to evaluate acute intracranial injuries and are of lim-
ited use for CT image interpretation. The purpose of this
study is to establish a set of normal sutural widths, and to
evaluate sutural variability in the first year of life.
MATERIALS & METHODS

Patient Selection and Methods. The series is comprised retrospectively of 539 different patients, ages 1 day to 395 days, who were examined by CT and given the diagnosis of no acute intracranial pathology. The sagittal suture and bilateral coronal sutures were evaluated on axial imaging using a method similar to Erasmie and Ringertz. Statistics. Histograms and other various plots were used to view the distribution of the data. An analysis of variance was run for each suture measured, with month as the independent class variable.

RESULTS

Prior methods of determining normal sutural width used a combination of values rather than direct evaluation to determine what was a normal sutural appearance. Using 5 mm or 7.5 mm axial CT imaging, the average proximal and distal sagittal suture widths were measured at 5.25 mm and 4.82 mm at 0 months respectively. At 1 month the average proximal and distal sagittal sutures measured 2.56 and 2.82 mm respectively, and at 12 months the average proximal and distal sagittal sutures measured 1.19 and 1.17 mm respectively. The coronal sutures demonstrate a similar reduction in width over time. The average proximal coronal suture measured 2.59 mm at 0 months while measuring 1.36 and 0.86 mm at 1 and 12 months. The average distal coronal suture measured 1.55 mm in width at 0 months, and at 1 month and 12 months the distal coronal suture measured 1.06 and 0.55 mm respectively.

CONCLUSION

We demonstrate that throughout the infants first year, the rate of change of proximal to distal sutural approximation from the fontanel is variable. This new data may serve as a baseline to correlate CT appearance of sutures to intracranial changes. We also show that the closure pattern of the proximal sutures rapidly declines followed by a very slow closure and that the distal sutures maintain a more steady closure rate.

KEY WORDS: Pediatric suture, suture width, head trauma

Comparison of Spin-Echo and Gradient-Echo T1-weighted Images at 3 T for Term Equivalent Neonatal Myelination Evaluation and Interobserver Agreement

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PURPOSE

Term equivalent imaging often is utilized to assess neonatal myelination for the purpose of evaluating for hypoxic-ischemic encephalopathy (HIE) or in developmental assessment. Theoretically, this assessment could be augmented at 3.0 T, but there has yet to be comparison of myelination scoring between gradient-echo (GRE), spin-echo (SE) T1-weighted imaging (T1WI) and T2-weighted imaging (T2WI).

RESULTS

They were scored as +, - , or +/- for T1-bright myelination by SE and GRE T1WI, and for dark signal on T2WI. Myelination in general was definitely present in 58.2 - 66.4% of structures on T2WI, 20.5 - 38.5% on SET1WI and 51.6 - 63.9% on GRE T1WI. Kappa values for interobserver agreement were found to be 0.43 (P < 0.0001) for T2WI, 0.40 (P < 0.0001) for SE T1WI and 0.56 for GRE T1WI. Kappa values of agreement between T2WI and SE T1WI were 0.33 and 0.39 (P < 0.0001), for T2WI-GRE T1WI were 0.40 and 0.67 (P < 0.0001) and for SE T1WI-GRE T1WI were 0.33 and 0.40 (P < 0.0001).

CONCLUSION

Gradient-echo T1WI leads SE T1WI in myelination at 3 T, although it is unclear if this is indeed true myelination detected or a precursor to the expected myelination patterns on SE T1WI. However, this study found that T2WI demonstrated the highest number of myelinated structures, while GRE T1WI has been shown to have highest interobserver agreement amongst all three. Future prospective studies are necessary to determine whether GRE T1WI vs T2WI at 3 T is the best harbinger for myelination progression in term equivalent patients.

KEY WORDS: Myelination, MR imaging, term equivalent
Tuesday Morning
10:45 AM – 12:30 PM
Room 312

(19d) Head and Neck: Pharynx, Larynx, Soft Tissue Neck, Sinonasal and Temporal Bone
(Scientific Papers 198 - 210)

See also Parallel Sessions
(19a) Adult Brain: Functional Imaging
(19b) Interventional: New Devices and Techniques
(19c) Pediatric: Developmental/Congenital Malformations and Demyelinating/ Degenerative and Neonatal Imaging

Moderators: Nancy J. Fischbein, MD
John R. Hesselink, MD, FACR

Paper 198 Starting at 10:45 AM, Ending at 10:53 AM
Predictive Value of Negative PET/CT in Head and Neck Squamous Cell Carcinoma

McDermott, M. · Branstetter, B. F.
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Pittsburgh, PA

PURPOSE
PET/CT has become a critical modality in the surveillance of treated head and neck squamous cell carcinoma (HNSCC). It has been proposed that a negative PET/CT examination performed at least 8 weeks after the conclusion of surgery or chemoradiation can predict long-term remission, and potentially reduce the need for additional radiographic surveillance. The purpose of this study was to determine whether the negative predictive value of PET/CT was adequately high to discontinue radiographic surveillance in patients with HNSCC.

MATERIALS & METHODS
We retrospectively reviewed the medical records at a single academic institution between 2002 and 2008. We identified 1089 patients with PET/CT performed for head and neck pathology. Three hundred fifteen of these patients (29%) had negative PET/CT scans after treatment for HNSCC. We obtained clinical and radiographic follow up on these patients, with a minimum follow-up period of 12 months required for inclusion in the study. Outcome measures included disease-free interval and time from PET/CT to recurrence.

RESULTS
Two hundred eighty-eight of the 315 patients (91%) had no evidence of recurrence, with a median follow-up interval of 17 months. Of the remaining 27 patients with clinical or radiographic evidence of recurrence, 25/27 (93%) had a disease-free interval of at least 6 months following their first negative PET/CT.

CONCLUSION
A negative PET/CT following treatment for HNSCC is highly predictive of cure, but does not obviate the need for further radiologic surveillance. Negative PET/CT may, however, permit a longer interval before the next radiologic examination is needed.

KEY WORDS: PET/CT, head and neck squamous cell carcinoma, radiologic surveillance

Paper 199 Starting at 10:53 AM, Ending at 11:01 AM
Head and Neck Amyloidosis: CT and MR Imaging Findings with Clinicopathologic Correlation

Hito, R. · Murakami, A. M. · Berk, J. · Sakai, O.
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Boston, MA

PURPOSE
To review the CT and MR imaging findings of localized and systemic amyloidosis involving the head and neck, with particular attention to imaging characteristics and location of amyloid deposition. To correlate the imaging findings with clinical and pathologic presentation.

MATERIALS & METHODS
This HIPAA compliant, retrospective study was IRB approved and the need for consent was waived. Cross-sectional head and neck imaging of patients with localized and systemic amyloidosis evaluated at our Amyloid Treatment and Research Center between 2006-2008 was reviewed. Imaging findings were analyzed in conjunction with biopsy results, endoscopic direct visualization, and physical exam findings. Only patients with biopsy-proved amyloidosis were included in the study. The lesions were categorized by a radiologist based on location and morphology.

RESULTS
We identified 47 patients with biopsy-proved amyloidosis and cross-sectional head and neck imaging. Two of the patients had a diagnosis of systemic amyloidosis; forty-five patients had localized disease. Twenty-five patients had amyloid deposits at more than one location; five had lesions at noncontiguous sites. The most common locations for lesions were the trachea and subglottic larynx with 21 and 17 patients demonstrating lesions at those sites, respectively. The number of patients with lesions at the following locations is as follows; glottic larynx 11, bronchus/bronchiole 7, supraglottic larynx 7, hypopharynx 1, nasopharynx 6, lymph nodes 4, oropharynx 4, sinonasal 2, nasolacrimal duct 1, tongue 1. The two patients with systemic amyloidosis had diffuse lymphadenopathy of the neck. Lesions were of a concentric diffuse nature in 26 of the patients. Ten patients had discrete mass-like lesions. In two patients a combination of
discrete mass with adjacent areas of thickening were noted. Calcifications were present in the lesions of 21 of the patients.

**CONCLUSION**

Imaging findings in this case series revealed the subglottic larynx and trachea as the most common site of localized head and neck amyloid, followed by the glottic larynx. Most lesions were diffuse in morphology with 21 of the 47 patients displaying calcifications. Head and neck amyloidosis is a rare disease with often nonspecific imaging findings. However, identification of characteristic amyloid lesions by the radiologist can guide diagnosis and treatment.

**REFERENCES**


**KEY WORDS:** Amyloid

**Paper 200 Starting at 11:01 AM, Ending at 11:09 AM**  
Imaging Findings of Radiation-Induced Sarcomas of the Head and Neck

Debnam, J. M. · Guha-Thakurta, N. · Mahfouz, Y. M. M. · Ginsberg, L. E.

The University of Texas M. D. Anderson Cancer Center Houston, TX

**PURPOSE**

Sarcomas may develop as a consequence of radiation therapy for primary malignancies and are often very aggressive. The purpose of this study was to review the patient demographics and imaging findings of radiation-induced sarcomas of the head and neck treated at our institution.

**MATERIALS & METHODS**

Twenty-two radiation-induced sarcomas of the head and neck were diagnosed between May 1998 and January 2009 in 21 patients (13 male, 8 female; ages 9-83, mean 47.2 years). The radiation doses, available in nine patients, ranged between 35 and 74 Gy (mean 57.9 Gy). The sarcomas developed between 4.5 and 25 years (mean 12.7 years) after radiation therapy. The primary tumors treated with radiation therapy included squamous cell carcinoma (6 patients) and retinoblastoma (2 patients). The remaining histologies included one each of the following: melanoma, salivary gland carcinoma, Schneiderian carcinoma, basal cell carcinoma, adenoid cystic carcinoma, mucoepidermoid carcinoma, sebaceous adenocarcinoma, rhabdomyosarcoma, Hodgkin lymphoma and clival chordoma. Additionally, non-head and neck cancers included intracranial low-grade glioma, medulloblastoma and primitive neuroectodermal tumor. The initial imaging comprised of CT (19 cases) and MR imaging (15 patients). The lesions were assessed for presence of a soft tissue mass, the enhancement pattern, associated bone destruction, and the tumor matrix.

**RESULTS**

The radiation-induced sarcomas included the following: osteogenic osteosarcoma (n = 12), chondroblastic osteosarcoma (n = 2), chondroblastic osteosarcoma versus chondrosarcoma (n = 1), spindle cell sarcoma (n = 3), malignant peripheral nerve sheath sarcoma (n = 1), angiosarcoma (n = 1), sarcomatid squamous cell carcinoma (n = 1), and malignant fibrous histiocytoma (n = 1). On both CT and MR imaging, all 22 of the lesions demonstrated an associated soft tissue mass which ranged in size between 1.4 and 9.5 cm (mean 4.7 cm). Enhancing patterns were as follows: diffuse (n = 6), heterogeneous (n = 7), peripheral (n = 3), or minimal enhancement (n = 2). Four lesions initially presented as a predominately osteogenic soft tissue mass. Associated bone destruction was present in 16 cases, an osteoid matrix in 10 cases, and a chondroid matrix in two cases. Eleven of the 21 patients are deceased from the disease.

**CONCLUSION**

Radiation-induced sarcomas of the head and neck can occur not only after radiation therapy for tumors of the head and neck, but also of the intracranial compartment. These tumors can develop after a long latency period and often are clinically malignant. Although aggressive radiographic findings with a variable enhancement pattern is common, these sarcomas also can have a nonaggressive appearance. Identification and early diagnosis of these tumors is important to ensure proper management. Head and neck radiologists should be aware of this entity to avoid misinterpretation of radiation-induced sarcomas as recurrent primary tumor or other processes. Knowledge of prior radiation therapy, including location of the treatment field, and suggestive imaging findings, such as prior surgery, will aid in the diagnosis.

**KEY WORDS:** Radiation-induced, sarcoma

**Paper 201 Starting at 11:09 AM, Ending at 11:17 AM**  
Carotid Body Detection with Multi-Detector Computed Tomography

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University of Utah  
Salt Lake City, UT

**PURPOSE**

The carotid body is a normal physiologic structure involved in chemo and baro reception helping to regulate pulse and blood pressure. Anatomic literature describes the normal carotid body as situated at the bifurcation of the internal and external carotid arteries. Neoplasms arising from the carotid body (i.e., paragangliomas) have a characteristic imaging appearance of splaying the internal and external carotid arteries. With the advances in multidetector computed tomography (CT), the spatial resolution is as minute as 0.5 mm, which enables detection of the normal carotid body. To our knowledge, there has been no discussion of imaging findings of the normal carotid body in the radiologic literature.

**MATERIALS & METHODS**

We performed a retrospective analysis of 200 multidetector CT angiograms (400 carotid bodies) of the neck. The studies were randomly selected from the last year at our institu-
tion. A database of the size and Hounsfield unit of the carotid body were recorded. The patient’s age, gender, and smoking history were recorded.

RESULTS
The normal carotid body can be seen 86.0% of thin section (1mm) contrast enhanced angiograms. The carotid body measures approximately 2.3 mm in the transverse dimension by 2.1 mm in the AP dimension on average with a standard deviation of 0.8 and 0.6 respectively. There is no correlation to size of the carotid body between gender. In our sample population, the carotid body is seen with higher frequency in the above 30 years of age population.

CONCLUSION
With advances in multidetector CT, the normal carotid body can be seen frequently. It is important to recognize the imaging appearance of the normal carotid body on CT angiograms to avoid misinterpretation of early carotid paragangliomas.

KEY WORDS: Anatomy, Carotid, Body

Paper 202 Starting at 11:17 AM, Ending at 11:25 AM
Imaging Features that Distinguish Cervical Lymphoceles from Other Cystic Neck Masses

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Oregon Health and Sciences University
Portland, OR

PURPOSE
Lymphoceles are benign cysts that may arise in the neck as a postsurgical complication or spontaneous occurrence. They are important to differentiate from more aggressive pathology, such as cystic nodal metastasis or infectious etiologies. Retrospective analysis of a series of histologically confirmed lymphoceles and other cystic neck mass mimics is reviewed here, in order to delineate the radiologic and clinical characteristics of lymphoceles that differentiate them from other cystic neck masses.

MATERIALS & METHODS
A computer-generated search of radiology report impressions for the term “lymphocele” or “lymphatic cyst” was performed on all neck CT, MR imaging, sclerotherapy studies from January 2003 to December 2009 at our institution. Clinical records from the department of otolaryngology were reviewed also to identify any additional cases. Images from these studies then were reviewed electronically on our digital radiologic picture archiving and communication system (PACS) to assess anatomical features pertinent to lymphoceles and compared to other cystic neck masses. Digital medical records and pathology reports were reviewed to confirm diagnosis.

RESULTS
A total of 14 (7 female, 7 male) adults aged 29 to 87 years had cystic neck masses with clinical or radiologic suspicion for lymphocele on 11 enhanced and one unenhanced neck CT, one enhanced chest CT, and one enhanced neck MR image. There were seven confirmed lymphoceles, two ranulas, one lymphoma, one nodal sarcoid, one mycobacterial lymph node, one case of skin cancer metastasis, with two cases pending removal and histologic confirmation. Three lymphoceles were spontaneously occurring, with the remainder related to postsurgical origin. One patient had two (bilateral) lymphoceles. True lymphoceles were all found to be located in the supraclavicular fossa of either side of the neck (four right and five left sided), in the expected anatomical location of the lymphatic duct, often immediately adjacent to or abutting the upper aspect of the subclavian vein. All appeared unicocular in nature, with water attenuation of signal intensity and no perceptible cyst wall or pathological enhancement. Size was variable. By comparison, the other cystic neck masses all demonstrated radiologic features of complicated or complex appearance for cysts: perceptible wall or rim enhancement, internal heterogenous attenuation or internal attenuation or signal characteristics differing from water. Locations were varied, with only one occurring in the classically described supraclavicular fossa location, though distinct from lymphocele in light of several other atypical features.

CONCLUSION
Lymphoceles are rarely encountered nonenhancing unicocular cystic neck masses that may mimic more ominous pathology. Most arise as a complication of previous neck dissection due to inadvertent disruption of normal lymphatic drainage. Although classically described as left sided, they may occur in either side of the neck. They can be differentiated from infectious and malignant etiologies by their expected location in the supraclavicular fossa in close proximity to the subclavian vein, often with cephalad extension into the posterior triangle of the neck, lack of cyst wall or enhancement, and lack of internal complex attenuation or signal characteristics.

KEY WORDS: Lymphocele, lymphatic cyst, cystic neck mass

Paper 203 Starting at 11:25 AM, Ending at 11:33 AM
Percutaneous Embolization of Nasopharyngeal Angiofibroma: Technical Strategies

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1Boston Medical Center, Boston, MA, 2National Institute of Mental Health and Neuro Sciences, Bangalore, INDIA

PURPOSE
Juvenile nasopharyngeal angiofibroma (JNA), a locally aggressive tumor, is one of the common vascular head and neck tumors in adolescent males. Management of such patients includes both medical and surgical techniques. Surgery is the treatment of choice for large JNAs. However, intraoperative blood loss is a potentially lethal problem and necessitates preoperative tumor devascularization. Traditional preoperative embolization via a transarterial approach has been proved beneficial but is often limited by complex vascular anatomy, intra-extracranial anastomosis and unfavorable locations. We report varied technical strategies and consideration of dangerous anastomosis to reduce complications with our experience of the preoperative percutaneous devascularization of JNA by using an intralesional injection of cyanoacrylate.

MATERIALS & METHODS
We have prospectively analyzed 42 cases of JNA who underwent percutaneous embolization through transnasal and/or precondylar approach. Percutaneous puncture of the lesion
was performed by using roadmap fluoroscopic guidance. Acrylic glue was injected by using continuous biplane fluoroscopy. The presence of tumor blush in postembolization DSA was discussed in detail with regard to technical difficulties in reaching the tumor component and/or due to dangerous anastomosis to ICA branches. All patients underwent postembolization control angiography and immediate postoperative CT scanning.

RESULTS
Angiograms showed that complete devascularization was achieved in all cervical tumors, whereas near-total devascularization was achieved in tumors with intracranial extension. In this latter location, the injection of acrylic glue was limited by the difficulty to reach the the tumor by percutaneous approach. The tumors could be successfully embolized and operated with minimal blood loss in all the patients.

CONCLUSION
In conclusion, percutaneous preoperative embolization of JNA is a useful and cost-effective technique. We obtained good devascularization of tumor with reduced operative time and minimal blood loss. Availability of biplane angiography suite with road map technique helped in fine-tuning the technique we could embolize regions of tumor in spite of the tumor supplied by dangerous anastomotic channels.

KEY WORDS: Juvenile nasopharyngeal angiofibroma, percutaneous embolization

Paper 204 Starting at 11:33 AM, Ending at 11:41 AM
Withdrawn

Paper 205 Starting at 11:41 AM, Ending at 11:49 AM
Cystic Lymph Nodes In HPV Positive Oropharyngeal Cancer: CT Neck Study

Ahmed, M. · Smith, A. · Hoschar, A.
Cleveland Clinic Foundation
Cleveland, OH

PURPOSE
To study the prevalence and patterns of lymph nodes in HPV positive oropharyngeal squamous cell carcinoma and correlate to history of smoking and T-stage of the primary tumor.

MATERIALS & METHODS
All the squamous cell head and neck cancers which underwent in situ hybridization (ISH) for high risk HPV(16,18,31,33) were searched in the institution database system. Only oropharyngeal cancers and unknown primaries were included in the study. Consensus T-stage, surgically determined tumor origin and smoking history were noted from the patient’s medical records. Initial pretreatment CT soft tissue neck exams were reviewed. The lymph nodes were categorized into four subtypes: a) Simple cystic (unicystic smooth inner lining), b) Multicystic (smooth inner lining with more than 1 cyst or with septations), c) Complex cystic (does not meet the criteria for simple cystic or multicystic), and d) Solid lymph nodes (no cystic changes identifiable). Minimum size of the lymph node was 1.5 cm and lymph node criteria applied to the largest lymph node. The smoking history was divided into three groups: a) nonsmokers, b) smokers who quit > 15 years, and c) smokers in the last 15 years.

RESULTS
A total of 38 cases met the criteria. All except one case was positive for high risk HPV. Primary tumors were present in faucial tonsils (n = 20), base of tongue (n = 17) and one case was unknown primary. Four patients did not have imaging evidence of lymphadenopathy. The prevalence of different lymph nodes groups was the following: a) Simple cystic (n = 2), b) Multicystic (n = 11), c) Complex cystic (n = 17), and d) Solid (n = 4). The initial T-staging showed 65% of the cases as T1 and T2 while 35% were T3 and T4. Majority of the cystic lymph nodes (type a, b and c) had T1 or T1 stage at presentation, i.e., > 75% for cystic and complex cystic lymph nodes. Three cases did have grossly solid lymph nodes despite HPV positivity. One patient had cystic lymph nodes but high risk HPV was negative. Smoking history for each group was as follows: a) n - 10, b) n - 15, and c) n - 13.

CONCLUSION
There are various patterns of cystic lymph nodes in HPV + oropharyngeal cancer. Simple or unicystic lymph nodes (which can mimic branchial cleft cyst) are less common. The larger cystic lymph nodes suggest the early presentation and early T-stage of primary tumor. Gross cystic change may not be present in a small number of patients on CT imaging in HPV + cancers. Smoking history is a confounding factor with no clear relationship to the types of lymph nodes in the setting of HPV+ oropharyngeal cancer.

KEY WORDS: HPV, cystic, oropharynx

Paper 206 Starting at 11:49 AM, Ending at 11:57 AM
“Dark Halo Sign” on T1-Weighted Images: An Ominous Finding of Aggressive Sphenoid Sinusitis

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PURPOSE
MR imaging (MRI) studies of the brain often are performed in patients with headaches. MR imaging is also the imaging study of choice in patients with visual loss and diplopia. Opacification of the sphenoid sinus commonly is seen on routine sagittal T1 MR images and is usually of no significance. We report the “dark halo sign”, a rind of low T1 signal in the clivus bordering the posterior wall of the sphenoid sinus in conjunction with sphenoid sinus opacification as an indicator of clival osteitis caused by an aggressive fungal sinus infection requiring immediate surgical intervention.

MATERIALS & METHODS
The clinical histories and imaging findings of three patients who presented with severe headaches were reviewed. All three patients also presented with unilateral vision loss and diplopia. Noncontrast sagittal T1 image demonstrated a halo of hypointense T1 signal within the clivus bordering the opacified sphenoid sinus. CT demonstrated the halo corresponded to an area of sclerosis within the clivus consistent with osteitis. In all three patients, MRI also demonstrated an
infiltrative mass in the optic foramen and orbital apex. CT also demonstrated destruction of the lateral wall of the sphenoid sinus and invasion of the optic foramen and orbital apex.

RESULTS
One of these patients with visual loss also had a history of breast cancer and the findings were interpreted initially as metastatic disease as well as concomitant mucoperiosteal inflammation in the sphenoid sinus. Surgical debridement confirmed in all patients sphenoid fungal sinusitis with bone necrosis and no evidence of malignancy. The headaches resolved in two patients, but the visual loss was permanent in all three patients with one patient requiring enucleation.

CONCLUSION
In patients presenting with headaches with or without associated visual loss or diplopia, the combination of sphenoid sinus opacification and the “dark halo sign” in the clivus on the sagittal T1 images is consistent with an aggressive sinusitis and osteitis, most likely fungal, requiring immediate surgical debridement.

REFERENCES

KEY WORDS: Clival osteitis, sphenoid sinusitis, visual loss

Paper 207 Starting at 11:57 AM, Ending at 12:05 PM
Diffusion-Weighted MR Imaging Sequence to Rule out Recurrent Cholesteatoma and Avoid Unnecessary Second-Look Mastoidectomy

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1Assuta Medical Center, Tel-Aviv, ISRAEL, 2Sheba Medical Center, Ramat-Gan, ISRAEL

PURPOSE
To present our experience in using diffusion-weighted sequence MR imaging for diagnosis and follow up of recurrent cholesteatoma in patients who underwent mastoidectomy for cholesteatoma.

MATERIALS & METHODS
Thirty patients (19 female, age range 12-56 years) who had undergone mastoidectomy for cholesteatoma were referred for MR imaging to exclude recurrence. MR imaging was performed with a 1.5 T unit by using diffusion-weighted echo planar and nonecho planar imaging (SIMENS HASTE sequences), high-resolution T2-weighted imaging, FSE T2, unenhanced fat saturation T1-weighted SE imaging and delayed contrast material-enhanced fat saturation T1-weighted imaging.

RESULTS
The MR imaging diagnosis of recurrent cholesteatoma was confirmed at surgery in 10 patients and was not confirmed in one. The MR study was negative for presence of cholesteatoma in one patient and only chronic eustachitis was diagnosed during the endoscopic revision surgery in this case. Two patients with positive MR findings are scheduled for revision surgery in the near future, and since cholesteatoma had not been detected in the other 16 patients, they are scheduled for a repeated MR imaging 2 years after the first one. To date, our series demonstrated 10 true positive, one true negative and one false positive results.

CONCLUSION
Nonecho planar and echo planar diffusion-weighted MR imaging enables the depiction of recurrent cholesteatoma in patients who have undergone cholesteatoma surgery and helps in avoiding unnecessary revision/second look procedures.

KEY WORDS: DWI, cholesteatoma, second-look operation

Paper 208 Starting at 12:05 PM, Ending at 12:13 PM
Radiologic and Histopathologic Correlations in Clival Chordoma

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University of Pittsburgh
Pittsburgh, PA

PURPOSE
Chordomas are rare neoplasms thought to derive from notochordal remnants. They occur anywhere along the midline neuraxis but are encountered most frequently in the clivus. The classic MR appearance is an erosive midline mass with uniform T2 hyperintensity. The purpose of this study was to assess whether the MR features of clival chordomas correspond to their histopathologic characteristics.

MATERIALS & METHODS
We performed a retrospective review of the medical records at a large academic center to identify patients with clival chordoma who underwent MR imaging for local staging between 1997 and 2009. Under consensus review, two CAQ-certified neuroradiologists, with 9 and 5 years of experience interpreting skull base MR imaging, characterized the T1, T2, and diffusion-weighted signal intensities, as well as the contrast enhancement, of the lesions. Signal intensities were normalized to the pons and to cerebrospinal fluid. Preoperative and recurrent tumors were analyzed separately. A neuropathologist who was blinded to the radiologic appearance of the tumors characterized the resected specimens with particular attention to the myxoid content of the tumors and the percentage of physaliferous cells.

RESULTS
We identified 34 patients with preoperative MR imaging, and an additional 19 patients with recurrent tumors who had only postoperative imaging. Forty-three samples were available for histopathologic analysis. The imaging characteris-
tics in preoperative scans, along with the corresponding tissue myxoid content, are shown in the Table. Imaging characteristics of recurrent tumors did not significantly differ from preoperative characteristics. Myxoid tissue percentage was positively correlated with percentage of physaliferous cells \((r = .471, p = .002)\) and negatively correlated with contrast enhancement in preoperative scans \((r = -.571, p = .02)\). These correlations were not present, however, in recurrent tumors. On T2-weighted imaging, 87.9% of cases demonstrated signal intensity greater than the pons; of these, 55.2% were heterogeneous.

**KEY WORDS:** Chordoma, rad-path correlation, skull base neoplasm

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**Paper 209** Starting at 12:13 PM, Ending at 12:21 PM

**Can MR Replace the Need for CT in Evaluating Semicircular Canal Dehiscence? A Comparison Study between FIESTA MR Imaging and High Resolution CT of the Temporal Bone**

Browaeys, P.1, 2 · Larson, T. L.1 · Wong, M. L.4 · Patel, U.3

1University Hospital, Lausanne, SWITZERLAND, 2University of Washington, Seattle, WA, 3Seattle Radiologists, Seattle, WA, 4Washington Otolaryngology Group, Seattle, WA

**PURPOSE**

Patients with vertigo and symptoms of semicircular canal dehiscence currently are studied initially by both CT and MRI. Due to economic constraints favoring the ordering of one examination as well as concern for radiation exposure, we undertook this study to determine if MRI by itself would be sufficient.

**MATERIALS & METHODS**

One hundred twelve consecutive patients (224 ears) underwent concurrent MRI and high resolution CT of the temporal bones between Oct 2007 and Oct 2009. MR imaging protocol included an axial FIESTA acquisition (0.8 mm slice thickness, 0.4 mm spacing) covering the temporal bone (either on 3T or 1.5T). CTs were performed on a 64-row MDCT (0.625 mm axial and coronal). Patient data were anonymized. Dehiscence of superior and posterior semicircular canals (SSC and PSC) were evaluated, in consensus by two neuroradiologists, utilizing multiplanar reformation tools. FIESTA evaluation was performed for all patients on both ears. High resolution CT evaluation then was performed at least 2 weeks after, resulting in a blinded comparison of FIESTA MRI to CT.

**RESULTS**

For SSC dehiscence, FIESTA sensitivity was 100%, specificity was 97%, positive predicted value (PPV) was 61% and negative predictive value (NPV) was 100% in comparison to CT (Table 1). For PSC dehiscence, FIESTA sensitivity was 100%, specificity was 99%, PPV was 33% and NPV was 100% in comparison to CT (table 2).

<table>
<thead>
<tr>
<th>Dehiscence on CT</th>
<th>No dehiscence on CT</th>
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<tr>
<td>FIESTA sensitivity</td>
<td>100%</td>
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<tr>
<td>FIESTA specificity</td>
<td>97%</td>
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<tr>
<td>FIESTA PPV</td>
<td>61%</td>
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<td>FIESTA NPV</td>
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**CONCLUSION**

FIESTA MR acquisition, with sensitivity and NPV of 100%, is able to conclusively exclude SSC or PSC dehiscence. A negative MRI study precludes the need for CT imaging to detect semicircular canal dehiscence. Only patients with a positive MRI study should have further CT evaluation.

**KEY WORDS:** Semicircular canal dehiscence, FIESTA

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**Paper 210** Starting at 12:21 PM, Ending at 12:29 PM

**Inner Ear Imaging Findings in Patients with Sickle Cell Disease**

Saito, N.1 · Liao, J.2 · Watanabe, M.2 · Flower, E.3 · Nadgir, R.3 · Sakai, O.3

1Saitama International Medical Center, Saitama Medical University, Saitama, JAPAN, 2Boston University School of Medicine, Boston, MA, 3Boston Medical Center, Boston University School of Medicine, Boston, MA

**PURPOSE**

Sensorineural hearing loss (SNHL) is a well recognized complication of sickle cell disease (SCD) (1, 2). Additional inner ear complications of SCD include vestibular symptoms such as dizziness and vertigo. Labyrinthine hemorrhage and labyrinthitis ossificans have been reported in patients with SCD (3, 4); however, the prevalence of these imaging findings is unknown. The purpose of this study is to assess inner ear imaging findings and the prevalence of these findings in SCD patients.

**MATERIALS & METHODS**

Following IRB approval, clinical charts and imaging data of 91 SCD patients (43 males, 48 females) who underwent CT or MR imaging for a variety of clinical indications between January 2004 and December 2008 were evaluated retrospectively. Clinical symptoms/imaging indications, hemoglobin (Hb) genotype, past medical history and imaging findings were documented.
RESULTS
Of the 91 SCD patients studied, 17 patients (10-48 years old; 14 males, 3 females) were evaluated for inner ear complaints: SNHL (6 patients), dizziness (6), vertigo (5), and tinnitus (3). Imaging evaluations included temporal bone CT, temporal bone MR imaging, and routine brain CT and MR imaging. Using these imaging modalities, labyrinthine hemorrhage was identified in three patients (13-18 years old; 3 males) and labyrinthitis ossificans was identified in another three patients (12-26 years old; 2 males, 1 female). The patients with labyrinthine hemorrhage all had HbSC genotype while the patients with labyrinthitis ossificans consisted of HbSS (2) and HbS/ß-thalassemia (1) genotypes. Patients with labyrinthine hemorrhage presented with vestibular symptoms (2 with vertigo and 1 with dizziness), while the patients with labyrinthitis ossificans presented with SNHL. No imaging abnormalities were found in the remaining 11 patients.

CONCLUSION
Labyrinthine hemorrhage and labyrinthitis ossificans are not uncommon findings and can be seen in approximately one third of SCD patients with inner ear symptoms and preferentially affects males. Although these two pathologies were observed at similar prevalence rate, they exhibit unique disease patterns that differed primarily with Hb genotype and nature of inner ear dysfunction.

REFERENCES

KEY WORDS: Sickle cell disease, labyrinthine hemorrhage, labyrinthitis ossificans
received awards from American Society of Pediatric Neuroradiology and American Society for Sickle Cell Disease.

LEARNING OBJECTIVES
Upon completion of this presentation, participants will be able to:
1) Review the role of nonMR imaging in management of children with SCD.
2) Demonstrate utility of nonMR imaging modalities in screening of patients with SCD.
3) Contrast conventional TCD and imaging TCD.
4) Recommend an algorithm for neuroimaging patients with SCD in different settings.

PRESENTATION SUMMARY
Sickle cell disease (SCD) is a family of recessively inherited disorders of hemoglobin (Hb). Stroke and subclinical “silent infarcts” are major and frequent causes of morbidity in children with SCD. There is also a high risk of stroke recurrence that can be reduced but not eliminated by regular blood transfusion. Infarctive strokes are relatively more common in children than in adults while the reverse is true for hemorrhagic stroke. In patients with acute stroke the goal of neuroimaging such as computed tomography (CT), magnetic resonance (MR), positron emission tomography (PET), single photon emission CT (SPECT) and Transcranial Doppler ultrasonography (TCD) is to document whether the stroke is ischemic or hemorrhagic, to assess the extent of parenchymal abnormalities and to determine presence of cerebrovascular changes. However, initiation of neuroprotective therapy, including exchange transfusion therapy to minimize secondary brain damage and neutralize “ischemic cascade”, should not be delayed by arrangement for imaging studies. CT without contrast is the primary imaging modality for the assessment of acute stroke because of its 24/7 availability, ease of accessibility, and ability to exclude hemorrhagic causes. MR imaging (MRI) and MRA are recommended for better assessment of extent of infarction and demonstration of cerebrovascular abnormalities. In the case of hemorrhagic stroke, the goal is to identify with digital subtraction angiography (DSA) an arteriovenous malformation or aneurysm(s) amenable to surgery or catheter intervention. Exchange transfusion prior to invasive DSA is recommended. The risk of first stroke can be reduced substantially by chronic transfusions in asymptomatic children with SCD, in whom intracranial arterial mean velocities are over 200 cm/s on TCD examination. The ultimate goal is to preserve brain function and to prevent the progression of preclinical ischemia to permanent neuronal loss with disability. Large cerebral vessel disease detected by TCD can be confirmed or excluded by MRI/MRA, while those patients with high TCD velocity due to hyperemia can be studied additionally by conventional MRI or quantitative MRI. Those with evidence of parenchymal and/or cerebrovascular changes should be followed by preventive therapy. In patients with neurologic symptoms and negative MRI/MRA findings PET or SPECT is recommended. A study is needed, however, to determine cost-effectiveness of different neuroimaging modalities in the evaluation of symptomatic and asymptomatic patients with SCD and suspected stroke. There are no specific neuroimaging findings that can suggest that blood transfusions be safely halted in children with SCD.
Tuesday Afternoon
1:30 PM - 3:00 PM
Ballroom ABC

(21) ASFNR Programming: Adult (AR+)* SAM**

(214) Presurgical Brain Mapping (fMRI/DTI) for Adult Brain Lesions
— Jay Pillai, MD

(215) Perfusion/Diffusion in Adult Brain Tumors
— Meng Law, MD

(216) Perfusion/Diffusion in Cerebrovascular Diseases
— A. Gregory Sorensen, MD

Questions and Answers
Moderator: Scott H. Faro, MD

*An educational grant was received by Bayer Healthcare Pharmaceuticals, Inc. in support of the Audience Response Plus+ (AR+) technology in the Maintenance of Certification (MOC) Review Sessions.

**Session is under review as of April 6, 2010 by the American Board of Radiology to meet the criteria for self-assessment toward the purpose of fulfilling requirements in the ABR Maintenance of Certification. To obtain current SAM credit information, visit www.asnr.org.

Presurgical Brain Mapping (fMRI/DTI) for Adult Brain Lesions
Jay Pillai, MD

**LEARNING OBJECTIVES**
Upon completion of this presentation, participants will be able to:
1) Review the complementary roles of BOLD fMRI and DTI in presurgical mapping.
2) Illustrate the combined use of BOLD fMRI and DTI in patients with brain tumors and other resectable adult brain lesions.
3) Review some of the limitations of the techniques and how to reasonably overcome some of these limitations.

PRESENTATION SUMMARY
Blood oxygen level dependent (BOLD) fMRI and diffusion tensor imaging (DTI) play complementary roles in current state-of-the-art presurgical brain mapping. The combination of the two techniques provide for comprehensive mapping of language, sensorimotor and visual function by delineating both eloquent cortex and eloquent white matter tracts in the adult brain. Neurosurgeons consider this combined noninvasive mapping approach to be very valuable in their planning of surgical trajectory, extent of potentially complementary intraoperative mapping, and extent of necessary craniotomy exposure, as well as in their preoperative risk assessment and determination of extent of possible safe surgical lesion resection or biopsy. This lecture will explain both advantages and limitations of these techniques and demonstrate examples of how these techniques can be optimally utilized clinically.

Perfusion/Diffusion in Adult Brain Tumors
Meng Law, MD

**LEARNING OBJECTIVES**
Upon completion of this presentation, participants will be able to:
1) Describe the role of perfusion, permeability and diffusion imaging in adult brain tumors.
2) Evaluate the current literature and state of evidence of current and new methods available clinically and in the research settings for these techniques.
3) Assess the current and potential future role of these techniques in the post-therapeutic brain, particularly in the characterization of pseudo-phenomena.

PRESENTATION SUMMARY
The characterization of the intracranial mass lesion forms the bread and butter of daily neuroradiology practice. The application of perfusion, permeability and diffusion imaging techniques is becoming increasingly important in increasing our sensitivity, specificity and diagnostic confidence. Reliable imaging biomarkers of tumor biology, coupled with novel therapeutic agents which have resulted in new clinical challenges such as pseudoprogression and pseudoresponse have necessitated the utilization of more mechanistic techniques to aid in the therapeutic triage and management of brain tumor patients.

REFERENCES
Imaging of Sinonasal and Anterior Cranial Base Malignancies
Michelle A. Michel, PhD

LEARNING OBJECTIVES
Upon completion of this presentation, participants will be able to:
1) Review the epidemiology, etiologies, and classification, and current treatment of sinonasal malignancies.
2) Compare the roles of CT, MR, and PET imaging in the evaluation of sinonasal malignancy.
3) Cite the characteristic imaging features of a variety of sinonasal neoplasms and be able to describe involvement of adjacent anatomical structures, including the anterior skull base, by these lesions.
4) Identify contemporary staging of squamous cell carcinoma of the maxillary sinus and ethmoid sinuses.

PRESENTATION SUMMARY
Although sinonasal malignancies are rare and they account for less than 1% of cancer deaths in western countries, these tumors arise in a complex anatomical location and are histologically diverse. In addition to new histologic and clinical classifications, the last decade has brought new insights into the etiological risk factors, tumor biology, and therapeutic options of these lesions. Sinonasal malignancies have a poor prognosis and many present at an advance stage. Diagnosis may be delayed because symptoms often mimic those of chronic rhinosinusitis, they generally present with little pain, and there is space for tumor growth within the sinus lumen. Larger sinonasal neoplasms may extend into adjacent compartments including the anterior cranial fossa. It is important to define the location of origin for lesions involving the anterior skull base as they may arise from above, from below, or within the skull base. Epithelial tumors account for the majority of sinonasal malignancies. Malignancies of bone and cartilage include osteosarcoma, chondrosarcoma, malignant giant cell tumor, and Ewing sarcoma. Esthesioneuroblastoma, mucosal melanoma, and lymphomas are uncommon, but may have characteristic features that help to distinguish them from other lesions. CT and MR imaging are the modalities of choice for imaging neoplasms of the sinonasal cavities. CT demonstrates bony remodeling or destruction, identifies intratumoral calcification, demonstrates the matrix of cartilaginous and osseous neoplasms, and delineates obstruction of sinus drainage pathways. MR imaging is superior for distinguishing tumor margins from obstructed secretions; for delineating extension of tumor into the infratemporal fossa, orbit, and intracranial cavities; for detecting perineural tumor spread; and for demonstrating the vascularity of neoplasms. PET imaging may be useful in a number of roles. Paranasal sinus cancers are staged using the American Joint Committee on Cancer (AJCC) TNM system. Treatment options vary depending upon several factors including tumor histology, tumor extent and involvement of critical anatomical structures, presence of distant metastases, and the patient’s general condition. Surgical resection and radiation therapy are the most common treatment options.

REFERENCES

Imaging of Nasopharynx and Central Skull Base Malignancy
Nancy J. Fischbein, MD

LEARNING OBJECTIVES
Upon completion of this presentation, participants will be able to:
1) Review the complex anatomy of the nasopharynx and central skull base as it relates to malignant tumors in the region.
2) Demonstrate common and uncommon nasopharyngeal and central skull base malignancies.
3) Identify pitfalls and “don’t touch” lesions in this region.
PRESENTATION SUMMARY
We will begin with a brief review of the complex anatomy of the nasopharynx and central skull base, with an emphasis on skull base foramina and the often complementary roles of CT and MR imaging. We then will discuss key imaging points related to nasopharyngeal carcinoma (NPC), and we will review the T staging of nasopharyngeal carcinoma with an update from the new 7th edition of the AJCC Cancer Staging Manual. Malignancies other than NPC that can affect the nasopharynx also will be discussed. Malignancies of the central skull base then will be reviewed, including those primary to the central skull base and those that extend to the central skull base from either an extracranial or an intracranial location, such as the cavernous sinus. We will conclude our discussion with illustrations of benign and/or “don’t touch” entities that can affect the central skull base and that should be recognized in order to avoid a potentially dangerous biopsy of such a lesion.

REFERENCES

Imaging of Temporal Bone and Periauricular Cancer
C. Douglas Phillips, MD, FACR

LEARNING OBJECTIVES
Upon completion of this presentation, participants will be able to:
1) Identify benign and malignant disease of the temporal bone.
2) Review the appearance of common and some uncommon lesions of the temporal bone.
3) Demonstrate CT and MR appearances of these lesions.

PRESENTATION SUMMARY
This presentation will cover primary benign and malignant disease of the temporal bone, and also neoplasms which arise in the periauricular region. Cross sectional imaging of these diseases, and characteristic appearance will be depicted.

Tuesday Afternoon
1:30 PM - 3:00 PM
Room 208

(23) Synaptic Junction Programming - Lecture: Making the Reading Room More Pleasant

— Barton F. Branstetter IV, MD

(220) How to Get Speech Recognition that Actually Works

— Barton F. Branstetter IV, MD

(221) Make Yourself Comfortable! The Importance of Ergonomics

— Eliot J. Siegel, MD

How to Get Speech Recognition that Actually Works
Barton F. Branstetter IV, MD

LEARNING OBJECTIVES
Upon completion of this presentation, participants will be able to:
1) Describe the components of a speech recognition system.
2) Identify speech recognition features critical to success in neuroradiology.
3) Summarize key ergonomic factors that affect radiologist comfort and performance in the reading room.

PRESENTATION SUMMARY
Radiologists spend 8 hours a day sitting in front of a computer, interpreting digital images. Thus, a small effort spent on improving the reading room environment can have a dramatic long-term impact on comfort and morale. In this two-part session, we will focus first on ways to improve speech recognition (both purchasing a good system and making good use of a purchased system) and then focus on ergonomics that can improve your comfort in the reading room.

Make Yourself Comfortable! The Importance of Ergonomics
Eliot J. Siegel, MD
β-Amyloid Binding on PET Imaging Correlated with Volumetric Analysis in Alzheimer Disease and Mild Cognitive Impairment Patients

Hardin, V. · Bonilha, L. · Roberts, D. R. · Spicer, K.
Medical University of South Carolina
Charleston, SC

PURPOSE
In vivo detection of amyloid plaques using positron emission tomography (PET) would be useful as a biomarker for early diagnosis and monitoring of Alzheimer disease (AD) and mild cognitive impairment (MCI). We correlated binding of a novel radiolabeled compound that specifically and sensitively binds β-amyloid (18F-AV-45; Avid Radiopharmaceuticals, Philadelphia, PA) with volumetric analysis.

MATERIALS & METHODS
Twelve subjects who were enrolled in an ongoing clinical trial at our institution and had provided informed consent underwent 18F-AV-45 PET imaging and volumetric MR imaging. The subjects also underwent a neuropsychologic battery including the Mini-Mental State Examination (MMSE) and Clinical Dementia Rating (CDR). These scores were interpreted as MMSE score (10 - 24 = AD; 24 to 28 = MCI and > 28 = Normal) and CDR (greater than 0.5 to 1 = AD; 0.5 = MCI and less than 0.5 = Normal). Based on CDR scores, six of 12 subjects were classified as Alzheimer patients. Subjects underwent high-resolution MRI in a Siemens 1.5T scanner including T1-weighted images with 1 mm isotropic voxels. Probabilistic maps of gray matter (GM) volume were computed with voxel-based morphometry (VBM5 toolbox; http://dbm.neuro.unijena.de/vbm/). Significance was determined with a Wilcoxon signed-rank test-based test.

RESULTS
A significant negative correlation, with correction for multiple comparisons, of GM volume with MMSE score is highlighted in Figure 1. The color bar displays the z-score. A significant difference between the MCI group and the AD group (based on CDR score) also was found for mesial temporal and parietal cortex (figure not shown). We then compared 18F-AV-45 binding across groups (MCI versus AD). Highlighted in Figure 2 are locations of significantly greater binding in patients with AD compared with MCI patients. Figure 2 shows differences overlaid onto the PET study from an individual but represents group differences.

CONCLUSION
A novel β-amyloid binding compound (18F-AV-45) shows greater binding in AD vs MCI patients involving areas of the medial temporal lobe and parietal cortex.

KEY WORDS: Alzheimer disease, voxel-based morphometry, PET
diagnostic marker

PURPOSE

1 Stanford University Medical Center, Stanford, CA, MR imaging as small hypointense foci in animal models and development of Alzheimer disease (AD), are detectable with $\beta$-amyloid plaques, which may have an important role in the

Zeineh, M. M.1 · Kitzler, H.2 · Rutt, B. K.1 · Atlas, S. W.1

Zeineh, M. M.1 · Kitzler, H.2 · Rutt, B. K.1 · Atlas, S. W.1

1 Stanford University Medical Center, Stanford, CA, 2 Technische Universität Dresden, Dresden, GERMANY

CONCLUSION

These results demonstrate that automated MRI measurements of cortical thickness and volume predict the time to progress from MCI to AD, demonstrate excellent consistency across multiple cohorts, and exhibit a significant advantage when compared to neuropsychologic and clinical assessments alone for predicting disease progression. Taken together, these findings indicate the importance of using automated MRI-based software tools as a predictive marker for Alzheimer disease.

KEY WORDS: Neuroimaging, neurodegenerative disease, diagnostic marker

Effect of Field Strength and Susceptibility-Weighted Imaging Processing on Alzheimer Plaque Detection in Human Brain Specimens

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1 Stanford University Medical Center, Stanford, CA, 2 Technische Universität Dresden, Dresden, GERMANY

Purpose

$\beta$-amyloid plaques, which may have an important role in the development of Alzheimer disease (AD), are detectable with MR imaging as small hypointense foci in animal models and ex vivo human specimens. The underlying cause of the signal change may be the iron within the $\beta$-amyloid plaques. Iron results in signal loss that increases with field strength on magnitude images. To investigate this phenomenon, we imaged human AD brain specimens at 3 T and 7 T with balanced steady-state free processing imaging (bSSFP). Iron also elicits differences in signal phase best demonstrated by susceptibility-weighted imaging (SWI). To explore this effect, we compared 7 T GRE imaging with and without SWI processing.

Materials & Methods

Five AD and five normal formalin-fixed human brain specimens were obtained. Each consisted of 3 cm square 4 mm thick tissue slabs immersed in Fluorinert in a 4 cm diameter sealed container. These were scanned with size-matched transmit/receive solenoid coils at 3 T/7 T using a modified bSSFP sequence. To predict the SNR ratio between 3 T/7 T, we measured $T_1$ and $T_2$ at 3 T and 7 T in white and gray matter from one AD and one control specimens using IR-FSE and SE sequences, respectively, and computed the signal ratio using the bSSFP signal equation. 7 T GRE imaging was performed on one AD specimen with subsequent SWI processing. Quantitative data analysis on signal voids which presumably represent plaques was performed.

RESULTS

$T_1$ increased by roughly 70% in moving from 3 T to 7 T, while $T_2$ decreased by 20-30%. Predicted and measured FIESTA hippocampal SNR was 77% and 70% higher at 7 T compared to 3 T, respectively. Importantly, presumed plaque CNR was 3 times higher at 7 T compared to 3 T, which reflects the combined effects of increased SNR and plaque contrast. Susceptibility-weighted imaging performed on the GRE images demonstrated plaque contrast increased by 10% compared to the unprocessed GRE images.

Conclusion

Signal to noise ratio increased less than linearly with field strength from 3 T to 7 T because of the increasing $T_1$ and decreasing $T_2$. Nevertheless, CNR increased more than linearly with field strength, possibly the result of the iron con-
tent of the \( \beta \)-amyloid plaques. Similarly, plaque contrast increased with SWI processing, emphasizing the likely contribution of signal phase to microscopic iron. Future studies will include correlation with pathologic analysis of these specimens to confirm the iron content hypothesis. We conclude that combined 7 T MRI and SWI processing offers striking benefits for presumably iron-based amyloid plaque detection.

Acknowledgments: GE Healthcare, RSNA

**KEY WORDS:** Alzheimer, susceptibility, 7 T

**Paper 225 Starting at 3:54 PM, Ending at 4:02 PM**

**Arterial Spin Labeling MR Imaging Detects Perfusion Differences in Cognitively Normal ApoE2 and ApoE4 Carriers: A Possible Explanation for Alzheimer Protection vs Risk**

Chiang, G. C.1,2 · Tosun, D.1,2 · Mueller, S.1,2 · Zhang, Y.1,2 · Ching, C.2 · Schuff, N.1,2 · Weiner, M. W.1,2

1University of California, San Francisco, CA, 2Veteran Affairs Medical Center, San Francisco, CA

**PURPOSE**

The apolipoprotein E4 (ApoE4) genotype increases risk for Alzheimer disease (AD). FDG-PET and fMRI studies have described reduced glucose metabolism in the posterior cingulate, precuneus, parietotemporal lobes, and frontal cortex among cognitively normal ApoE4 carriers, a pattern similar to that seen in Alzheimer disease. On the other hand, the ApoE2 genotype is considered protective against AD, but no known studies have characterized functional changes associated with this genotype. In this arterial spin labeling MR imaging (ASL-MRI) study, we hypothesized that ApoE4 carriers would have decreased perfusion in the aforementioned brain regions relative to ApoE3 controls, and ApoE2 carriers would have comparably increased perfusion.

**MATERIALS & METHODS**

Forty-six individuals underwent ASL-MR imaging on a 4 T Bruker/Siemens system: ApoE2/3 genotype (n = 10, median age = 66.5 ± 11.5 years, median MMSE = 30 ± 0.70), ApoE3/3 (n = 23, median age = 69 ± 9.1 years, median MMSE = 30 ± 0.72), ApoE3/4 (n = 13, median age = 63 ± 13.2 years, median MMSE = 30 ± 0.60). There were no group differences in age, gender, or MMSE (p >> 0.05, Kruskal-Wallis, Fisher’s Exact). Labeled ASL images were subtracted from unlabeled images to obtain the perfusion-weighted image. After partial volume correction, perfusion-weighted images were spatially normalized to a study-specific template, derived from spatially normalizing the T1 images of 28 ApoE3/3 controls. Images were smoothed with an 8 mm\(^3\) Gaussian kernel. Regional perfusion was assessed voxel-by-voxel, as implemented by SPM2. A linear regression model with age as a covariate was used to assess for statistical differences between ApoE2 and ApoE3 and between ApoE3 and ApoE4 (Puncorrected< 0.005).

**RESULTS**

Consistent with our apriori hypothesis, ApoE2 carriers had increased perfusion in the posterior cingulate, left orbital gyri, and left anterior temporal lobe, relative to the ApoE3 carriers (Figure A), regions typically involved in AD. ApoE2 carriers had decreased perfusion in the bilateral insular cortex, medial thalami, anterior cingulate, and a few frontoparietal regions compared to ApoE3/3 controls. ApoE4 carriers demonstrated decreased perfusion in the anterior cingulate, precuneus, right inferior frontal cortex, and a few parietotemporal regions compared to ApoE3 carriers (Figure B), consistent with the literature. In contrast, ApoE4 carriers had increased perfusion in the left subinsular cortex relative to ApoE3/3 carriers.

**CONCLUSION**

This is the first report of increased perfusion in ApoE2 carriers relative to ApoE3/3 subjects and is consistent with prior reports suggesting that ApoE2 is protective against development of AD. Furthermore, this is the first report of decreased perfusion in normal ApoE4 carriers, consistent with prior FDG-PET findings. These results suggest that ASL perfusion MRI provides similar information to PET in assessing AD risk.

**KEY WORDS:** Alzheimer disease, apolipoprotein, perfusion

**Paper 226 Starting at 4:02 PM, Ending at 4:10 PM**

**Apolipoprotein E Genotype and Regional Gray Matter Volume Loss in Mild Cognitive Impairment and Alzheimer Disease**

Spampinato, M. · Thampy, R. · Rumboldt, Z.

Medical University of South Carolina Charleston, SC

**PURPOSE**

Apolipoprotein E epsilon4 (apoE4) has been strongly linked with Alzheimer disease (AD). We assessed the relationship between apoE4, regional gray matter (GM) volume loss and disease severity in patients with newly diagnosed AD and stable mild cognitive impairment (MCI) using voxel-based morphometry.
RESULTS

There were no differences in cognitive profile between apoE4-positive and apoE4-negative subjects in each group. ApoE4 carriers who converted from MCI to AD showed significant GM volume loss in the hippocampi, temporal neocortex, parietal lobes, caudate nuclei, and insulae. In apoE4 carriers with stable MCI GM volume loss was observed in the bilateral frontal and temporal lobes. There were no significant changes in GM volume in noncarriers of the apoE4 allele in each group.

CONCLUSION

ApoE4 carriers with cognitive decline undergo faster GM atrophy than noncarriers. The involvement of apoE4 in the progression of hippocampal/neocortical atrophy has potential important implications for therapeutic approaches in AD and should be taken into consideration in clinical trials.

KEY WORDS: Alzheimer disease, mild cognitive impairment, voxel-based morphometry

Paper 227 Starting at 4:10 PM, Ending at 4:18 PM

Pulvinar Hypointensity on MR Images of Patients with Alzheimer Dementia: A New FLAIR Finding and Its Possible Association with Iron Accumulation as Evidenced by a T2* Map

Moon, W. · Choi, J. · Roh, H. · Han, S.
Konkuk University Medical Center
Seoul, KOREA, REPUBLIC OF

PURPOSE

To describe a new finding of pulvinar (PUL) hypointensity on FLAIR in patients with Alzheimer dementia (AD) at 3.0 T GE MR imaging, and to determine if PUL hypointensity is associated with brain iron accumulation using a T2* map.

MATERIALS & METHODS

Twenty-one consecutive patients with AD and 21 age-matched control subjects were reviewed prospectively for the presence of PUL hypointensity on FLAIR. Pulvinar signal intensity was rated according to the presence of hypointensity relative to normal white matter. Pul-putamen-to-CC (PUL/CC) and globus pallidus-to-CC (GP/CC) signal intensity ratios were measured for comparison. T2* was calculated from a T2* map using a single-shot EPI T2* sequence with multiple echoes. The measurement differences between the two groups were analyzed by a paired t-test. A correlation of the measurements with the Mini-Mental State Examination (MMSE) score and age was obtained with the Pearson correlation test.

RESULTS

As compared to normal white matter, the FLAIR signal intensity of the pulvinar was significantly more hypointense in AD patients than in control subjects (p < 0.01). The PUL/CC ratio was smaller in AD patients than in control subjects (p < 0.01). Although the PUT/CC ratio was decreased significantly in AD patients as compared to control subjects (p < 0.01), the GP/CC ratio was not significantly different between the two groups (p = 0.09). Pulvinar T2* was 52.25 ± 4.97 ms in AD patients versus 55.69 ± 5.65 ms in control subjects (p < 0.05). When the control and AD groups were combined, the PUL/CC and PUT/CC ratios had a positive correlation with age (r = 0.319, p = 0.020 and r = 0.317, p = 0.021, respectively). Controlling for age, however, only the PUL/CC ratio was positively correlated with the MMSE score (r = 0.303, p < 0.05), suggesting a disease effect. PUL T2* tended to decrease as the MMSE score decreased (r = 0.186, p = 0.122).

CONCLUSION

Pulvinar hypointensity is a new imaging finding for AD patients representing PUL neurodegeneration. This finding may be explained by iron accumulation in the thalamic PUL, as evidenced by a T2* map.

KEY WORDS: Alzheimer dementia, T2* map, neurodegeneration
POSTMORTEM T2 VALUES IN WHITE MATTER NEAR THE ANTERIOR AND POSTERIOR HORNS OF THE LATERAL VENTRICLES WERE SIGNIFICANTLY PROLONGED BY 10-20 MS IN THE GROUP OF HEMISPHERES WITH HIGH LIKELIHOOD OF AD COMPARED TO BOTH THE INTERMEDIATE AND LOW LIKELIHOOD GROUPS (FIGURE). ADDITIONALLY, THE T2 IN THE GLOBUS PALLIDUS WAS SHORTENED SIGNIFICANTLY IN THE GROUP WITH HIGH LIKELIHOOD FOR AD. THE DIFFERENCES IN T2 WERE LESS SIGNIFICANT BETWEEN THE INTERMEDIATE AND LOW GROUPS.

CONCLUSION
The significant increase in T2 in the group with high likelihood of AD, as indicated by the NIA-Reagan criteria, occurred in periventricular regions, frequently affected by white matter hyperintensities (WMH). Furthermore, the significant reduction in T2 in the globus pallidus may be due to increased levels of iron implicated in the pathophysiology of AD3. This work shows that postmortem MR imaging is sensitive to this type of pathology.

REFERENCES

KEY WORDS: Postmortem, MR imaging, Alzheimer disease

Functional imaging of the “default mode network” using fMRI has identified changes in the coordinated activity of large-scale brain networks in early AD (1), but changes in the underlying white matter pathways interconnecting these networks remain poorly understood. The goal of this work was to compare measures of cortical connectivity in brain networks (2-4) constructed using diffusion MRI and probabilistic tractography in a small cohort of healthy elders and subjects with mild AD.

MATERIALS & METHODS
Age-matched controls (N = 10) and subjects with mild AD (N = 10) both underwent whole-brain structural and diffusion MRI on a 3 T EXCITE scanner using an 8-channel phased-array head coil (GE Healthcare, Waukesha, WI) according to an IRB-approved protocol. Volumetric T1 SPGR images were acquired at 1.0 mm isotropic voxel resolution (TR/TE = 7.6/2.9 msec, NEX = 1), and a customized spin-echo echo planar DTI sequence was used to acquire data at 2.0 mm isotropic resolution (TR/TE = 11200/64 msec, NEX = 1, 55 directions, b = 1000 s/mm2). Using the anatomical images as an intermediate, a template of gray matter structures (5) was superimposed onto the diffusion data by nonrigid registration. The entire cortex thus was parcellated into 39 regions per hemisphere, each serving as a network node. The connectivity between nodes then was calculated from the diffusion data using probabilistic tractography (FSL, Oxford, UK). Topologic parameters of the resulting networks, including sparsity, mean clustering coefficient (MCC), characteristic path length (CPL), and node and edge betweenness centrality were calculated using MatlabBGL. Group parameters were compared using two-tailed t-tests.

RESULTS
As has been reported (2-4), we consistently observed “small world” network properties in both healthy elders and patients with mild AD (high MCC and low CPL). There was a trend towards increasing network sparsity in the group with mild AD, although this was not significant (9.7 +/- 0.9% vs 10.8 +/- 0.5%). Characteristic path length was significantly higher in the AD group (2.85 +/- 0.09 vs 2.71 +/- 0.05), with no significant difference in MCC. Nodes with the highest betweenness centrality, which have been described previously as “hubs”, were observed in the parietal lobes of all subjects. Betweenness centrality was smaller for these nodes in the AD group than in healthy elders.

CONCLUSION
Networks derived using diffusion MRI show a similar loss of “small world” characteristics in AD as has been described previously for networks constructed using EEG, MEG and fMRI. More work is necessary to determine how structure and function are integrated at the network level in dementia, and whether using an automated strategy for network analysis may ultimately improve diagnostic sensitivity for the individual patient.

REFERENCES

KEY WORDS: Alzheimer, dementia, diffusion
Apathy and Cognitive Impairment in Multiple Sclerosis: Correlation with Diffusion Tensor Imaging Metrics

Lerner, A. · Berkovich, R. · Frech, P. · Rajderkar, D. · Habibi, M. · Shirioishi, M. S. · Mogensen, M. A. · Kim, P. E. · Go, J. L. · Boyko, O. B. · Zee, C. S. · Law, M.

University of Southern California
Los Angeles, CA

PURPOSE
Cognitive impairments only recently have attracted attention as a common symptom of multiple sclerosis (MS), with prevalence rates ranging from 43% to 70%. Multiple sclerosis affects various aspects of cognitive functioning, including attention, executive functions, immediate memory (visual and verbal) and information processing speed. Neuropsychiatric and behavioral symptoms in MS include depression (most commonly reported symptom), dysphoria, agitation, anxiety, apathy, euphoria, disinhibition, personality syndromes, and eating disorders. These clinical manifestations of MS do not correlate well with conventional MR imaging (MRI) evaluation of MS. Evaluation and early diagnosis of neuropsychiatric and behavioral symptoms is paramount for better management and prognosis of MS and alternative imaging techniques that correlate better with these symptoms are needed. The purpose of this study is to correlate the presence and severity of apathy and cognitive symptoms in multiple sclerosis patients with regional differences in cerebral DTI metrics.

MATERIALS & METHODS
We performed a retrospective review of 16 patients, diagnosed with clinically definite multiple sclerosis. Patients underwent clinical assessment of cognitive impairment (CI), apathy using Apathy Evaluation Scale, and disability using EDSS. The patients also underwent diffusion tensor imaging of the brain using six noncollinear axes following acquisition of conventional MRI. The data were postprocessed on the Advantage Workstation using GE Func tool software. Fractional anisotropy (FA) and mean diffusivity (MD) were measured with regions of interest (ROIs) placed in normal-appearing brain in the following locations: genu, body, and splenium of the corpus callosum, frontal lobe white matter, temporal lobe white matter, head of the caudate nucleus, cingulum, sagittal stratum, and external capsule. Measurements were obtained bilaterally within these locations with the exception of corpus callosum. We then compared and correlated these neuropsychiatric and cognitive measures with DTI metrics of FA and MD in specific regions of interest within the brain.

RESULTS
Decreased FA values in the left frontal lobe white matter correlated with increased clinical apathy, increased disability scores and cognitive impairment. There were also significant differences in FA in the external capsular regions of white matter. Diffusion tensor imaging metrics of the head of the caudate nucleus, cingulum, and sagittal stratum revealed no significant correlation with apathy and cognitive impairment.

CONCLUSION
Apathy and cognitive dysfunction in MS may result from derangement of the microarchitecture of the white matter of the left frontal lobe. Fractional anisotropy and MD values in the left frontal lobe normal-appearing white matter may be useful in evaluation and early diagnosis of neuropsychiatric and behavioral symptoms in MS.

KEY WORDS: Multiple sclerosis, apathy and cognitive impairment, diffusion tensor imaging

Diffusional Kurtosis Imaging in Patients with Multiple Sclerosis
Bester, M. · Raz, E. · Jensen, J. H. · Tabesh, A. · Grossman, R. I. · Inglese, M.
1University Hamburg-Eppendorf, Hamburg, GERMANY, 2New York University, New York, NY, 3Sapienza University, Rome, ITALY

PURPOSE
Pathologic studies have shown early involvement of gray matter (GM) structures in multiple sclerosis (MS); however, GM lesions are difficult to detect with conventional MR imaging (MRI). Quantitative metrics derived from diffusion tensor imaging (DTI) are sensitive to tissue damage in the normal-appearing GM (NAGM) in MS, but DTI might be of limited utility in GM because of highly isotropic diffusion properties of this tissue. Diffusional kurtosis imaging (DKI), a new MR imaging method that allows the non-Gaussianity of water diffusion to be quantified, and its derived averaged kurtosis coefficient - mean kurtosis (MK) - has been shown to be sensitive to structural changes in isotropic tissue such as GM. Mean kurtosis can be regarded as an index of tissue microstructural complexity. Our aim was to investigate: GM abnormalities in MS using MK and DTI measures; the association among GM-MK, white matter lesions and conventional MRI measures of volume.

MATERIALS & METHODS
Twenty-nine patients with relapsing-remitting MS (mean age 39 ± 9 years; mean disease duration 3.6 ± 4.2; median expanded disability status scale: 2.0, range 0-5) and 14 healthy controls (mean age 38 ± 12 years) underwent MRI on a 3 T magnet (Siemens, Erlangen, Germany). The MRI protocol included: T2-TSE, 3D-T1-MPRAGE, and twice-refocused spin-echo (TRSE) diffusion for DKI. The DKI parameters were: 30 diffusion encoding directions, 3 b-values for each direction, TR = 3700 ms, TE = 96 ms, FOV = 222 × 222 mm2, matrix size = 82 × 82, slice thickness = 2.7 mm. Diffusion tensor imaging and DKI maps were calculated using an in-house developed software. The mean MK, MD and FA of lesions, NAGM, NAWM with lesions and NAWM without lesions were measured using histogram analysis. Normalized brain volume (NBV), GM volume (GMV), and WM volume (WMV) were assessed on MPRAGE images using SIENAX.

RESULTS
In GM, a significant decrease of MK (0.70 vs 0.73; p = 0.009) and FA (0.13 vs 0.14; p = 0.014) and increase of MD (1.18 vs 1.10 mm2/s * 10-3; p = 0.009) was found in patients compared to controls. In NAWM with lesions and NAWM
without lesions, FA was lower (0.28 vs 0.30; p < 0.001), whereas MD and MK did not show a significant difference when patients were compared to controls. No correlation was found among GM-MK, GM-MD and GM-FA. Gray matter volume and WMV showed a negative correlation with GM MD (r = -0.3, p = 0.045; r = -0.3, p = 0.007) but not with GM-MK and GM-FA (p = 0.1). T2LV and T1LV were correlated with GM-MD (r = 0.7, p < 0.001, r = 0.73, p < 0.001) but not with GM-MK and GM-FA (p = 0.1). NAWM-FA was correlated with GM-MD (r = -0.3, p = 0.015) and GM-FA (r = -0.3, p = 0.04) but not with GM-MK (p = 0.1). Lesion-MD was correlated with GM-MK (r = -0.4, p = 0.011) and GM-MD (r = 0.5, p = 0.002). Lesion-MK was correlated with GM-MK (r = 0.6, p < 0.001) and GM-MD (r = -0.4, p = 0.016).

**CONCLUSION**

Our study suggests that DKI can provide information about brain tissue microstructure which is complementary to that DTI-derived metrics, especially with respect to highly isotropic tissue such as GM. The GM abnormalities are, at least in part, associated with the severity of intrinsic lesion damage rather than with lesion volume.

**KEY WORDS:** Multiple sclerosis, Diffusion kurtosis imaging, gray matter

**Paper 232 Starting at 4:50 PM, Ending at 4:58 PM**

**MR Imaging and Clinical Follow-Up Data on Patients with Clinically Isolated Syndrome**

Rovira, A. · Auger, C. · Tintore, M. · Mitjana, R. · Sastre-Garriga, J. · Huerga, E. · Montalban, X.

Hospital Vall d’Hebron
Barcelona, SPAIN

**PURPOSE**

Natural history studies have demonstrated that patients who have a clinically isolated syndrome (CIS) attributable to a monofocal or multifocal CNS demyelinating lesion and brain lesions consistent with demyelination on MR imaging (MRI) have an 88% chance of developing clinically definite MS (CDMS) over the subsequent 14 years, as compared with 19% of such patients with normal brain MRI findings (1). However these studies were initiated more than 20 years ago, when brain MR studies were obtained with low field magnets and low resolution images, factors that could limit the sensitivity of MRI in showing central nervous system demyelinating lesions. The purpose of this study is to present longitudinal MRI and clinical data on patients who presented with a CIS in whom a baseline and 1-year brain MR scan, obtained under a standardized protocol using high-resolution images and high field magnets (1.5 T), was obtained.

**MATERIALS & METHODS**

From July 2001 to April 2009, patients with CIS within 3 months of symptoms onset were included in a prospective study. A subgroup of these patients were selected for the present study if fulfilled the following inclusion criteria: (1) age between 14 and 50 years; (2) availability of two comparable brain MR examinations, the first within the first 3-5 months, and the second 12 months after CIS onset; and (3) minimum clinical follow up of 24 months after CIS onset. In these MR exams the presence of subclinical T2 lesions, number of Barkhof criteria, and number of new T2 lesions (on the follow-up scan) were assessed.

**RESULTS**

One hundred and ninety-eight patients were included in this study (mean age: 30.6 years; female-to-male ratio: 2.47). At baseline MRI, 47 patients (24%) showed no subclinical lesions (group A), 21 patients (11%) showed subclinical lesions but without fulfilling any of the Barkhof criteria (group B), and 130 patients (66%) fulfilled at least one of the Barkhof criteria (group C). Patients in group A presented more frequently with optic neuritis (49%) as compared to those included in groups B (33%) and C (30%). In the follow-up brain MRI two patients of group A (4%) showed new T2 lesions on the follow-up brain MRI, while this occurred in six patients included in group B (29%), and in 83 patients in group C (71%). Conversion to clinically definite MS after 2 years of follow up was observed in three patients in group A (6%); in one patients in group B (6%); and in 66 patients in group C (50%).

**CONCLUSION**

Compared to previous natural history studies, the present study shows higher sensitivity in demonstrating subclinical demyelinating lesions in patients with CIS, which can be explained easily by MRI technical improvements. Despite this fact, normal brain MRI at CIS presentation does not exclude the risk of early development of clinically definite MS.

**REFERENCES**


**KEY WORDS:** Multiple sclerosis, MR imaging, clinically isolated syndrome

**Tuesday Afternoon**

3:30 PM – 5:00 PM

Room 302-304-306

(24b) Adult Brain: Cerebrovascular Occlusive Disease II (Scientific Papers 233 - 243)

*See also Parallel Sessions*

(24a) Adult Brain: Alzheimers/Demyelinating
(24c) Head And Neck: Anatomy, Face, Orbit and Congenital
(24d) Pediatric: New Techniques & Other
(24e) Excerpta Extraordinaire: Adult Brain

Moderators: Robert W. Tarr, MD
Ronald L. Wolf, MD, PhD
Can Location of Evolving Infarction and Arterial Occlusion Predict Perfusion-Weighted and Diffusion-Weighted Imaging Changes after Endovascular Therapy?

Samim, M. M. · Liebeskind, D. S. · Saver, J. L. · Salamon, N.
David Geffen School of Medicine, University of California Los Angeles Los Angeles, CA

PURPOSE
To determine whether pretreatment (1) deep and/or superficial MCA territory infarction and (2) anatomical location of arterial occlusion are predictive of therapeutic response to endovascular therapy for acute ischemic stroke.

MATERIALS & METHODS
We analyzed 103 consecutive MCA stroke patients who presented to an academic stroke center and underwent mechanical thrombectomy within 8 hours of stroke onset between August 2002 and 2008. Perfusion-weighted imaging (PWI) and diffusion-weighted imaging (DWI) lesion volumes at baseline prior to angiography and within 24 hours after revascularization were measured using the Mirada fusion program with a Vitrea workstation. We divided cases into three categories based on anatomical location of the pretreatment DWI abnormality: (1) superficial MCA territory (SUP), (2) deep including basal ganglia and periventricular white matter (BG), and (3) mixed lesions (MIX). Volume and intensity for the lesions in each category were measured and compared with the posttreatment volume. Cases also were categorized by site of arterial occlusion: (1) occlusion at or proximal to the terminal ICA bifurcation (ICA) and (2) occlusion in M1 segment or distal (M1). Differences between groups were evaluated using a two-tailed t-test and one-way ANOVA.

RESULTS
Sixty-six patients had both pre and posttreatment MR imaging within 48 hours of stroke onset. Only one patient had proximal ICA occlusion with SUP only infarction. Recanalization was complete in 12% of ICA and 24% of M1 and was partial in 66% and 62%, respectively. The most significant increase in DWI and ADC abnormality and most pronounced decrease in PWI volume was seen in BG group, regardless of the level of arterial occlusion (Table). Among the patients with ICA occlusion, PWI abnormality decreased by 17% (20.2 ± 65.4 cm³) in MIX group compared with 84% (73.9 ± 11.8 cm³) in BG group. Basal ganglia patients had more reduction in PWI and mismatch degree when the occlusion was in ICA than M1. In the MIX group, the degree of mismatch and PWI volume decreased by 61% and 17% in ICA, and 90% and 52% in M1, respectively. The largest mismatch was seen in BG group in both ICA (73.9 ± 11.8 cm³) and M1 (81 ± 26.3 cm³) occlusion.

CONCLUSION
Our results suggest that patients with both superficial and deep infarction and proximal ICA occlusion have the least dramatic imaging changes following mechanical thrombectomy, whereas those with proximal ICA occlusion and only deep basal ganglia infarction have better imaging results. This finding likely relates to the presence of robust collateral circulation in the group of proximal ICA occlusion with only deep infarction and sparing of superficial regions. Classifying stroke cases based on anatomical categories of infarction and level of arterial occlusion at baseline may be useful in clinical practice.

KEY WORDS: Stroke, location of infarction, MR imaging

Degree of Penumbra-Core Mismatch and Percentage of Mismatch Loss in Acute Proximal MCA Occlusion Are Correlated to the CTA Collateral Score

Lin, K. · Raz, E. · Gavlin, A. · Dodelzon, K. · Filatov, A. · Mir, Y. · Newey, A. · Pramanik, B. K.
1New York University Langone Medical Center, New York, NY, 2Sapienza University of Rome, Rome, ITALY

PURPOSE
Degree of collateral recruitment likely plays an important role in maintaining tissue viability in acute proximal MCA occlusion. We aimed to determine the effect of collaterals on the volumes of the initial infarct core and penumbra, their mismatch ratio, and the percentage of mismatch that is ultimately lost (%ML) with or without treatment-induced recanalization.

MATERIALS & METHODS
This is a retrospective study of acute nonlacunar MCA strokes imaged < 3 hours from onset by CT angiography (CTA) and CT perfusion (CTP). Patients with proximal MCA occlusions (M1 or M2 segment) were included. All CT exams were performed on a 16-slice scanner with CTP acquired over the proximal MCA territory (z-coverage of 24 mm) in a 60 sec dynamic series. Delay-invariant deconvolution software was used to generate CTP maps of cerebral blood flow (CBF) and cerebral blood volume (CBV). Thresholding with CBF <= 25 mL/100 g/min and CBV <= 1.2 mL/100 g allowed automatic segmentation of the penum-
PURPOSE
Barrow Neurological Institute
Emergency department setting.
brovascular disease in patients with dizziness in the emer-
To determine the overall frequency with which MDCT
Utility of MDCT Angiography in the Evaluation of
Paper 235 Starting at 3:46 PM, Ending at 3:54 PM
Utility of MDCT Angiography in the Evaluation of
Emergency Department Patients with Dizziness
Alhilali, L. M. · Fakhran, S. · Bird, R.
Barrow Neurological Institute
Phoenix, AZ
PURPOSE
To determine the overall frequency with which MDCT
angiography of the head and neck detects significant cere-
brovascular disease in patients with dizziness in the emer-
gency department setting.

MATERIALS & METHODS
CT angiograms of the head and neck of 80 consecutive
emergency department patients (39 men and 41 women;
mean age, 55.2 years) who presented to the emergency
department with dizziness were reviewed retrospectively.
Additional presenting symptoms, the patient’s known med-
history, and demographics related to the patient’s age and
sex also were documented. The findings for the noncon-
trast portion of the study were recorded separately from find-
ings seen on the angiographic portion of the study.

RESULTS
At CT angiography, five of the 80 patients (6%) had findings
compatible with significant vertebrobasilar cerebrovascular
disease; an additional patient (1%) had a hemodynamically
significant stenosis of the anterior circulation; 29 (36%) had
incident findings. Of those with incidental findings, only
15 (19%) had findings that would not be seen on a noncon-
trast head CT. No patient had an acute finding. No patient
less than 45 years of age had evidence of hemodynamically
significant stenosis. There was no significant difference in
the rate of vertebrobasilar cerebrovascular disease in patients
presenting with dizziness alone compared to those patients
presenting with other symptoms in addition to dizziness.

CONCLUSION
CT angiography may be helpful in the emergent work up of
symptoms of dizziness, but the prevalence of vertebrobasilar
cerebrovascular disease in this population is low and the use
of CT angiography in emergency patients with dizziness less
than 45 years of age may be unwarranted.

KEY WORDS: CT angiography, cerebrovascular disease

Paper 236 Starting at 3:54 PM, Ending at 4:02 PM
Time-Resolved CT Angiography Predicts Final Infarct
Volume in Acute Stroke
Chakraborty, S. · Ahmed, M. E. · Hogan, M. · Stotts, G. ·
Costa Pinto, E.
University of Ottawa
Ottawa, ON, CANADA

PURPOSE
CT angiogram and CT perfusion have been established as
important tools for evaluation of the acute stroke patients.
With the advent of 320 slice whole brain CT scanner we are
able to get whole brain perfusion data. From the same
dataset time-resolved dynamic CT angiogram images could
be reconstructed. This enables us to analyze the blood flow
in intracranial circulation.

MATERIALS & METHODS
Forty-seven consecutive patients presenting with acute
stroke in less than 6 hours from onset of symptoms are
included. Whole brain perfusion scans were acquired on
Toshiba 320 detector scanner and perfusion maps and
dynamic CTA were generated using Vitrea 4D brain perfu-
sion analysis software. Nine patients were excluded due to
corrupted data or motion artifact significantly degrading the
processed images. One patient was excluded due to known
contralateral MCA stenosis. One patient had posterior circu-
lotion stroke and was excluded. Within the remaining 36
patients; 20 did not show any infarction in the follow-up

 RESULTS
Thirty-eight subjects were included with a median age of 65
(interquartile range 58-80) and a median NIH stroke scale
score of 12 (8 - 15). There were 22 M1 and 16 M2 occlusions
with a median CS of 2 (1-3). Median initial penumbra and
core volumes were 46.3 (29.3 - 66) and 7.4 (3.2 - 20.3) mL,
respectively. Median mismatch ratio was 4.7 (2.7 - 9.6).
Collateral score was negatively correlated to core volume
(rho = -0.55, p < 0.001) and, if restricted to M1 occlusions,
to penumbra volume (rho = -0.54, p = 0.013). Collateral
score was positively correlated to mismatch ratio (rho =
0.66, p < 0.001). Sixteen (42.1%) patients achieved recanal-
ization. Median final infarct volume was 19.9 (10.6 - 32.3)
ml. Irrespective of recanalization, CS was negatively corre-
lated to %ML: rho(recanalized) = -0.51 (p = 0.047) and
rho(occluded) = -0.627 (p = 0.004). Despite recanalization,
the subgroup with CS < 2 (n = 7) had a higher median %ML
= 70% (47.7 - 93.1) compared to CS>= 2 (n = 9) with %ML
= 25.9% (5.0 - 44.1), p = 0.016. Despite persistent occlusion,
the subgroup with CS>= 2 (n = 17) had a lower median
%ML = 43.9% (27.0 - 77.2) compared to CS>= 2 (n = 5)
with %ML = 98.1% (85.3 - 100), p = 0.004.

CONCLUSION
Poor collateralization is correlated to larger initial infarct
core size, larger penumbra size (with M1 occlusions), small-
er mismatch ratio, and is associated with a higher percent of
mismatch loss with or without recanalization.

KEY WORDS: Mismatch, collateral score, CT angiography
scan but were included in the study. The dynamic CT angiogram 3D MIP data are interpreted with documentation of the time of arrival of contrast at the supraclinoid ICA, M1, M2 and distal cortical branches at equivalent position on each side. The filling of cortical branches also is analyzed for antegrade or retrograde flow, which is a measure of collateral flow. We correlated the final volume of infarct on follow-up CT scan with the delay in the flow on the affected side. Clinical assessment at the presentation and discharge also was recorded using NIHSS scores.

**RESULTS**

The Pearson correlation coefficient was used to assess the linear correlation between the final volume infarct on follow-up CT scan with the delay in appearance of contrast between 2 sides at different vascular levels (Table 1). Retrograde flow in cortical branches was noted in three subjects. Most important observation in this study was the exclusion of any significant infarct in presence of a symmetric dynamic CTA. The smallest infarct size in presence of a delay in filling was 10.3 ml. In patients with smaller infarcts the dynamic CTA was symmetric.

**Table 1**

<table>
<thead>
<tr>
<th></th>
<th>Correlation coefficient (95% confidence interval)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>ICA / Final infarct</td>
<td>-0.0739 (-0.39 to 0.26)</td>
<td>0.6683</td>
</tr>
<tr>
<td>M1 / Final infarct</td>
<td>0.3753 (0.05 to 0.62)</td>
<td>0.0241</td>
</tr>
<tr>
<td>M2 / Final infarct</td>
<td>0.5620 (0.28 to 0.75)</td>
<td>0.0004</td>
</tr>
<tr>
<td>Cortical / Final infarct</td>
<td>0.7058 (0.49 to 0.83)</td>
<td>&lt;0.0001</td>
</tr>
</tbody>
</table>

**CONCLUSION**

The volume of infarct is most significantly correlated with delay in filling of the cortical branches. A negative dynamic CTA is an excellent predictor of very small or no infarct.

**KEY WORDS:** Acute stroke, dynamic CT angiogram, infarct size

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**Paper 237 Starting at 4:02 PM, Ending at 4:10 PM**

**Cerebral Blood Volume Measurements in Acute Ischemic Stroke Are Technique-Dependent and Cannot Substitute for DW Imaging**

Deipolyi, A. R. · Wu, O. · Schaefer, P. W. · Macklin, E. A. · Schwamm, L. H. · Ackerman, R. H. · Gonzalez, R. G. · Copen, W. A. 

Massachusetts General Hospital
Boston, MA

**PURPOSE**

In acute stroke, diffusion- (DWI) and perfusion-weighted (PWI) MRI have been used to distinguish irreversibly injured “core” from potentially salvageable “penumbral” tissue. Some have suggested using perfusion CT or MRI to identify the core instead of DWI, assuming that cerebral blood volume (CBV) is consistently decreased in the core. This conflicts with some PET and SPECT studies that demonstrated elevated CBV in many infarcts. The discrepancy may be due to underestimation of CBV caused by short CT and MR scan durations. We sought to assess the validity of using CBV to identify infarct core.

**RESULTS**

Calculated rCBV increased with increasing scan duration (slope=0.0084/sec, p=0.0013). Varying scan duration changed rCBV from below-normal to above-normal in 11/21 patients (52%, 95% CI 30%-74%). Though 95% of infarcts had decreased rCBV at the shortest simulated scan duration, CBV measurements from such a short scan are heavily weighted by bolus arrival time and blood flow rather than CBV, presumably resulting in very low specificity for identifying infarct core. When the longest scan duration of 120 seconds (110 seconds post-injection) was used, resulting in the most accurate available CBV measurements, only 9/21 infarcts (43%, 95% CI 22%-66%) exhibited reduced rCBV.

**CONCLUSION**

When more accurate CBV measurements are obtained by using a long scan duration, most infarcts demonstrate elevated, rather than decreased CBV. CBV maps cannot reliably substitute for DWI in identifying infarct core.

**KEY WORDS:** Stroke, perfusion-weighted imaging, diffusion-weighted imaging
Admission Diffusion-Weighted Imaging and Clinical Data Predict Acute Stroke Patients’ Discharge Condition

Souza, L. S. C. · Payabvash, S. · Furie, K. L. · Gonzalez, R. · Lev, M. H.
Massachusetts General Hospital
Boston, MA

PURPOSE
We integrated admission imaging and clinical data into a multivariate model in order to predict stroke patients’ discharge outcome classified as: discharged to home, admitted to rehabilitation institution, or deceased.

MATERIALS & METHODS
We included 95 consecutive acute ischemic stroke patients who underwent MR diffusion-weighted (DWI) scan within 6 hours of symptom onset in our study. Infarct-core volumes were segmented manually on admission DWI. Clinical parameters included in the analysis were: patients’ gender, age, admission systolic blood pressure (SBP), blood glucose concentration, admission NIHSS exam score, thrombolytic therapy status, and presence or absence of major proximal cerebral artery occlusion on admission CTA/MRA. Patients were stratified into three groups: those discharged to home, those discharged to a rehabilitation institution and those deceased. We performed an ordinal logistic regression to determine the independent predictors of patients’ clinical outcome at the time of discharge according to above classification.

RESULTS
The only independent variables predicting patients’ discharge condition were admission DWI lesion volume as well as admission NIHSS exam score, and SBP. The regression equation helps predict the patients’ clinical outcome (Table). Based on equation we developed a patient-discharge scoring system: score = (admission NIHSS)/6 + (SBP; mmHg)/40 + (DWI lesion volume; ml)/50. If the score falls < 4.6, the patient has 61% chance of being discharged home, whereas if the score is > 9.5, there will be 60% chance of death; and 71% of patients with score between 4.6 and 9.5 were discharged to a rehabilitation institution. The overall accuracy of the scoring system in prediction of clinical outcome was 68%.

CONCLUSION
We created an easy-to-apply scoring system to predict stroke patients’ discharge condition using imaging and clinical information collected within 6 hours of symptom onset. Using admission DWI lesion volume, blood pressure, and NIHSS exam we could predict clinical outcome with 68% accuracy in our cohort of patient.

KEY WORDS: Stroke, outcome prediction, MR imaging

What ASPECTS Value Best Predicts the 100-mL Volume Threshold on Diffusion-Weighted Imaging? Study of 150 Patients with Middle Cerebral Artery Stroke

Lin, K. · Lee, S. A. · Zink, W. E.
1New York University Langone Medical Center, New York, NY, 2New York Presbyterian Hospital Weill-Cornell Medical College, New York, NY

PURPOSE
Infarct volume ≥100 mL on diffusion-weighted imaging (DWI) predicts symptomatic hemorrhagic transformation and poor outcome and recently has been termed a “malignant profile” in the Diffusion and Perfusion Imaging Evaluation for Understanding Stroke Evolution (DEFUSE) study. The Alberta Stroke Program Early CT Score (ASPECTS) is a semiquantitative scoring system for delineating MCA infarct extent rapidly and reliably that also has been shown to predict outcome. Our aim was to determine the correlation between ASPECTS and absolute infarct volume and to identify the optimal value for describing infarcts ≥ 100 mL.

MATERIALS & METHODS
This was a retrospective cross-sectional study of acute infarcts isolated to the MCA territory imaged by DWI < 48 hours from ictus. Two observers blinded to volumetric measurements assigned ASPECTS while a third observer used a semiautomated thresholding technique to determine DWI infarct volume based on signal intensity > 3 standard deviations from the mean intensity of the contralateral hemisphere (method used in DEFUSE). Correlation of ASPECTS and absolute volume was determined using Spearman’s rank coefficient (rho). Receiver operating characteristics curve (ROC) analysis was performed to identify the optimal ASPECTS for lesions ≥ 100 mL.

RESULTS
One hundred fifty patients were evaluated; the median and range for infarct volumes were 32.3 and 10.0-277 mL, respectively. The median and range for ASPECTS were 7 and 1-9, respectively. A strong correlation was found with rho = -0.807 (p < 0.0001). Twenty-two (14.7%) infarcts were ≥ 100 mL and the area under the ROC curve was 0.976 (p < 0.0001). The optimal ASPECTS cutpoint was ≤ 3 with sensitivity and specificity of 77.3% and 97.7%, respectively. Figure 1 shows the scatterplot of datapoints. Figure 2 shows a DWI lesion measuring 110 mL with ASPECTS = 3.
CONCLUSION
Diffusion-weighted imaging-ASPECTS may serve as a surrogate marker of absolute infarct extent, with a value \( \leq 3 \) describing most lesions \( \geq 100 \) mL.

KEY WORDS: Diffusion-weighted imaging, Alberta Stroke Program Early CT score, acute stroke

Paper 240 Starting at 4:26 PM, Ending at 4:34 PM
CT Angiographic Clot Burden Score Predicts Symptomatic Hemorrhagic Transformation of Acute MCA Stroke Independent of ASPECTS

Lin, K.1 · Gavlin, A.1 · Zink, W. E.2 · Tsiouris, A. J.2 · Filatov, A.1 · Dodelzon, K.1 · Sanelli, P. C.2
1New York University Langone Medical Center, New York, NY, 2New York Presbyterian Hospital - Weill Cornell Medical College, New York, NY

PURPOSE
The Clot Burden Score (CBS) and Collateral Score (CS) are semiquantitative metrics recently introduced to CT angiography (CTA) for added utility in the assessment of anterior circulation stroke outcome independent of infarct extent as assessed by the Alberta Stroke Program Early CT Score (ASPECTS). We aimed to determine if CBS and CS are also predictors of symptomatic hemorrhagic transformation (SICH), independent of ASPECTS.

MATERIALS & METHODS
Ninety-four patients with acute nonlacunar MCA stroke imaged < 9 hours from symptom onset were included in this retrospective study from two academic stroke centers. On CTA, CBS was scored on a 10-point scale with 2 points subtracted for occlusion of the supraclinoid ICA, proximal M1, or distal M1 segment, and 1 point subtracted for occlusion of the infracranial ICA, A1 segment, or either M2 branch. On CTA, using thick axial maximum intensity projections, CS was scored on a 4-point scale for collateral filling compared to the normal side: 0 (none visible), 1 (> 0 but < 50%), 2 (> / = 50 but < 100%), and 3 (100%). ASPECTS was determined on CTA source images using the conventional 10-point scale. Clot Burden Score, CS, and ASPECTS were graded by two blinded readers. Clinical data including age, comorbidities, admission serum glucose level, NIHSS score, time to CT, subsequent thrombolytic treatment, and posttreatment recanalization were collected. Hemorrhagic transformation (HT) was categorized by ECASS II criteria and SICH was defined by the appearance of HT on imaging temporally related to worsening of symptoms \( \geq 4 \) points on NIHSS. Univariate logistic regression was performed for all baseline clinical and imaging variables. Odds ratios (OR) were calculated with 95% confidence intervals (95% CI). Variables with \( p < 0.05 \) were entered into multivariate logistic regression (model constructed using backward elimination) to determine independent predictors. Receiver operating characteristics (ROC) analyses were used to determine optimal thresholds. Additional interaction terms with thrombolytic treatment and recanalization were assessed.

RESULTS
Median (IQR) values for baseline variables were: age 71 (61-81) years, glucose 6.5 (5.6-7.9) mmol/L, NIHSS score 12 (8-16), and time to CT 3.0 (2.0-5.0) hours. Forty-six (48.9%) patients received IV and/or IA tPA. Twenty-seven (28.7%) patients achieved posttreatment recanalization (thrombolytic and/or thrombectomy). Median (IQR) ASPECTS, CBS, and CS were 7 (6-8), 9 (7-10), and 2 (2-3), respectively. ASPECTS, CBS, CS, and NIHSS score were covariates. Eight (8.5%) patients developed SICH during the hospital course. On univariate analysis, only ASPECTS and CBS were significant predictors after adjustment for covariates [ASPECTS OR = 0.43 (95% CI: 0.23-0.81), \( p = 0.008 \) and CBS OR = 0.59 (95% CI: 0.36-0.97), \( p = 0.038 \]). On multivariate analysis, both ASPECTS and CBS remained significant [ASPECTS OR = 0.45 (95% CI: 0.26-0.78), \( p = 0.005 \) and CBS OR = 0.59 (95% CI: 0.38-0.94), \( p = 0.025 \)]. The optimal ASPECTS and CBS thresholds for SICH were \( < 5 \) and \( < 6 \), respectively. The interaction of ASPECTS \( < 5 \) with thrombolytic treatment was also significant but that between CBS and treatment was not.

CONCLUSION
The CTA Clot Burden Score is a predictor of SICH, independent of ASPECTS.

KEY WORDS: Hemorrhage, ischemic stroke, clot burden score

Paper 241 Starting at 4:34 PM, Ending at 4:42 PM
Prediction of Tissue Outcome in Acute Stroke Patients Based upon Different Whole-Brain CT Perfusion Parameters in 320-Slice Scanner

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University of Ottawa
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PURPOSE
CT perfusion has been established as an important tool for the evaluation of acute stroke patients. Quick and objective evaluation of different perfusion parameters is essential to make timely clinical decisions and to assess the volume of brain tissue at risk. We tested different perfusion parameters to find the one which best correlates with final volume of infarct, based upon quick visual assessment using simple method of measurement.

MATERIALS & METHODS
Forty-eight patients presenting with acute stroke in less than 6 hours from onset of symptoms are included. We correlated the final volume of infarct on follow-up CT scan with volumes of perfusion abnormality seen on different admission CT perfusion color maps. Whole brain perfusion scans were acquired on Toshiba 320 detector scanner and perfusion...
maps were generated on Vitrea 4D brain perfusion analysis software. The volume of abnormality on perfusion maps was measured based upon visual assessment of 3-colored perfusion maps using formula ABC/2. Follow-up unenhanced CT scans were performed between 24-48 hours after presentation and volumes of infarcts were assessed using same formula. Clinical assessment at the presentation and discharge also was recorded using NIHSS scores. The Pearson correlation coefficient was used to assess the linear correlation between the final volume infarct on follow-up CT scan with the volumes of perfusion abnormality seen on different perfusion parameters and the P-value was calculated to test wether these correlations are statistically significant. The sensitivity, specificity, positive and the negative predictive values were estimated for each of the perfusion parameters to see wether these parameters would accurately predict the presence of infarct.

RESULTS
The sensitivity analysis shows that TTP and delayed has highest level of sensitivity in detecting the infarct (90%) followed by CBV and CBF (75%, 65%), and MTT had a lower sensitivity compare to others (60%). All the 95% confidence intervals are calculated to provide a better estimate of these factors.

<table>
<thead>
<tr>
<th></th>
<th>Sensitivity %</th>
<th>Specificity %</th>
<th>Positive Predictive Value %</th>
<th>Negative Predictive Value %</th>
<th>Accuracy %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Delayed</td>
<td>90 (69-98)</td>
<td>86.95 (66-97)</td>
<td>85.71 (63-96)</td>
<td>90.9 (70-98)</td>
<td>88.4%</td>
</tr>
<tr>
<td>TTP</td>
<td>90 (68-98)</td>
<td>86.95 (66-97)</td>
<td>85.71 (63-96)</td>
<td>90.9 (70-98)</td>
<td>88.4%</td>
</tr>
<tr>
<td>MTT</td>
<td>60 (36-80)</td>
<td>100 (85-100)</td>
<td>100 (73-100)</td>
<td>74.19 (55-88)</td>
<td>81.4%</td>
</tr>
<tr>
<td>CBV</td>
<td>75 (50-91)</td>
<td>100 (85-100)</td>
<td>100 (78-100)</td>
<td>82.14 (63-93)</td>
<td>88.4%</td>
</tr>
<tr>
<td>CBF</td>
<td>65 (40-84)</td>
<td>100 (85-100)</td>
<td>100 (75-100)</td>
<td>76.66 (57-90)</td>
<td>83.7%</td>
</tr>
</tbody>
</table>

CONCLUSION
The volume of perfusion abnormality seen on CBF and CBV perfusion parameter at the time of presentation is best predictor of final outcome of infarct. However, the time to peak and delayed corrected maps are most sensitive to detect small (less than 6 cm³) volume infarcts.

**KEY WORDS:** Stroke, CT perfusion, Toshiba 320

**Paper 242 Starting at 4:42 PM, Ending at 4:50 PM**

**Dose Estimation for CT Perfusion Quality Control**

Lin, P. · Hackney, D. B.
Beth Israel Deaconess
Boston, MA

**PURPOSE**
The computed tomographic dose index, volume (CTDIvol) displayed on the control console of a CT scanner has a complex relationship to actual patient dose. Currently, there is no commonly accepted conversion method to obtain patient dose from the values of CTDIvol. To address this and to estimate the actual dose from a stroke head CT study, including CT perfusion, the dose delivered to the lens of eye, and the retina or brain was measured with MOSFET detectors using a Rando (head) Phantom.

**MATERIALS & METHODS**
We performed a CT perfusion acquisition using our clinical protocol (fixed tube current mode, no mA-modulation) on a Rando head phantom. Radiation dose was measured with MOSFET detectors on the surface simulating lens of eye, and in the central position to simulate the retina or brain. Since most CT scanners installed in this institution have HVL of 6.5 ~ 7.5 mmAl at 120 kVp, MOSFET detectors were calibrated with a conventional radiographic unit at 118 kVp with beam quality of 7.15 mmAl HVL by adding 5.5 mm of aluminum to the faceplate of the collimator. There are three component scans in the stroke study. Measurements were performed for those three separate scan series; (a) a noncontrast scan of the brain, (b) a perfusion scan with contrast, and (c) a CT angiography (CTA) scan. The noncontrast scan is performed as a contiguous axial acquisition, the perfusion CT scan is conducted using the “shuttle mode”, comprising a pair of modified axial acquisitions, and the CTA scan is performed as a helical scan with a pitch factor of “0.516”.

RESULTS
The computed tomographic dose index, volume values listed by the control console were 65 mGy, 200 mGy, and 103 mGy for the scan series (a), (b) and (c) listed above, respectively. Although far below the erythema dose, these figures substantially overestimate the true doses. The measured dose for the lens of eye, and the retina/brain were 14 mGy and 18 mGy for scan series (a), and 70 mGy and 79 mGy for scan series (b), and 25 mGy and 33 mGy for scan series (c), respectively.

**CONCLUSION**
The computed tomographic dose index, volume is useful for verifying that the stated protocol has been followed at least from the point of view of planned exposure. However, accurate dosimetry requires phantom. The dose our patient receives from one session of CTP is overestimated by the CTDIvol and this should not be used to evaluate the actual exposure. The total radiation dose a typical patient receives would be 109mGy to lens of eye and 130 mGy to retina (or brain). These dose levels are less than one fifteenth of the erythema dose of 2000 mGy. Even multiple examinations in the course of a week should not raise the patient exposure to erythema levels.

**KEY WORDS:** Perfusion, CT, dosimetry

**Paper 243 Starting at 4:50 PM, Ending at 4:58 PM**

**Neuroradiologic Correlates of Cognitive Impairment in Adult Moyamoya Disease**

Mogensen, M. A.1 · Karzmark, P.2 · Zeifert, P. D.2 · Rosenberg, J.2 · Marks, M.2 · Steinberg, G. K.2 · Dorfman, L. J.2
1University of Southern California, Los Angeles, CA, 2Stanford University, Stanford, CA

**PURPOSE**
Moyamoya disease (MMD) is a rare cerebrovascular disorder of uncertain etiology. Moyamoya disease has been shown to result in cognitive impairment in adults that is most apparent in executive functioning. It is unclear whether this is attributed to a reduction in cerebral blood flow (CBF) and cerebrovascular reserve (CVR) related to underlying MMD or due to secondary damage from cerebral infarction in these patients. Understanding the association of CBF and stroke with the development of cognitive impairment in adult
MMD patients could influence treatment strategies. The purpose of this study was to examine the correlation between presurgical neuropsychologic assessments with 1) primary MMD as measured by CBF and CVR, and 2) secondary damage from MMD as estimated by cortical stroke and white matter disease (WMD).

**MATERIALS & METHODS**
We performed a retrospective analysis of 31 adult patients (mean age, 37 years; range, 19 to 61 years) who presented to Stanford University for presurgical evaluation for MMD. All patients included in the study received neuropsychologic testing and imaging evaluation including a Xenon (Xe) CT examination with acetazolamide vasodilatory challenge and an MRI of the brain. Xenon CT was used to obtain CBF and CVR data on a per region basis (three levels/slices with six regions each for a total of 18 regions per patient) and MRIs were reviewed to assess for and grade chronic cortical stroke or WMD in the corresponding regions. Two tests of executive functioning, the Controlled Oral Word Association (FAS) and the Trail Making Test Part B (TMT-B) were correlated with imaging findings. White matter disease score and stroke score were the total number of regions with the presence of WMD and chronic cortical stroke, respectively. Cerebral blood flow and CVR were calculated as mean values across all 18 regions. To assess the effects of CBF, CVR, cortical stroke, and WMD on executive functioning scores, a multiple regression was performed with patient age as a covariate.

**RESULTS**
For the FAS test, there was a significant (p < .001) positive relationship between baseline CBF and the FAS score, and a significant (p = .017) negative relationship between the WMD score and the FAS score. Neither CVR nor the stroke score had a significant association with the FAS score. There was a significant (p = .007) U-shaped relationship between the FAS score and age. For the TMT-B, there was a significant (p < .014) positive relationship between CBF and the TMT-B score, but no significant associations with CVR, the WMD score, or the stroke score. There was also a significant (p = .014) positive linear relationship between the TMT-B score and age. FAS and TMT-B scores were moderately positively correlated (r = 0.60, p < .003).

**CONCLUSION**
Executive functioning as measured by neuropsychologic testing in adult MMD patients is significantly positively correlated with baseline cerebral blood flow. Deficits in executive functioning are associated with increasing white matter disease burden, but not the presence of cortical infarcts. There does not appear to be a correlation between decreased CVR and deficits in executive functioning; however, further assessment with regional analysis separating the anterior and posterior circulations is needed.

**KEY WORDS:** Moyamoya disease, cerebral blood flow, cognitive deficit
Furthermore, a positive correlation was detected between the headache score and each of size and number of spinal cysts (Pearson’s $r \approx 0.45$ and $p < .0001$).

**CONCLUSION**

We suggest that the abnormality involving the vessel wall in adult polycystic kidney disease also might have affected the spinal dura. This may explain the increased number of the nerve root sleeve cysts in these patients. Moreover, the leakage of CSF secondary to the nerve root sleeve cysts may be responsible for the recurrent severe headaches in these patients.

**KEYWORDS:** Spinal cysts, autosomal dominant polycystic kidney, headache

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**MATERIALS & METHODS**

MR images of the inner ear were acquired at 7 T (Achieva, Philips, Cleveland, OH, USA) in four healthy volunteers (ages 26-51 years) using a transmit/receive head coil or an 8-channel SENSE receive coil with a larger volume coil for transmit. A range of pulse sequences was tested including a 2D TSE sequence (TR/TE = 5500/80 echo train length of 13), a T1-weighted inversion recovery prepared 3D turbo field echo sequence (TI/TR/TE/flip = 1350/13/2.2/8 degrees), and a 3D balance field echo sequence (TR/TE/flip = 9.7/4.8/25 degrees). Reconstructed voxels sizes ranged from 0.45 x 0.45 x 2.5 m to 0.3 x 0.3 x 0.4 mm.

**RESULTS**

Inner ear structures were seen with all three sequences and included the cochlea, vestibule, semicircular canals, internal auditory canal and the facial, cochlear and vestibular nerves within. The T1 sequence generated excellent overall depiction of anatomy in the brain stem with lower signal in the fluid inner ear filled spaces. The 2D TSE sequence produced excellent results with the SENSE coil, but with the smaller transmit/receive coil, the B1-field inhomogeneity led to lower flip angles and decreased receive sensitivity in the inner ear. Despite the use of balanced gradients there was some signal loss in the CSF spaces. Furthermore, balanced field echo sequences require combination of data acquired with different phase angles for the RF pulses (CISS, SIMCAST) to prevent serious banding artifacts.

**CONCLUSION**

Our initial studies have demonstrated that inner ear imaging at 7 T is feasible. Artifacts from static and RF field inhomogeneity effects are seen but appear to be manageable. Ultrahigh field inner ear imaging potentially can depict anatomical detail not seen at lower field strength, and may provide further insight in disease such as Meniere’s and acoustic neuroma.

**KEY WORDS:** MR imaging, inner ear, 7 T

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**Tuesday Afternoon**

**3:30 PM – 5:00 PM**

**Room 311**

(24c) Head and Neck: Anatomy, Face, Orbit and Congenital (Scientific Papers 244 - 253)

See also Parallel Sessions
(24a) Adult Brain: Alzheimers/Demyelinating
(24b) Adult Brain: Cerebrovascular Occlusive Disease II
(24d) Pediatric: New Techniques and Other
(24e) Excerpta Extraordinaire: Adult Brain

Moderators: Christine M. Glastonbury, MBBS
Yoshimi Anzai, MD, MPH

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**Paper 244 Starting at 3:30 PM, Ending at 3:38 PM**

**High-Resolution MR Imaging of the Human Inner Ear at 7 T**

Sammet, S.1 · Schmalbrock, P.1 · Koch, R. M.2 · Knopp, M. V.1

1The Ohio State University, Columbus, OH, 2Brigham and Women’s Hospital, Boston, MA

**PURPOSE**

The purpose of this study was to assess the feasibility for high-resolution imaging of anatomical structures in the inner ear at 7 T, to assess adverse effects from magnetic field inhomogeneity due to susceptibility artifacts near air/tissue interfaces in the temporal bone, and to evaluate effects from RF inhomogeneity leading to decreased sensitivity in that anatomical region.
Determining the Topographical Relationship of the Seventh and Eighth Nerves in the Cerebellopontine Cistern and Internal Auditory Canal in Living Humans by Using 3D Gradient-Echo Sequence Constructive Interference in Steady-State M R Imaging

Unel, S.1 · Albayram, S.2 · Ceyhan, E.3 · Aydin, S.4 · Gurbuz, D.4 · Hatipoglu, N.4 · Savas, Y.4 · Odabasi, S.4 · Kurs, A.4
1Bezm-i Alem Vakif Gureba Training and Research Hospital, Istanbul, TURKEY, 2Cerrahpasa Medical School, Istanbul University, Istanbul, TURKEY, 3Koc University, Istanbul, TURKEY, 4Haseki Training and Research Hospital, Istanbul, TURKEY

PURPOSE
Understanding of the topographical relationship of the nerves in human auditory canal (IAC) is important in the diagnosis and surgical planning of acoustic schwannomas and in evaluating cochlear implant candidates. The advancements in the microsurgery and endoscopic surgery in the IAC made this knowledge even more important. The detailed anatomical studies were performed mainly in cadavers, but the absence of cerebrospinal fluid and blood pressure in these models distorts normal spatial relationships. There are only a few in vivo MR studies in the literature. Our purpose was to investigate the topographical relationship of the facial and vestibulocochlear nerves from the brain stem through the IAC in living humans by using MR imaging.

MATERIALS & METHODS
We performed T2*-weighted 3D gradient-echo sequence constructive interference in steady-state (CISS) oblique parasagittal MR imaging in 138 canals of 73 patients. We examined the topographical relationships of the facial and vestibulocochlear nerves at five locations; near the brainstem, the midportion between the brainstem and the porus acusticus, at the porus acusticus, the midportion of the IAC and at the lateral portion of IAC near the fundus. We also examined the relative sizes of the nerves in the lateral portion of the IAC (where they separated into individual nerves) and symmetry of two IACs within an individual.

RESULTS
Although it may rotate inferiorly from fundus to porus in some cases; in general the facial nerve locates anterior and superior to the vestibulocochlear nerve throughout its course. The vestibulocochlear nerve does not rotate around the facial nerve as reported in cadavers, but the superior vestibular nerve keeps its posterosuperior position in the canal. The inferior vestibular nerve and the cochlear nerve passes beneath the superior vestibular nerve. The facial nerve is a round structure throughout its course. The vestibulocochlear nerve is usually rectangular but sometimes round and rarely triangular in shape near the brainstem and it becomes crescent shaped in 89% of the cases at the porus. The cochlear nerve, the first nerve separated from the vestibulocochlear nerve, occupies the anteroinferior portion of the canal. The superior and inferior vestibular nerves are divided by the falciiform crest in 53% of the cases. The inferior vestibular nerve is the smallest in 51%, the cochlear nerve is the largest in 36%. The facial and the cochlear nerves are of similar size in 48% of the cases. Only in 45% of the cases the relative sizes of the nerves are symmetrical within an individual. The symmetry of the relationships of the nerves is found to be less than what is reported in previous studies.

CONCLUSION
To the best of our knowledge, this study is the most extensive in vivo MR study and most of our findings differ from those of the previous cadaver studies.

KEY WORDS: Internal auditory canal, vestibulocochlear nerve, facial nerve

Evaluation of the External Carotid Artery and Its Branches on Multidetector CT Angiography

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The National Hospital for Neurology and Neurosurgery London, UNITED KINGDOM

PURPOSE
The external carotid artery (ECA) and its branches supply the head and neck. Digital subtraction angiography (DSA) has been used conventionally to visualize the ECA and its branches. We set out to evaluate whether multidetector CT angiography (MD-CTA) as a widely available noninterventional imaging modality with its good spatial resolution provides an effective alternative way of assessing these vessels.

MATERIALS & METHODS
Two independent observers analyzed every CTA study (performed on a Siemens SOMATOM Definition © 128 MDCT) on an IMPAX© Barco 5MP HR monitor with multiplanar reformat capability to assess the visualization of the ECA and its branches on each side of the body. The visualization of these branches was graded as 0.1, 2 or 3 (not visualized, partially visualized but not of diagnostic quality, visualized but of suboptimal opacification, excellent diagnostic visibility respectively). The anatomical comparative standard adopted was Gray’s Anatomy 39th ed. Churchill Livingstone Publications. The main ECA trunk, 8 first order branches, 50 named second order branches on both anatomical body sides in 30 patients were evaluated making a total of 3450 segments. The Mann Whitney U test was used to assess for difference between ratings of image quality. Kappa evaluation was undertaken for degree of interobserver agreement. Analysis of variance was used to assess relative differences in scores of each of the individual segments assessed.

RESULTS
So far we have completed a third of the analysis as a pilot. Results from the pilot are presented in this abstract. The full set of results will be available for the ASNR meeting. Both observers concurred that 100% of the main ECA trunk, 93% of the first order branches and 58% of the second order branches were of at least grade 2 or 3 visibility on CTA. Both concurred that 100% of the main trunks, 85% of the first order and 36% of the second order branches were of “excellent diagnostic visibility”. No significant difference was seen between observers with regards to image quality scores assigned in each case (p = 0.8). Kappa with regard to image quality = 0.60. Analysis of variance showed differences between the visibility of first order branches (posterior auricular least well visualized).
CONCLUSION
Early results show that MD-CTA is a feasible and effective alternative to conventional invasive angiography for the assessment of the ECA system as it enables an easily accessible noninvasive 3D volumetric imaging technique with good spatial resolution.

KEY WORDS: External carotid artery, MD-CTA, DSA

3D Transaxial Measurement of Carotid Stenosis Using Curved Multiplanar Reformatting (Vitrea): A Comparison to Conventional B-Mode Ultrasound

Kwok, K. · Lu, S.
Monmouth Medical Center
Long Branch, NJ

PURPOSE
Several studies have investigated and compared the degree of carotid stenosis comparing CT angiography and B-mode ultrasound. However, due to the intrinsic tortuosity and orientation of the carotid arteries, a true measurement of the degree of stenosis may not be possible by using conventional methods of measurement in orthogonal planes. In this study, we are comparing the percent stenosis as calculated by 3D curved multiplanar reformatting (Vitrea) of a carotid angiogram to the estimated stenosis based on measured peak systolic velocity of a carotid duplex study.

MATERIALS & METHODS
Patients who have undergone both CT angiogram and carotid duplex study in the period of 1/1/2008-10/31/2009 at the Monmouth Medical Center are selected. A total of 26 patients are eligible as part of the study. A board-certified fellowship-trained neuroradiologist at our institution, measured the transaxial diameters of the stenotic lumen and expected lumen of the carotid bulb, orthogonal to the long axis, using the curved multiplanar reformatting and fly-through function of the 3D reconstruction of the CT angiogram. The ultrasound studies were reviewed retrospectively in all cases. Gradation of the stenosis was based on recorded peak systolic velocities as follow: 0-49% (Grade 0), 50-69% (Grade 1), 70-98% (Grade 2), ~99% (Grade 3), and 100% (Grade 4).

RESULTS
A total of 26 patients and 52 carotid vessels were evaluated. Based on the CT angiogram, 0-49% stenosis (n = 23), 50-69% stenosis (n = 12), 70-98% stenosis (n = 13), ~99% stenosis (n = 0), and complete occlusion (n = 4) were observed. Based on the ultrasound grading scale, grade 0 (n = 33), grade 1 (n = 11), grade 2 (n = 2), grade 3 (n = 2), and grade 4 (n = 4) were observed. The Pearson score was calculated using the set of data from the percent stenosis and ultrasound grading. A good correlation was found between the 2 sets of data, (R = 0.68).

CONCLUSION
Carotid stenosis as determined by the curved multiplanar reformatting appears to demonstrate a good correlation with the conventional grading system based on the peak systolic velocity of a B-mode carotid ultrasound. According to our data, in patients who have less than 50% stenosis based on the CT angiogram, ultrasound may underestimate the degree of stenosis as evidenced by the total number of vessels in the grade 0 category. A larger sample size would be helpful to further delineate the relationship between the correlation between measured carotid stenosis by CT angiogram and an estimated stenosis based upon the peak systolic velocity of an ultrasound study.

KEY WORDS: Carotid stenosis, ultrasound, CT angiography

Craniofacial Bone Infarcts in Sickle Cell Disease: Prevalence and Clinicoradiologic Manifestations

Watanabe, M. · Liao, J. · Saito, N. · Nadgir, R. · Sakai, O.
Boston Medical Center - Boston University School of Medicine
Boston, MA

PURPOSE
Headache is a common indication for MR imaging of the head in patients with sickle cell disease (SCD). Although bone infarct may be a cause of headache, it is not well appreciated by radiologists and its prevalence has not been reported. The purpose of this study is to investigate the prevalence and clinicoradiologic manifestations of craniofacial bone infarct in patients with SCD.

MATERIALS & METHODS
Following IRB approval, a retrospective search identified 91 patients with SCD (43 males, 48 females; age 1-53 years) who underwent head and neck CT or MR imaging over a period of 5 years (1/1/2004-12/31/2008). Their clinical presentations and radiologic findings were reviewed.

RESULTS
Among 91 patients, 39 patients presented with pain. Of these 39 patients, eight patients (20.5%) (5 males, 3 females; age 2-31 years; 7 HbSS, 1 HbSC) were diagnosed with bone infarcts. Four infarcts occurred in the mandibular ramus (50.0%), three in the sphenoid bone (37.5%), two in the mandibular condyle (25.0%), one in the orbital wall (12.5%), one in the frontal bone (12.5%), one in the temporal bone.
Six patients were diagnosed by MRI imaging with acute bone infarct, which demonstrated bone marrow edema (100%), subperiosteal fluid collection (66.7%), and geographic nonenhancing area (16.7%). In the four patients with subperiosteal fluid (2 mandibular rami, 1 orbit and 1 frontal bone), susceptibility effects were seen, suggesting associated hemorrhage. The remaining two patients diagnosed by CT alone demonstrated mixed sclerotic and lytic changes, suggesting prior bone infarct. A separate patient (HbSS) presenting with pain and swelling demonstrated findings similar to bone infarct in the mandibular ramus; however, CT demonstrated peripherally enhancing subperiosteal collection, which was drained and proved to be an abscess. This patient was diagnosed with osteomyelitis/abscess.

CONCLUSION

Craniofacial bone infarcts are not uncommon in patients with SCD (8.8%), particularly in patients who present with pain (20.5%). Subperiosteal collections are seen most often in infarcts involving relatively thin bones. The accurate diagnosis of bone infarct is important for appropriate management, and should be distinguished from osteomyelitis, which requires a more aggressive treatment with antibiotics and drainage.

REFERENCES


KEY WORDS: Sickle cell disease, bone infarct, craniofacial bone

Paper 249 Starting at 4:10 PM, Ending at 4:18 PM

Value of Fat-Suppressed FLAIR and Diffusion-Weighted Imaging in Evaluating for Optic Neuritis with Clinical Correlation

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Minneapolis, MN

PURPOSE

Postcontrast fat-suppressed T1-weighted imaging (T1WI) has been considered a sensitive MR sequence in evaluating for optic neuritis (ON). However, this does not always correlate with the clinical diagnosis, and other routine MR sequences may have additional value. Hence, we decided to evaluate the utility of fat-suppressed FLAIR and diffusion-weighted imaging (DWI) for ON.

MATERIALS & METHODS

Internal review board approval was obtained. The clinical data and MR examinations were reviewed retrospectively of 60 patients presenting to the neuroophthalmology clinics for various indications, who underwent neuroophthalmologic exam. Each patient had undergone routine, axial 5 mm fat-suppressed FLAIR and DWI, as well as 3 mm axial and coronal fat-suppressed T1-weighted imaging (T1WI), in accordance with our routine orbit protocol. Two staff neuroradiologists independently evaluated the FLAIR and DWI sequences, recording +, −, or indeterminate for abnormality, and reviewed the postcontrast T1-weighted images by consensus. These results were correlated with each other, as well as with the clinical diagnosis.

RESULTS

Thirty-one patients were clinically positive, and 29 clinically negative for ON. The sensitivity of FLAIR, DWI, and T1WI for both reviewers was 64.7-67.6%, 70.6-70.6%, and 88.2% respectively with respect to the clinical diagnosis. The specificities were 88.3-91.9%, 75.6-77.9%, and 82.6% respectively. There was strong or moderate − correlations of FLAIR (r = 0.54-0.62, p < 0.001), DWI (r = 0.43-0.46, p < 0.001), and T1WI (r = 0.66, p < 0.001) with the clinical diagnosis. Interobserver kappa was 0.785 (p < 0.0001) for FLAIR, and 0.693 (p < 0.0001) for DWI.

CONCLUSION

Being more specific than T1WI, fat-suppressed FLAIR likely has additional value in evaluating for ON, where DWI can be hampered by artifacts but may help in some cases.

KEY WORDS: Optic neuritis, fat-suppressed FLAIR, diffusion-weighted imaging
Determining the Anastomosis of the Nerves in the Internal Auditory Canal and Cerebellopontin Cistern in Living Humans by Using 3D Gradient-Echo Sequence Constructive Interference Steady-State MR Imaging

Unel, S.1 · Albayram, S.2 · Ceyhan, E.3 · Aydín, S.4 · Gurbuz, D.4 · Hatipoglu, N.4 · Savas, Y.4 · Odabasi, S.1 · Kirs, A.4
1Bezm-i Alem Vakif Gureba Training and Research Hospital, Istanbul, TURKEY, 2Cerrahpasa Medical School, Istanbul University, Istanbul, TURKEY, 3Koc University, Istanbul, TURKEY, 4Haseki Training and Research Hospital, Istanbul, TURKEY

PURPOSE
The vestibular, cochlear and facial nerves have a common anatomical course within the internal auditory canal (IAC). In early studies, connections and anastomosis between these nerve bundles within the IAC were revealed by light microscopy, scanning electron microscopy and observed during surgical procedures. Vestibulofacial connections may be important clinically because some vertiginous patients develop spontaneous nystagmus as a side effect of facial nerve block for the treatment of hemifacial spasm. The presence of anastomotic connections between the facial and vestibular nerves in the IAC was reported to contribute to the vestibular disturbance in patients with bell’s palsy. Additionally, the presence of vertigo after vestibular neurectomy or the presence of tinnitus after cochlear neurectomy in some patients may be the consequence of the presence of connections between vestibular and the cochlear nerve bundles. Therefore connecting branches between the nerve bundles of the IAC may be important during both surgery and in the explanation of unexpected disturbances. The aim of this study is to define and locate the connections between these nerves by MR imaging in living humans.

MATERIALS & METHODS
We performed T2*-weighted 3D gradient-echo sequence constructive interference in steady state (CISS) oblique parasagittal MR imaging in 138 canals of 73 patients. We examined the nerves at five locations: near the brainstem, midportion between the brainstem and the porus acusticus, at the porus acusticus, the midportion of the IAC and at the most lateral portion of IAC near the fundus. The anastomosis of the nerves and their levels were recorded.

RESULTS
Totally in 75 of our cases (54%) vestibulocochlear and vestibulofacial connections occur. Vestibulofacial connections occur in 44 cases (31%) and 21% of them were located at the lateral portion of the canal. Vestibulocochlear connections occur in 31 cases (22%), 18% of which appear at the midportion of the IAC. Furthermore, there are connections between the separated superior and inferior vestibular nerves in 15 cases (11%).

CONCLUSION
We have observed the anastomotic connection fibers between the nerves in the IAC (which were previously observed by cadaver studies and surgical procedures) by using MR imaging in living humans. Most of these connection fibers were located at the midportion and lateral portion of the IAC.

KEY WORDS: Anastomosis, facial nerve, vestibulocochlear nerve

Optic Nerve Demyelination and Axonal Loss—Magnetization Transfer Ratio as a Tool of Deferentiation!

Chaganti, J. R. · Klistorner, S. · Garrick, R.
St. Vincents Hospital Sydney, AUSTRALIA

PURPOSE
While magnetization transfer ratio (MTR) is claimed to be an important in vivo indicator of MS pathophysiologic processes, its true nature is still obscure. While there is evidence that it correlates with both axonal density and demyelination, the extent of this correlation has not been defined. Optic nerve represents a good model to study MS due to the fact that it subserves aspects of vision which are easily identifiable and measurable. Objectives. In this pilot study we studied the result of MTR in comparison to electrophysiologic markers of neuronal injury after an episode of optic neuritis (ON). Latency of a newly developed multifocal visual evoked potential (mfVEP) was used as a marker of demyelination, while amplitude indicated axonal loss.

MATERIALS & METHODS
Patients with single unilateral episode of ON were enrolled. Based on result of the mfVEP testing patients were divided into two groups: patients with no axonal loss but extensive demyelination (normal amplitude, but significantly delayed latency) and patients with axonal loss, but no demyelination in the remaining fibers (amplitude reduction, but no latency delay). Orbital MR imaging was performed on Phillips 3 T machine. Asymmetry between MTR of affected and fellow eyes was analyzed.

RESULTS
There was consistent asymmetry in MTR between affected and fellow eyes in all patients with axonal loss with former eye demonstrating considerably smaller values compare to later (average MTR asymmetry = 0.05 +/- 0.008). Patients with demyelination (latency delay) but without axonal loss (fully recovered amplitude), on the other hand, did not demonstrate significant MTR asymmetry (average MTR asymmetry = 0.001 +/- 0.019).

CONCLUSION
Results of our pilot study suggest a possibility that axonal loss has strong relationship with MTR. Latency delay in cases where MTR was normal, on the other hand, may indicate that demyelination is not always reflected by MTR.

KEY WORDS: MTC, optic nerve, demyelination/axonal loss
PURPOSE

Eagle's syndrome is a series of symptoms including recurrent throat pain, foreign body sensation, dysphagia, and/or facial pain believed to result from an elongated styloid process, hyoid or calcified stylohyoid ligament impacting nearby soft tissue structures. This project retrospectively reviewed the radiographic findings of patients with Eagle's syndrome imaged in the neutral and head turned positions, assessing the relationship of the hyoid, an elongated styloid or ossified stylohyoid ligament on adjacent critical soft tissue, such as the carotid arteries.

RESULTS

The data demonstrated that proximity of the hyoid bone, styloid, stylohyoid ligament, to the carotid arteries may correlate with symptomatology, more often than an elongated styloid process alone. Additionally, CT radiographs obtained in a head turned position may increase the proximity to the soft tissue structures and further elucidate the cause of symptomatology.

CONCLUSION

This study demonstrates that the hyoid bone and the associated attached structures including the styloid process and stylohyoid ligament, may be implicated in symptomatic Eagle’s syndrome and that CT imaging in symptomatic head positioning may play a useful diagnostic role in evaluating this unique subset of patients.

KEY WORDS: congenital syndrome, MRA, vascular anomalies

REFERENCES


**KEY WORDS:** Fibrodysplasia ossificans progressiva, craniofacial findings

### Paper 24b Starting at 3:30 pm, Ending at 3:50 pm
Pediatric: New Developments and Questions in Pediatrics

Barkovich, A.

UCSF Medical Center
San Francisco, CA.

### Tuesday Afternoon
3:30 PM – 5:00 PM
Room 312

(24d) Pediatric: New Techniques and Other
(Scientific Papers 255 - 262)

See also Parallel Sessions
(24a) Adult Brain: Alzheimers/Demyelinating
(24b) Adult Brain: Cerebrovascular Occlusive Disease II
(24c) Head And Neck: Anatomy, Face, Orbit and Congenital
(24e) Excerpta Extraordinaire: Adult Brain

Moderators: P. Ellen Grant, MD
Peter Kalina, MD

Paper 255 Starting at 3:56 PM, Ending at 4:04 PM
Alteration of Human Fetal Subplate Layer and Intermediate Zone during Normal Development on MR and Diffusion Tensor Imaging: 2010 Cornelius G. Dyke Memorial Award winner

Widjaja, E.¹ · Geibprasert, S.¹ · Zarei Mahmoodabadi, S.¹ · Blaser, S.¹ · Brown, N. E.¹ · Shannon, P.²

¹Hospital for Sick Children, Toronto, ON, CANADA,
²Mount Sinai Hospital, Toronto, ON, CANADA

**PURPOSE**
The subplate layer and intermediate zone are the precursors for neonatal white matter. Therefore it is important to understand the normal changes in the subplate layer and intermediate zone on imaging in order to detect abnormal white matter development. The aims were to evaluate (1) T1 and T2 signal, (2) FA of subplate and intermediate zone in postmortem fetuses and correlate with histology, and (3) T2 signal of subplate and intermediate zone on antenatal MR imaging.

**MATERIALS & METHODS**
Fourteen immersion-fixed normal brain from 18-25 gestational weeks underwent 1.5 T MR imaging including diffusion tensor imaging (DTI) and histologic examination. The subplate and intermediate zone were graded on a scale of 1-5 on T1 and T2 and correlated with age. The subplate and intermediate zone FA were evaluated and then correlated with age. T2-weighted antenatal MR imaging of 17 fetuses from 20-26 gestational weeks with normal brain were evaluated using the same grading as on postmortem MR imaging.

**RESULTS**
On T1 postmortem MR imaging, subplate has lower signal compared to intermediate zone; subplate signal correlated positively ($r = 0.66, p = 0.012$) with age, and intermediate zone signal correlated negatively ($r = -0.78, p = 0.001$) with age. On T2 postmortem MR imaging, subplate has higher signal compared to intermediate zone and remained persistently high signal; intermediate zone signal showed moderate correlation ($r = 0.48, p = 0.086$) with age. FA of subplate correlated positively with age ($r = 0.55, p < 0.001$); FA of intermediate zone correlated negatively ($r = -0.64, p < 0.0001$) with age. On histology, extracellular matrix decreased and cellularity increased in subplate layer, tangentially organized cellularity decreased and projecting fibers became thicker in intermediate zone with increasing gestation. The findings on T2-weighted antenatal MR imaging were similar to T2-weighted postmortem MR imaging.

**CONCLUSION**
The changes in signal and FA of subplate and intermediate zone in the second trimester reflect microstructural changes on histology. Understanding the normal changes in the subplate layer and intermediate zone is important before such knowledge can be incorporated in the antenatal assessment of normal development, white matter injury in fetuses from ischemia or infection, as well as abnormal white matter development in association with brain malformations.

**KEY WORDS:** Fetal, brain development, diffusion tensor imaging
PURPOSE
To determine the sensitivity and specificity of fetal MR imaging (MRI) for supratentorial brain abnormalities using postnatal MRI as gold standard.

MATERIALS & METHODS
We identified all patients imaged by fetal MRI who had a postnatal MRI of the brain. Fetal MRIs included single-shot fast spin-echo T2-weighted imaging with 3-4 mm thick slices obtained in axial, sagittal, and coronal planes. Postnatal MRI technique varied as they were performed at different sites. Fetal MRIs and postnatal MRIs were reviewed in a blinded manner by 2 pediatric neuroradiologists. Exams with poor image quality were excluded. Cases of periventricular nodular heterotopia, polymicrogyria, callosal abnormalities, and abnormal white matter T2 signal detected by fetal MRI and/or postnatal MRI were compared.

RESULTS
A total of 77 patients were identified. Gestational age (GA) at time of fetal MRI by last menstrual period ranged from 19.71-38.14 weeks (median GA 24.29 weeks). Age at postnatal MRI ranged from 0 days - 4 years. Twelve patients had periventricular nodular heterotopia on postnatal MRI, 10 patients had polymicrogyria on postnatal MRI, 18 patients had white matter abnormalities on postnatal MRI, and 34 patients had callosal abnormalities (18 agenesis/hypogenesis, 1 dysgenesis, 15 thin) on postnatal MRI. Sensitivity and specificity of fetal MRI for heterotopia was 58% and 100%, respectively. Median GA at fetal MRI for cases of heterotopia detected by both fetal MRI and postnatal MRI was 26.14 weeks, compared with median GA of 22.29 weeks for those cases detected by postnatal MRI but not fetal MRI. Sensitivity and specificity of fetal MRI for polymicrogyria was 80% and 100%, respectively. Median GA at the time of fetal MRI for those cases of polymicrogyria detected by both fetal MRI and postnatal MRI was 31; 14 weeks, compared with median GA of 24.22 weeks for those cases detected by postnatal MRI but not fetal MRI. Sensitivity and specificity of fetal MRI for white matter signal abnormalities was 28% and 93%, respectively. Parenchymal abnormalities not detected by fetal MRI but present on postnatal MRI included focal as well as diffuse white matter hyperintensity, periventricular infarcts, and a subcortical tuber in a patient with tuberous sclerosis. Median GA at the time of fetal MRI for cases of white matter signal abnormalities detected by both fetal and postnatal MRI was 32.29 weeks, compared with median GA of 25 weeks for those cases detected by postnatal MRI but not fetal MRI. Sensitivity and specificity of fetal MRI for callosal abnormalities overall was 68% and 100%, respectively. When cases of thin callosum were excluded, fetal MRI was 89% sensitive in detecting callosal abnormalities.

CONCLUSION
The sensitivity and specificity of fetal MRI varies for different abnormalities and gestational ages. It has highest diagnostic accuracy for polymicrogyria, followed by callosal abnormalities, and periventricular nodular heterotopia; and detection is improved at greater gestational ages. Fetal MRI is more limited in detection of white matter signal abnormalities. Knowledge of the diagnostic accuracy of fetal MRI for different brain abnormalities is important in accurate counseling of patients who undergo fetal MRI.

KEY WORDS: Fetal, MR imaging

Can We Demonstrate Fetal Eye Movement Patterns Using MR Imaging?

PURPOSE
To evaluate whether different types of fetal eye movements can be demonstrated using dynamic MR sequences. As morphologic brainstem evaluation on fetal MR imaging is limited due to its small size the assessment of fetal eye movements might allow indirect evaluation of brainstem development and function.

MATERIALS & METHODS
Seventy fetuses with normal brain development from 18-40 GW were examined using dynamic SSFP sequences (1.5 T, sense cardiac coil, slice thickness 15-20 mm, 6 frames/s) with durations of 35 seconds per sequence and 1-5 SSFP sequences per fetus. Fetuses were divided into 3 groups: 18-23 GW: 16 fetuses, 24-32 GW: 33 fetuses, 33-40 GW: 21 fetuses. Eye movements were classified following Birnholz (Science 1981): Type 0 = no eye movements; Type I = single transient deviation; Type II = prolonged single deviation; Type III = complex sequence of deviations without periodicity; Type IV = repetitive/nystagnoid deviations. Additionally we divided Type I eye movements into Type Ia (fast deviation, slow reposition) and Type Ib (fast deviation, fast reposition).

RESULTS
Among normally developing fetuses Type 0 eye movements decreased from the youngest to the oldest age groups. Type Ia decreased with gestational age while Type Ib eye movements were distributed almost equally among the fetal age groups. Type II, III and IV increased with gestational age. Differences between the fetal age groups were significant concerning Types Ia and IV.

CONCLUSION
The different eye movement patterns of the fetal age groups may represent steps of brainstem maturation. The assessment of fetal eye movements might be helpful in the diagnosis of malformations associated with impairment of brainstem functions, such as, molar-tooth malformations, hydrocephalus and Chiari II malformations.

KEY WORDS: Fetal, MR imaging, eye
Paper 258 Starting at 4:20 PM, Ending at 4:28 PM
In Utero MR Imaging of Fetuses with Developmental Central Nervous System Abnormalities from Multifetal Pregnancies

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PURPOSE
In utero MR imaging (iuMR) is used increasingly to detect brain and spine abnormalities of the fetus with many studies reporting significant improvements in diagnostic accuracy. Most publications indicating the diagnostic efficacy of the procedure have studied singleton pregnancies. The purpose of this work was to see if the reported advantage of using iuMR in singleton pregnancies is also true for multifetal pregnancies.

MATERIALS & METHODS
This study was approved by the South Sheffield Research Ethics Committee. Forty pregnant women were recruited consecutively from ten fetal assessment units in England and Scotland. Entrance criteria for the study were: multifetal pregnancy with an abnormality of the fetal brain and/or spine diagnosed on ultrasonography referred to our center at 20 weeks gestational age or later. In utero MR examinations were performed within 5 working days of the referral. All images were acquired at 1.5 T (Infinion, Philips Medical Systems or Signa HDx, General Electric Healthcare). A combination of ultrafast sequences was used to provide high quality imaging in the three orthogonal planes of the target organ(s). Results for diagnostic agreement between ultrasound and iuMR and the proportion of cases where additional diagnostic information was found by iuMR are expressed as percentages.

RESULTS
The results of the ultrasound and iuMR examinations were identical in 27/40 women scanned (68%), carrying 56 fetuses. In 23/27 only one fetus had an abnormality and in four cases more than one fetus had an abnormality. Of those 31 abnormal fetuses, 17 had isolated ventriculomegaly, six had spinal dysraphism (5 with Chiari 2 malformations), two had cerebellar hypoplasia, two had microcephaly and one each with ACC, anencephaly, holoprosencephaly and microphthalmia. Disagreements between ultrasound and iuMR were found in 13/40 (32%) of the women carrying a total of 26 fetuses. In 8/13 cases (62%) the fundamental disagreement between ultrasound and iuMR centered on the presence or absence of the corpus callosum. In five cases ultrasound had diagnosed isolated VM in one twin whilst iuMR showed agenesis of the corpus callosum (ACC). In one case VM was found in conjunction with an absent cavum septum pellucidum on ultrasound but ACC was shown on iuMR. In two cases ACC was diagnosed on ultrasound but not confirmed on iuMR (isolated VM in one and VM and absent cavum septum pellucidum in the other).

CONCLUSION
There was a high rate of disagreement between the fetal malformations defined on ultrasound and iuMR. As with singleton pregnancies abnormalities of the corpus callosum caused most diagnostic equipoise. We conclude that iuMR should be included routinely in the diagnostic pathway of multifetal pregnancies in which one or more fetus is suspected of having a developmental brain abnormality.

KEY WORDS: In utero MR imaging, multifetal pregnancies, malformations

Paper 259 Starting at 4:28 PM, Ending at 4:36 PM
Unusual Pattern of Hypoxic-Ischemic Encephalopathy, Involving Cerebral White Matter in Children

Feygin, T. · Khrichenko, D. V. · Zimmerman, R. A. · Shekdar, K. · Vossough, A. · Pollock, A. N. · Bilaniuk, L. T.
Children’s Hospital of Philadelphia
Philadelphia, PA

PURPOSE
To describe unusual pattern of ischemic injury of cerebral white matter in children and evaluate ADC values of this pathology.

MATERIALS & METHODS
The cases for this study, demonstrating abnormal lesions in the cerebral white matter, were selected retrospectively from patient population who had undergone MR imaging for suspected hypoxic-ischemic injury, from 1995 to 2009. Diffusion-weighted sequences were performed along with conventional MR imaging. The mean ADC values in areas of abnormal diffusion were obtained. The data were transferred in Digital Imaging and Communications in Medicine (DICOM) format onto a private server where they were analyzed by in-house software written in Interactive Data Language (IDL) that was developed specifically for this study. The data were transformed into a single four-dimensional array. A region of interest (ROI) drawn over the diffusion-weighted images was placed in the lesion. Mean signal intensities within the ROI were plotted against the B value. A nonlinear least square fitting algorithm, the Levenberg-Marquardt algorithm, was used to fit the data to a mono exponential decay function. The mean ADC values in each of these lesions were obtained. Imaging was performed on either 1.5 or 3 T Siemens magnet.

RESULTS
Total of 21 cases of diffuse ischemic injury predominantly involving cerebral white matter were found. All patients presented with prolonged seizures and all patients were examined with MR imaging after 3-7 days after the onset of symptoms. The most common trigger events included cardiac-pulmonary arrest, nonaccidental trauma, and meningoencephalitis, among others. The mean ADC values obtained ranged from 0.39 to 0.6 for cerebral white matter and mean 0.7 for hippocampi.

CONCLUSION
This unusual pattern of diffuse ischemic injury of cerebral white matter is important to be recognized. Larger studies are required to determine if this injury has unique ADC value which could complement conventional imaging for specific diagnosis.

KEY WORDS: Hypoxic-ischemic injury, white matter
Adaptive Iterative Reconstruction Technique for Reducing Pediatric CT Neuroimaging Radiation Dose: Initial Experience

Zuccoli, G.1 · Clayton, B.1 · Sperling, V.1 · Flom, L.1 · Fitz, C.1 · Panigrahy, A.1,2

1Children’s Hospital of Pittsburgh of University of Pittsburgh Medical College, Pittsburgh, PA, 2Childrens Hospital Los Angeles, Los Angeles, CA

PURPOSE
The purpose of this study was to evaluate the image noise, low contrast resolution, high contrast resolution, image quality and spatial resolution of adaptive statistical iterative reconstruction in low dose pediatric CT neuroimaging.

MATERIALS & METHODS
Adaptive statistical iterative reconstruction (ASIR) was used to scan the American College of Radiology Phantom at three values: infant head (kV 120, mA 120); pediatric head (kV120, mA 170); adult head (kV 120, mA 200). Test objects in the low and high contrast and uniformity modules were evaluated. Low dose CT with adaptive statistical iterative reconstruction then was tested on 12 patients who initially underwent a routine low dose CT on a department scanner without iterative reconstruction available followed by scanning on a department scanner with iterative reconstruction available (set at 30% reconstruction factors). Two radiologists blinded to the scanning techniques evaluate the image with respect to image quality. Quantitative noise measurements were made on the clinical images. Both CT dose index and dose length products values were recorded.

RESULTS
In the pediatric patients studied, the low dose head CT with adaptive statistical iterative reconstruction was associated with a 11-33% decrease in both CT dose index and DLP compared to low dose head CT without ASIR and was associated with improved image noise. There was no obvious difference between the scans with and without ASIR with respect to quality (evaluation of normal anatomy and lesion detection).

CONCLUSION
These preliminary results support body CT dose reduction 11-33 % percent when adaptive statistical iterative reconstruction was used for pediatric head CT imaging without compromising overall image quality. Further validation with a larger study population is need.

KEY WORDS: Adaptive statistical iterative reconstruction

Quantitative Characterization of the Maturation of the Normal Pediatric Spinal Cord Using Diffusion Tensor Imaging

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1Johns Hopkins University School of Medicine, Baltimore, MD, 2Case Western Reserve University School of Medicine, Cleveland, OH, 3Medical University of Vienna, Vienna, AUSTRIA

PURPOSE
Diffusion tensor imaging (DTI) has acquired immense clinical significance in the quantitative evaluation of the normal and abnormal maturation and development of the pediatric brain. Normative apparent diffusion coefficient (ADC) and fractional anisotropy (FA) metrics of the brain have been published previously (1, 2). Few studies, however, have focused on the development of the pediatric spinal cord (3). The goal of our study was to evaluate and quantitatively characterize the maturation of the normal cervical spinal cord (CSC) in children using DTI.

MATERIALS & METHODS
Seventy children aged 0-18 years received DTI of the spinal cord for various indications. Diffusion tensor imaging was performed on a 1.5 T MR scanner using a single-shot, spin-echo, echo planar DTI sequence. Scan parameters were as follows: TR 2400 msec; TE 100 msec; field-of-view 220 mm; matrix 192 x 192; slice thickness 1.9 mm; 14 slices; image resolution 1.1 x 1.1 x 1.9 mm. Images were measured in 20 directions using b-values of 0 and 750 mm2/s. Apparent diffusion coefficient and (color-coded) FA maps were reconstructed using vendor-specific postprocessing software. Twenty-six children (13 male, 12 female, mean age 6.6 years and range 0.6-16 years) without focal or systemic CSC pathology, as confirmed by imaging and neurologic examination, were selected for further analysis. Apparent diffusion coefficient and FA metrics were measured by positioning two regions of interest in the CSC. Linear regression was used to analyze the normal variation of ADC and FA metrics with age.

RESULTS
Regression analysis showed that the ADC values decrease (R² = 0.39; p = 0.0004), while the FA values increase with age (R² = 0.601; p < 0.0001) (Figure 1).
CONCLUSION
Our study demonstrates that DTI can be used to quantitatively evaluate the maturation of the normal pediatric CSC. The simultaneous age-related ADC decrease and FA increase likely reflect progressive maturation, myelination and fiber packing within the CSC similar to that observed in the brain. Our normative dataset for the pediatric CSC may serve as the basis upon which to explore patterns of various spinal cord pathologies.

REFERENCES

KEY WORDS: Diffusion tensor imaging, spinal cord, pediatrics.

Paper 262 Starting at 4:52 PM, Ending at 5:00 PM
Spinal Canal Subdural Hemorrhage in Abusive Head Trauma in Infants
Choudhary, A. K.1 · Bradford, R. 2 · Dias, M. S. 1 · Moore, G. J.1
1Penn State Milton S Hershey Medical Center, Hershey, PA, 2Penn State University College of Medicine, Hershey, PA.

PURPOSE
To assess the prevalence and significance of spinal canal subdural hemorrhage in abusive head trauma in infants.

MATERIALS & METHODS
We reviewed all cases of infants less than 24 months old treated at our institute with abusive head trauma. We reviewed all the cross-sectional imaging where available of both CT and MR imaging of brain, cervical, thoracic and lumbar spine, and CT chest abdomen and pelvis. We also recorded the time of injury if known and time of study.

RESULTS
We reviewed 80 cases of confirmed abusive head trauma, in infants less than 24 months old presenting to our institute between 1998-2009, where clinical data and radiologic studies were available. Out of these, 38 cases had no imaging of the spine and were further excluded from our analysis. Twenty-three cases had imaging of the abdomen done demonstrating subdural hemorrhage in 16 cases (69.5%). In addition, 19 cases had imaging of the cervical spine only which demonstrated subdural blood in seven cases. Overall we had at least 23/80 cases of spinal canal hemorrhage with majority of the hemorrhage in thoracolumbar region.

CONCLUSION
Spinal subdural hemorrhage is common in abusive head trauma but frequently underdiagnosed. It likely tracks down from intracranial subdural hemorrhage and is seen mostly in the thoracolumbar region. Most of the cases were asymptomatic however, if large can cause spinal cord compression. Awareness of spinal subdural hemorrhage in abusive head trauma is important. This may serve as an important marker of abuse.

KEY WORDS: Subdural, abuse, spine.

Paper 119 Starting at 5:00 PM, Ending at 5:08 PM
Longitudinal Diffusion Tensor Findings in Children with Diffuse Brainstem Glioma Treated with Radiation and Antiangiogenic Therapy: SENRS Award Winner
Helton, K. J. · Tran, H. D. · Scoggin, M. · Loeffler, R. · Ogg, R. · Patay, Z. · Broniscer, A. · Hillenbrand, C. St. Jude Children’s Research Hospital Memphis, TN.

PURPOSE
Diffuse pontine gliomas (DPG) make up 15% of all pediatric central nervous system tumors, and generally have a dismal prognosis despite attempts at effective therapies. We report initial results of a longitudinal analysis of diffusion tensor imaging (DTI) parameters of the bilateral cortical spinal (CS) tracts of the central pons in patients being treated for DPG with combined conformal radiation therapy (RT) and antiangiogenesis treatment.

MATERIALS & METHODS
Eight patients [4m/4f, median age 8.2 years (range 4.2-16.2 years)] were imaged on MR scanners (1.5 T and 3 T) on an IRB-approved therapeutic protocol. MR exams occurred at baseline, during RT (weeks 1, 3 and 6), and bimonthly thereafter until taken off the study. Conventional MR imaging (cMRI) and DTI using standard sequence parameters were analyzed offline: images were realigned for each exam by using SPM2. Diffusion tensors, fractional anisotropy (FA), and apparent diffusion coefficient (ADC) were calculated from regions of interest in the bilateral CS tracts. Changes in FA and ADC in the CS tracks were calculated, and compared with tumor response by cMRI.

RESULTS
Three major tumor response groups were identified: (1) relapse within the brainstem (n = 3), (2) relapse from leptomeningeal (LM) disease (n = 2), (3) stable over the observed time (n = 3). Figure 1 shows representative cases from each group. In group I, the mean FA was 0.41 dropping to 0.31 (23% decline), mean ADC was 0.93 increasing to 1.00 (8.1% increase). One patient demonstrated these DTI parameter changes 8 weeks before cMRI showed progressive disease (PD). In group 2, the mean FA was 0.29 and mean ADC was 0.97; for one patient DTI changes occurred 4 weeks before LM tumor by cMRI; for the second patient the FA and ADC stabilized at 7 weeks, but the patient developed diffuse LM tumor at 8 months. In group 3, the mean FA was 0.33, increasing to 0.49 (47% increase), and the mean ADC was 1.15 decreasing to 0.82 (28%) which represented normalization to published standards in healthy volunteers.

CONCLUSION
We found distinct patterns of tumor response by FA and ADC which allowed us to characterize response groups. Normalization of FA and ADC during treatment was associated with stability whereas low or declining FA and
increased ADC was associated with PD in the pons or by LM tumor. Analysis of DTI is ongoing in patients being treated for brainstem glioma (BSG) to establish the diagnostic utility of temporal changes of water diffusion in major tracts in the pons.

**KEY WORDS:** Diffuse brainstem glioma, diffusion tensor imaging, MRI

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**Tuesday Afternoon**

**3:30 PM – 5:00 PM**  
**Room 210**

(24e) Excerpta Extraordinaire: Adult Brain  
(Scientific Papers 263 - 279)

See also Parallel Sessions
(24a) Adult Brain: Alzheimers/Demyelinating  
(24b) Adult Brain: Cerebrovascular Occlusive Disease II  
(24c) Head and Neck: Anatomy, Face, Orbit and Congenital  
(24d) Pediatric: New Techniques and Other

Moderators:  
Christopher P. Wood, MD  
Gregory Nicola, MD

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**Paper 263 Starting at 3:35 PM, Ending at 3:40 PM**  
**Dynamic CT Angiography/CT Perfusion Imaging in the Evaluation of Cocaine-Induced Vasospasm, Differentiating Hypoperfusion vs Ischemia**

Mehta, S. · Iqbal, S. · Gluncic, V. · Frank, J. · Ansari, S. A.  
University of Chicago Medical Center  
Chicago, IL

**PURPOSE**  
Cocaine abuse is an epidemic in the United States that often can present with variable and confusing presentations resulting in patient morbidity and rising healthcare costs. The primary mechanism of disease is the development of vasospasm in the cardiac and cerebral vasculature.

**CASE REPORT/IMAGING FINDINGS**  
A 53-year-old female with history of cocaine abuse presented with sudden onset of slurred speech and dense right-sided hemiplegia (NIHSS 17). However, the patient’s profound neurologic deficits did not correlate with relatively benign CT/MR imaging (MRI) findings. Prior to initiating thrombolytic intervention for suspected acute ischemia, dynamic CT angiography/CT perfusion studies were performed. Grossly preserved cerebral blood volume, markedly elevated mean transit times (6-10 seconds), and reduced cerebral blood flow (40-60 mL/100 gram/min) in the bilateral anterior and middle cerebral artery distributions indicated global hypoperfusion with no large region of ischemia. Additionally, cerebral vasospasm was noted on CTA imaging directing medical therapy towards hemodynamic augmentation instead of thrombolysis. Following 3 weeks of sustained hemiplegia, the patient’s symptoms gradually resolved consistent with CT perfusion findings of a transient global hypoperfusion syndrome.

**SUMMARY**  
We present an unusual case of cocaine-induced vasospasm resulting in global hypoperfusion and exhibiting late (> 3 weeks) reversibility of focal neurologic deficits. Furthermore, we illustrate the benefits of dynamic CTA/CTP imaging in a setting of cocaine abuse, differentiating a transient hypoperfusion syndrome from acute ischemia. CT angiography/CTP imaging may assist in the management of patients with cocaine-induced cerebral vasospasm, altering medical and interventional treatment strategies.

**KEY WORDS:** Cocaine, vasospasm

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**Paper 264 Starting at 3:35 PM, Ending at 3:40 PM**  
**Isolated Inferior Sagittal Sinus Thrombosis: A Rare Diagnosis**

O’Leary, S. M. · Renowden, S. A.  
Frenchay Hospital  
Bristol, UNITED KINGDOM

**PURPOSE**  
Venous sinus thrombosis occurs most commonly in the superior sagittal sinus with one third of cases involving more than one sinus (1). It causes 1-2% of adult stroke (2). It often presents nonspecifically with headache, a reduced GCS, a focal neurologic deficit or seizures. CT and MR imaging are sensitive and specific in making the diagnosis. Isolated inferior sagittal sinus thrombosis is a rare diagnosis with only two other cases reported in the literature (3, 4). The inferior sagittal sinus drains the medial aspect of the cerebral hemispheres, which correlates with the anatomical distribution of the abnormal findings in both the previous case reports and our case.

**CASE REPORT**  
A 66-year-old man presented to our hospital with a right-sided weakness, speech impediment and truncal ataxia. Following MR/MRV, CT and CTV the diagnosis of inferior sagittal sinus thrombosis was made. The patient was referred to the neurologists and commenced on IV heparin and warfarin was started. He was investigated for a predisposing cause of the venous sinus thrombosis but none were discovered. He then developed a spontaneous retroperitoneal hematoma. His warfarin was stopped. He was commenced on aspirin. He did not deteriorate clinically on cessation of the warfarin. He has been improving clinically with near-normal speech and continued improvement in his right-sided weakness.

**IMAGING FINDINGS**  
Venous sinus thrombosis has extensive imaging findings on CT and MR which will be discussed in the presentation. In our case the CT demonstrated bilateral parasagittal areas of
mixed density consistent with hemorrhagic infarction. The anatomical distribution is very similar to the position of the findings made in the two reported cases (3, 4) and also the area drained by the inferior sagittal sinus. CT venography demonstrated the filling defect, tapering and irregularity in the inferior sagittal sinus. The MR confirmed the presence of the parasagittal hemorrhagic infarcts. The DWI and corresponding ADC map confirmed the acute infarct. On MRV the inferior sagittal sinus was not visualized. In view of these findings and on comparison with the two cases in the literature a diagnosis of isolated inferior sagittal sinus thrombosis was made.

SUMMARY

Isolated inferior sagittal sinus thrombosis is a rare diagnosis but should be investigated for when there are bilateral parasagittal hemorrhagic infarcts on imaging.

REFERENCES


KEY WORDS: Isolated inferior sagittal sinus thrombosis

Paper 265 Starting at 3:40 PM, Ending at 3:45 PM

Balo’s Concentric Sclerosis: Clinical progression and Imaging Findings.

Sattar, A. · Juhasz, C. · Garbern, J. · Haacke, M. · Hu, J.
1Wayne State University
Detroit, MI

PURPOSE

We report clinical features and imaging findings in a patient with multiple sclerosis who developed subacute hemiparesis and a coincidental large hemispheric lesion consistent with Balo’s concentric sclerosis (BCS).

CASE REPORT

A 35-year-old male presented with mild right-sided weakness and neurologic examination showed right upper motor neuron facial paresis and spastic gait. MR imaging (MRI) of the brain showed a solitary left peritrigonal T2 white matter hyperintense lesion and the cervical MRI showed several demyelinated plaques. The patient had a benign course and had been treated with glatimer acetate after being diagnosed with relapsing-remitting multiple sclerosis. At 37 years of age, the patient developed severe left-sided weakness and physical examination showed left central facial palsy, left hemiplegic gait and left-sided weakness.

IMAGING FINDING

MR imaging showed new large T2 hyperintense lesion in the right cerebral hemisphere with concentric alternating hyper and hypo intense signal within it. There was associated edema, minimal mass effect and mild patchy peripheral enhancement. Tryptophan PET showed intense uptake in right centrum semiovale. Susceptibility-weighted imaging revealed iron deposition in the lesion and basal ganglia. A MR spectroscopy revealed high choline level in the lesion supporting that choline is a measure of increased cellular turnover elevated in inflammatory processes. Glutamine and glutamate were elevated also resembling a tumor-like finding. Based on the MRI findings, a presumptive diagnosis of BCS was made and patient was treated with methylprednisolone and plasmapheresis with an excellent response. Follow-up MRI showed resolution of edema and peripheral enhancement; however size of lesion did not change. The patient had a benign prognosis during a follow-up period of 1 year.

SUMMARY

Balo’s concentric sclerosis is a rare variant of multiple sclerosis, prevalent among young men (1). It is characterized by large lesion consisting of concentric alternating rings of demyelinated and myelinated white matter. Balo’s concentric sclerosis can have a variable clinical course (2, 3). We conclude that BCS is not a fatal variant; it may run a prolonged fluctuating benign course. Traditionally, it was considered fatal and was diagnosed on postmortem findings or brain biopsy (4). But with advent of MRI, patients can be diagnosed earlier thus improving survival. MR spectroscopy and PET findings are similar to tumor; however, MRI findings of concentric alternating rings of myelination and demyelination, in a patient with prior history of MS are specific, thus obviating need of brain biopsy and making BCS a possible imaging diagnosis.

REFERENCES

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2. Ellen et al. Balo’s concentric sclerosis, presenting as stroke like syndrome. 2007

KEY WORDS: Concentric sclerosis, MR imaging, Susceptibility-weighted imaging
Paper 266 Starting at 3:45 PM, Ending at 3:50 PM
CT/MR Fusion Using Open Source Software for Evaluation of Surface and Depth Electrodes, a Novel Clinical Application

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PURPOSE
CT/MR fusion has been used primarily for preoperative tumor planning and deep brain stimulation. We describe a method using open-source digital imaging and communications in medicine (DICOM) viewer to fuse computed tomography (CT) and magnetic resonance (MR) images in order to evaluate intracranial electroencephalography (EEG) electrode placement.

CASE REPORT
Two illustrative cases are presented. Case 1 is a 23-year-old male with a left parietal dysembryoplastic neuroepithelial tumor and generalized tonic-clonic seizures for 11 years. The patient underwent preoperative placement of EEG surface electrode grids. CT/MR fusion allowed for visualization of grids relative to the mass and confirmation of the seizure focus. The patient underwent successful resection of the lesion and has remained seizure-free. Case 2 is a 20-year-old male with recurrent seizures after partial right temporal lobectomy for low-grade astrocytoma. The patient continued to experience partial complex seizures after surgery and medical management. At 1-year follow up, multiple imaging studies demonstrated no evidence for recurrent or residual tumor. Depth electrodes were placed to direct surgical excision of the epileptogenic focus but failed to detect seizure activity. CT/MR fusion demonstrated the electrodes to be embedded in white matter. Electrodes were replaced under stereotaxis and repeat CT/MR fusion images showed the new location to be within gray matter. The patient’s seizures were localized, he underwent successful partial temporal lobe re-resection and has remained seizure-free.

IMAGING FINDINGS
CT and MR studies from two index patients requiring imaging evaluation of intracranial EEG grids were done using OsiriX™, an open-source software DICOM viewer. Preoperative high-resolution 3D gradient-echo T1-weighted MR images and postoperative CT images were fused. Studies were fused using a simple 10-point registration incorporating both intracranial and extracranial landmarks (right and left ocular globe, right and left mandibular condyle, lambda, bregma, anterior septum pellicidum, pineal gland, right and left choroid plexus in the atria.) Automated compensation for CT gantry tilt was employed. Fused images were optimized to show electrodes relative to brain anatomy while minimizing artifact.

SUMMARY
Use of CT/MR fusion in the evaluation of grid electrode placement is a novel clinical application and may help identify epileptogenic foci with greater accuracy and confirm grid location. High quality CT/MR fusion no longer depends on expensive proprietary software and can be done on studies performed at different times. It is possible to obtain clinically useful information from fused images using a freely available DICOM viewer.

KEY WORDS: Epilepsy

Paper 267 Starting at 3:50 PM, Ending at 3:55 PM
Immune Reconstitution Inflammatory Syndrome after Initiation of Highly Active Antiretroviral Therapy in a Patient with Progressive Multifocal Leuкоencephalopathy

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PURPOSE
We describe the case of an HIV positive patient who initially presented with clinical and radiographic evidence of progressive multifocal leukoencephalopathy (PML). The patient was started on highly active antiretroviral therapy (HAART) and subsequently developed worsening clinical symptomatology as well as progression of disease on MRI of the brain. The constellation of findings is likely the result of the newly described entity in HIV patients: immune reconstitution inflammatory syndrome (IRIS).

CASE REPORT
JH is a 38-year-old male patient with a past medical history of hemophilia A, who is believed to have contracted HIV as a result of a blood transfusion in the early 1980s. He presented on 7/15/2008 with 10 days of headaches, fatigue, photophobia, and fevers. At this time, he had self discontinued
his antiretroviral medication for 1 year. Cerebrospinal fluid cultures were negative, and CT/MRI of the brain revealed evidence of PML. The patient was started on HAART and follow-up MRI on 8/8/2009 showed progression of multiple white matter lesions. JH then developed increasing headache, somnolence and intermittent mild confusion. Repeat lumbar puncture cultures were all negative. Clinical symptoms improved with supportive care and he was tolerating p.o. at the time of discharge. CD4 had increased from 143 to 331.

**IMAGING FINDINGS**

CT brain on 7/15/2008 revealed edema and encephalomalacia in the left frontal and right parietal lobes. MRI brain on 7/17/2008 demonstrated abnormal T2 hyperintensity in the left frontal and biparietal regions most consistent with PML. MRI brain on 8/8/2008 showed interval increase in T2 signal abnormality in multiple lobes.

**SUMMARY**

Progressive multifocal leukoencephalopathy is an opportunistic infection due to the JC virus that develops in immunosuppressed patients, commonly with HIV (2). An effective treatment has classically been the use of HAART. There is increasing literature regarding IRIS related to HAART, which is felt to worsen clinical symptomatology as well as imaging findings in patients with known PML (1,3). Interestingly, our patient’s viral DNA PCR was negative for the JC virus. Given the clinical and radiographic presentation, along with the fact the patient’s extensive work up was otherwise negative, we feel that PML is the likely diagnosis. Incidentally, there have been numerous reports of false negative JC virus DNA PCR results in patients with biopsy proved PML (4).

**REFERENCES**


**KEY WORDS:** Immune reconstitution inflammatory syndrome, progressive multifocal leukoencephalopathy, highly active antiretroviral therapy

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**Tuesday 154**
SUMMARY
Crystal-storing histiocytosis is a very uncommon lesion, and is distinctly unusual in the brain. Previous cases with accompanying advanced radiologic imaging of such a disease process within the brain parenchyma have not been identified during our extensive web-based literature search.

KEY WORDS: Crystal histiocytosis, MRS, MR perfusion

Paper 269 Starting at 4:00 PM, Ending at 4:05 PM
MR Imaging and Pathology Findings of a Cerebellar Cryptococcoma in an Immunocompetent Patient

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PURPOSE
To describe a case of a cerebellar cryptococcoma presenting as a rim-enhancing lesion in the cerebellum of an immunocompetent patient, with imaging features suggestive of a necrotic glioma.

CASE REPORT
A 35-year-old previously healthy male presented with headaches to an outside hospital. MR imaging demonstrated a cerebellar mass, and the patient was referred for further evaluation. On physical exam, no focal neurologic deficits were identified. The patient was negative for HIV, and no laboratory abnormalities were noted. Based on imaging findings suspicious for a left cerebellar glioma, the patient was brought to the operating room. A suboccipital craniotomy and gross total resection were performed, and videotaped. The patient awoke from the procedure, neurologically intact. To describe the development of leptomeningeal carcinomatosis in occipital arachnoid granulations.

Key Words: Cryptococcoma

Paper 270 Starting at 4:05 PM, Ending at 4:10 PM
Leptomeningeal Carcinomatosis in Arachnoid Granulations: Case Report

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PURPOSE
To describe the development of leptomeningeal carcinomatosis in occipital arachnoid granulations.

CASE REPORT
A 56-year-old woman with triple receptor-negative, stage IIIC, infiltrating ductal carcinoma of the breast was treated with a modified radical mastectomy, local radiation therapy, and systemic chemotherapy consisting of adriamycin, cyclophosphamide, and paclitaxel. At 10 months after diagnosis, she developed progressive symptoms of head pressure and pain, blurred vision, tremulousness, and confusion. She also had a generalized tonic-clonic seizure, and head imaging was performed, as described below. One of several lumbar punctures over several weeks yielded cytology results indicative of leptomeningeal carcinomatosis. Follow-up head MR imaging demonstrated rim enhancement, and enhancement of several thick and irregular septations. Several areas of internal high T2 signal and nonenhancement were present. In addition, there were several areas of susceptibility artifact, consistent with chronic blood products associated with the lesion. No diffusion restriction was identified. There was moderate surrounding edema, producing mass effect on the fourth ventricle and producing 1 cm of ascending transtentorial herniation of the cerebellar tonsils. MR permeability and perfusion examinations demonstrated mildly increased permeability, with no definite perfusion abnormality. MR spectroscopy was nondiagnostic, with a wandering baseline and no identifiable peaks, likely secondary to susceptibility artifact from hemorrhagic products.

CONCLUSION
Cryptococcus neoformans and Cryptococcus gattii are encapsulated yeast species with a propensity to involve the lungs and the central nervous system (CNS). Central nervous system involvement typically manifests as meningitis or meningocencephalitis. Solid space occupying lesions (cryptococcomas) may also occur. Cryptococcomas characteristically demonstrate low signal on T1 sequences and high signal on T2 sequences. Lesion enhancement appears to relate to functional immune status, with nonenhancement reported in several immunocompromised patients and rim enhancement reported in immunocompetent patients. There also is an epidemiologic difference between immunocompromised and immunocompetent patients, with preferential infection of immunocompetent patients by the Cryptococcus gattii species rather than the Cryptococcus neoformans species. In this case, a lesion with low T1 signal, high T2 signal, and rim enhancement were found to be consistent with Cryptococcus infection in an immunocompetent host. However, these findings are nonspecific, and are suggestive of a necrotic neoplasm when there is not a known diagnosis of Cryptococcus. Tissue biopsy is generally necessary for the diagnosis of cryptococcoma, and in this case resection was appropriate to resolve the issue of mass effect in the posterior fossa. The low perfusion may be an important differentiating finding from a high-grade glioma.
and CT findings also are described below. Spine MR imaging (MRI) showed multiple small osseous vertebral metastases. A cervical lymph node also was biopsied and found to be positive for metastatic carcinoma. The patient received whole brain external beam radiation therapy, and currently is receiving a revised course of systemic chemotherapy.

**IMAGING FINDINGS**

Initial head MRI showed minimal leptomeningeal signal abnormality in a cerebral convexity sulcus, and a small, circumscribed, enhancing nodule in a right occipital arachnoid granulation just inferior to the right transverse sinus. On follow-up MRI studies over the next 2 months, there was progression of leptomeningeal signal abnormality and enhancement in bilateral occipital, parietal, posterior temporal, and posterior frontal lobe sulci. The enhancing soft tissue within the occipital arachnoid granulation also enlarged, then completely filling this arachnoid granulation and an adjacent one (Figure 1, white arrow). There also developed adjacent cerebellar nonenhancing hyperintensity on T2-weighted images that was suggestive of edema. The arachnoid granulation enhancing soft tissue also showed moderate relative cerebral blood volume on MR perfusion imaging and moderate signal on DWI imaging, suggestive of solid tissue and tumor rather than cerebrospinal fluid. There also developed subtle erosion of the margins of the involved arachnoid granulations and of a thin septation between them, as visualized on CT bone windows. Following whole brain external beam radiation, MRI depicted a moderate improvement in the diffuse leptomeningeal abnormality and in the right cerebellar edema signal adjacent to the focal arachnoid granulation leptomeningeal carcinomatosis.

**SUMMARY**

We present a novel case of leptomeningeal carcinomatosis evolving within an arachnoid granulation. As arachnoid granulations are extensions of the subarachnoid space, this would not be unanticipated, perhaps particularly in the dependent portions of the head where this patient had other predominance of leptomeningeal carcinomatosis.

**KEY WORDS:** Leptomeningeal carcinomatosis, arachnoid granulation

**IMAGING FINDINGS**

Magnetic resonance imaging (MRI) of the brain identified multiple intraventricular masses in the bilateral frontal horns with involvement of the septum pellucidum, as well as in the lateral, third, and superior fourth ventricles with mild right to left midline shift, hydrocephalus and transependymal edema. These masses were hyperintense on T1 and heterogeneously hypointense on T2 imaging. Abnormal signal consistent with leptomeningeal spread also was identified in the quadrigeminal plate cistern and cerebellar fissures as well as the cerebellar folliculus regions bilaterally. Only mild peripheral enhancement was noted with absence of diffusion restriction. The 1-month postoperative lumbar spine MRI showed two intradural enhancing nodules involving the cauda equina and L4 nerve root consistent with spinal leptomeningeal metastases.
Summary
We present a case of a rare atypical central neurocytoma with craniospinal dissemination. This case is notable for older age at onset, extensive tumor burden at presentation, atypical pathologic findings consistent with malignancy, and aggressive tumor behavior including late leptomeningeal spread to the spine.

Key Words: Neurocytoma, leptomeningeal spread

Paper 272 Starting at 4:15 PM, Ending at 4:20 PM
Cerebral Neoplasms in L-2-Hydroxyglutaric Aciduria

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Purpose
L-2-hydroxyglutaric aciduria (L2HGA) is a rare inborn error of metabolism. Clinically, it is characterized by exclusive central nervous system involvement and dominantly leukodystrophy-like imaging appearance, suggesting that the target substance of neurotoxicity is the cerebral white matter. To date less than 100 cases of the disease have been reported. In contrast to most other common organic acidurias, L2HGA is characterized by a mild and more protracted clinical course; hence patients with L2HGA have a relatively long life expectancy. However, there is increasing evidence to suggest a fairly significant propensity to the development of cerebral neoplasms in patients with L2HGA, typically in young adulthood. The purpose of this presentation is to report two new cases of cerebral tumors in patients with L2HGA.

Case Report
The imaging files of eight patients (M/F: 6/2, age range at imaging: 7-36 years, mean: 16.1 years) with laboratory-confirmed L2HGA were reviewed. Two patients (1M/1F) were found to have intracranial neoplasms, diagnosed at the age of 19 and 36 years, respectively.

Imaging Findings
Both cerebral tumors developed supratentorially (1 right frontal oligodendroglioma and 1 left deep frontal “low grade glioma”). Both cases exhibited the classical MR imaging features of L2HGA within brain parenchyma at MR imaging work up, allowing confident diagnosis of the coexisting metabolic disorder in one of the patients, who was not known to have L2HGA at the time of tumor diagnosis.

Conclusion
The incidence of CNS neoplasms in patients with L2HGA is remarkably high, possibly higher than previously suggested. The genetic and/or biochemical factors predisposing to tumor genesis in this peculiar neurometabolic disorder are yet unknown, but it is conceivable that the risk for tumor development increases with age. Since the neurocognitive manifestations and disease course in L2HGA are rather benign, increased awareness of the apparently strong association between the two conditions is warranted. We recommend a close surveillance of L2HGA patients in order to allow early diagnosis and possible cure of potentially life-threatening cerebral neoplasms.

Key Words: Inborn errors of metabolism, cerebral neoplasm, L-2 hydroxyglutaric aciduria

Paper 273 Starting at 4:20 PM, Ending at 4:25 PM
Collision Tumor of the Sella: Coexistence of Craniopharyngioma and Pituitary Adenoma

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Purpose
Collision tumor is a rare occurrence of tumors arising from distinct cell lines and coexisting in the same anatomical location. The tumor components may be distinct or admixed with each other. Collision tumors of sella have been reported infrequently in medical literature. To the best of our knowledge, only 5 cases of coexisting pituitary adenoma and craniopharyngioma have been reported in the medical literature, and our case being the first in radiology literature. We present imaging findings in a case of this rare and interesting entity, with a distinct expansile sellar mass as pituitary adenoma and cystic suprasellar mass as craniopharyngioma, proved histologically.

Case Report
The patient was a 69-year-old male who presented with gait and visual disturbances. On examination patient had bitemporal hemianopsia and clinical localization of the lesion was made at the optic chiasm. The CT and MRI evaluation revealed an expansile sellar mass with large suprasellar cystic component. On endocrinological workup, the patient had decreased levels of FSH, LH and Testosterone. His Prolactin and TSH were normal.

Imaging Findings
Initial CT examination of the brain demonstrated a large sellar and suprasellar complex mass. The sellar component measured 1.5 x 2.7 cm and the cystic portion measured 3.3 x 5.2 cm. On CT, the sella showed widening and remodeling without destruction or infiltration. The intrasellar component was solid and the suprasellar component was predominantly cystic. The cystic component showed peripheral calcification. On further MR imaging, hypointensifying solid component in the sella with suprasellar cystic component showing intense peripheral enhancement was demonstrated. The cystic component was hyperintense on T2 weighted images and showed incomplete signal suppression on FLAIR sequence. There was small hematocrit level within the cyst suggesting...
previous intratumoral hemorrhage. As the tumor manifested imaging features of both macroadenoma and craniopharyngioma, the imaging findings were concluded as compatible with either macroadenoma or craniopharyngioma. However collision tumor having both tumor components coexisting was not considered initially. A cranio-orbital zygomatic craniotomy was performed for resection of tumor. On postresection histopathologic and immunohistochemical evaluation, the tumor consisted of adamantinomatous craniopharyngioma and pituitary adenoma. The components of the two neoplasms were identified distinct from each other, with no intermingling between the two.

**SUMMARY**
Collision of two tumors may present as diagnostic and surgical challenge. Neuroimaging with clinical and endocrinological correlation is important in establishing a preoperative diagnosis.

**KEY WORDS:** Craniopharyngioma, pituitary adenoma, collision tumor

**Paper 274 Starting at 4:25 PM, Ending at 4:30 PM**

**A Case of Nonenhancing Metastatic Small Cell Carcinoma to the Brain with MR Features Mimicking Lymphoma: Pathologic Correlation with Evidence of Azzopardi Effect.**

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**PURPOSE**
A 61-year-old man with known metastatic small cell carcinoma of the lung was referred to us for a newly discovered central nervous system (CNS) lesion. The patient experienced no headaches, but reported some difficulty with word finding. Examination revealed no focal motor or sensory deficits. The patient underwent advanced MR imaging including dynamic susceptibility perfusion. The lesion did enhance slightly on follow-up MR imaging 13 months later, which was followed by stereotactic biopsy.

**IMAGING FINDINGS**
MR imaging revealed a nonenhancing white matter lesion with only mild mass effect and abutting the lateral ventricle (Figure 1A, arrows). The tumor exhibited restricted diffusion and the perfusion imaging revealed only mildly elevated relative cerebral blood volume (rCBV) that was less than 1.8 times that of the normal contralateral white matter. The differential diagnosis at presentation included atypical lymphoma and tumor demyelination. While metastatic disease was considered it seemed less likely based on the low rCBV and lack of enhancement. Pathologic examination of the tumor revealed hypercellularity resembling lymphoma, with nuclear molding and neuroendocrine features of a small cell carcinoma that was confirmed with immunohistochemical stains. There were copious basophilic granular material surrounding blood vessels (Figure 1B, arrows), a phenomenon known as the Azzopardi effect, described mainly in tumors with neuroendocrine features. These materials are nucleic acids, presumably released from tumor necrosis. The Azzopardi effect is rare among metastatic lesions to the CNS.

**SUMMARY**
We present a case of metastatic brain tumor from a small cell carcinoma of the lung that exhibited no contrast enhancement, restricted diffusion, and mildly increased rCBV on perfusion imaging: all features more suggestive of CNS lymphoma. Pathologic examination revealed a rare vascular phenomenon -- the Azzopardi effect -- which suggests a possible mechanism for the lack of enhancement by behaving like a pseudo-blood brain barrier.

**REFERENCES**

**KEY WORDS:** Metastasis, nonenhancement, lymphoma
Development of Low Grade Astrocytoma in a Region of Cortical Dysplasia Associated with Partial Fused Lip Schizencephaly

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PURPOSE
Cortical dysplasia commonly is associated with schizencephaly. Cortical dysplasia’s association with brain neoplasms, specifically astrocytoma, is rare, but has been described, mainly in the pediatric population. We present a case of an older adult who developed a low-grade astrocytoma in a region of cortical dysplasia associated with a partial fused lip schizencephaly.

CASE REPORT
A 54-year-old woman presented with new onset seizures. Abnormality was identified in the right frontotemporal region on MR imaging (MRI) and biopsy was performed, with pathology consistent with a low-grade, well differentiated astrocytoma, World Health Organization Grade 2. The patient is currently undergoing chemotherapy with regular MRI surveillance. Over the past 3 years, the tumor has progressed. This patient with unilateral partial fused lip schizencephaly had not suffered neurologic impairment until presenting with seizures at 54 years of age. This clinical scenario is reasonably consistent with multiple studies which have demonstrated that unilateral defects on the closed lip schizencephalic spectrum have the mildest neurologic course. Schizencephaly and cortical dysplasia are believed to be frequently associated because they result from the same pathologic neuronal migrational process. Both cortical dysplasias and tumors cause epilepsy, but few studies have examined the coexistence of both together. It can be difficult to distinguish between the two preoperatively on MRI. Compared with the other associated tumor types, astrocytomas tend to occur in older patients, such as in this case. Cases of slow growing astrocytomas persisting for as long as 28 years have been described. Coexistence of such neoplasms with cortical dysplasia, most frequently seen in the pediatric population, suggests a dysplastic nature of these tumors.

IMAGING FINDINGS
Postgadolinium T1-weighted imaging reveals a prominent CSF space at the brain surface in the right frontotemporal region, with abnormality extending from its medial surface to the frontal horn of the right lateral ventricle. Medial to the prominent CSF space is a large region of cortical thickening/dysplastic gray matter. Within this dysplastic gray matter is a round nonenhancing mass (arrow) with surrounding vasogenic edema and associated mass effect on the right lateral ventricle and midline shift. These findings are most compatible with a unilateral partial fused lip schizencephaly and associated cortical dysplasia, with transformation into a nonenhancing brain tumor (Figure).

SUMMARY
A 54-year-old woman developed new onset seizures related to a low-grade astrocytoma which developed in a region of cortical dysplasia associated with a partial fused lip schizencephaly.

REFERENCES

KEY WORDS: Cortical dysplasia, astrocytoma, schizencephaly

Delayed Microhemorrhage on Gradient-Echo MR Imaging in Cerebral Fat Embolism

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PURPOSE
Cerebral fat embolism is a potentially serious complication of long bone fractures. Brain MR imaging (MRI) findings include numerous FLAIR and diffusion-weighted hyperintense lesions scattered throughout the gray and white matter
of the cerebral hemispheres ("starfield pattern"). While cutaneous petechial hemorrhage is a typical clinical finding and microhemorrhage is a consistent neuropathologic finding, there has been little information on detection of microhemorrhage on gradient-echo MRI. Our purpose is to report a case of cerebral fat embolism which demonstrated diffuse microhemorrhage on delayed gradient echo MRI.

CASE REPORT
A 80-year-old female unrestrained rear passenger in a motor vehicle collision presented with bilateral femur, tibial and fibular fractures and a left distal radius fracture. Admission noncontrast head CT revealed scattered areas of subarachnoid hemorrhage. Glasgow coma scale (GCS) on admission was 15. After surgical fixation of her multiple fractures, the patient was unable to be extubated and GCS was 3. Brain MRI on day 4 demonstrated diffuse FLAIR and diffusion hyperintensities in the cerebral hemispheres and posterior fossa. There was no significant hemorrhage on gradient-echo images. Clinical exam around this time revealed multiple small petechiae on the chest and right shoulder. Diagnosis of fat embolism syndrome was suggested. Over the next month, the patient remained in intensive care with respiratory insufficiency. While the patient's GCS did improve to score of 9, a repeat brain MRI was performed on day 35 because of her significant residual neurologic deficit.

IMAGING FINDINGS
Brain MRI on day 35 revealed diffuse confluent FLAIR hyperintensities in the hemispheric white matter and corpus callosum. There had been relative improvement in the cortical and posterior fossa signal abnormality. The diffusion signal abnormality had resolved. Gradient-echo images demonstrated numerous punctuate areas of hypointensity in the subcortical white matter, corpus callosum, internal capsule and posterior fossa white matter, including the central pons, middle cerebellar peduncles and cerebellar hemispheres. There was relative preservation of the deeper centrum semiovale and corona radiata white matter as well as the deep gray structures.

SUMMARY
Delayed gradient-echo imaging may be helpful in the diagnosis of cerebral fat embolism by demonstrating areas of microhemorrhage, particularly in the subcortical and posteri- or fossa white matter and the corpus callosum. The degree of microhemorrhage also may contribute to predicting neurologic prognosis.

KEY WORDS: Fat embolism, microhemorrhage, gradient echo

Paper 277 Starting at 4:40 PM, Ending at 4:45 PM
Extracranial Venous Obstruction Masquerading as Intracranial Hypotension: Another Cause for the Venous Distension Sign

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PURPOSE
We present an unusual case of intracranial venous hypertension caused by central venous obstruction, presenting with the classic imaging findings of intracranial hypotension (IH), including the venous distension sign (VDS). Intracranial hypertension is a well recognized clinical syndrome caused by CSF volume depletion and resulting low intracranial pressure. Characteristic imaging findings, including the VDS, can be explained on the basis of compensatory enlargement of the intracranial venous compartment. However, this case highlights the importance of considering veno-obstructive processes in the imaging differential diagnosis of IH.

CASE REPORT
A 48-year-old female with chronic seizure disorder and ESRD was referred for brain MR for headaches. A diagnosis of IH was made. As her symptoms were mild, no further treatment was performed. Two years later, during an outpatient dialysis session, she became dizzy and unresponsive. Despite aggressive medical therapy, including empiric antibiotic and antiviral therapy and epidural blood patch, she deteriorated, becoming comatose. Investigations eventually led to the diagnosis of central venous obstruction which was treated successfully with balloon angioplasty. Following treatment, she made a complete recovery and ultimately was discharged home.

IMAGING FINDINGS
Initial outpatient MR shows the typical imaging findings of IH: sagging of the central brain, crowding of the suprasellar cistern, flattening of the brainstem, tonsillar descent (Figure A), mildly engorged pituitary and dural thickening with diffuse pachymeningeal enhancement (Figure B). The VDS was present (Figure A inset). CT and MR imaging done just following the acute presentation 3 years later showed greater descent of the central brain and cerebellar tonsils, and marked effacement of the basal cisterns. However, the MR imaging also showed numerous flow voids within the basal cisterns raising concern for vascular pathology (dural fistula). Conventional angiogram showed marked brain congestion with delayed arteriovenous transit and diffuse “phlebitic” pattern, but no fistula. CT neck showed occluded right IJV and a tight stenosis of the left brachiocephalic vein. There was a significant pressure gradient (> 30 mmHg). This was treated successfully with balloon angioplasty. CT head performed several days after angioplasty showed consider-
able improvement with better delineation of the basal cisterns and resolution of tonsillar herniation, correlating with the clinical recovery.

**SUMMARY**

We present multimodality imaging of a patient with progressive congestive encephalopathy on the basis of extracranial venous obstruction. Interestingly, the initial imaging findings are those of IH. This case highlights the importance of considering extracranial venous obstruction in the imaging differential diagnosis of IH.

**KEY WORDS:** Venous obstruction, cerebral edema, intracranial hypotension

**Paper 278 Starting at 4:45 PM, Ending at 4:50 PM**

**Giant Cavernous Hemangiomas: A Diagnostic Challenge**

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**PURPOSE**

Sporadic cavernous hemangiomas are benign vascular malformations of unknown etiology that can be seen almost anywhere in the central nervous system. Their size varies from a few millimeters to a few centimeters. With increasing size their imaging findings may become less typical and they may not be considered in the differential diagnosis of a patient with a large and complex solitary intracranial mass. Giant cavernous hemangiomas (GCHs) occur rarely and little has been reported about their imaging features. Our purpose is to review the MR imaging (MRI) features of GCHs, their differential diagnosis, and best imaging approach.

**CASE REPORT**

The definition of GCHs is arbitrary. We review the imaging findings of 7 patients with intraaxial cavernous hemangiomas with a diameter ≥ 3 cm. All the GCHs were diagnosed based on MRI findings and/or pathology findings. According to the literature GCHs tend to be more common in children than in adults. The mean age of presentation of our patients was 7.5 years. The most common presentation symptoms were seizures, hemorrhages and focal neurologic signs.

**FINDINGS**

Imaging appearance of GCHs was variable and complex ranging from those typical of cavernous hemangiomas to completely cystic lesions or those resembling neoplasms with striking contrast enhancement and mass effect. A common association was that of a developmental venous anomaly which may help reach the correct diagnosis. When they bleed acutely, a slightly T1 hyperintense rim was typical. Contrast enhancement is usually minimal and fluid levels were common.
the lesion and sparing of the associated DVA. If only the hematoma is evacuated, follow-up MRI may showed the underlying cavernoma.

**KEY WORDS:** Giant cavernous hemangioma

**Paper 279 Starting at 4:50 PM, Ending at 4:55 PM**

**Thalamic Connectivity in Orthostatic Tremor**

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**PURPOSE**

Orthostatic tremor (OT) consists of rhythmic muscle discharges at around 14 to 16 Hz in the lower extremities whilst standing, resulting in a debilitating movement disorder. The pathophysiology is poorly understood. Deep brain stimulation (DBS) of the ventralis intermedius nucleus of the thalamus (VIM) has been reported with success. The purpose of this study is to analyse the diffusion tensor imaging (DTI) connectivity of the thalamus in this tremor syndrome.

**CASE REPORT**

We report a case of orthostatic tremor in an otherwise healthy female patient. Diffusion tensor imaging MR data was acquired in the patient and healthy controls using echo planar imaging, (70 2 mm thick slices; voxel size isotropic at 2 x 2 x 2 mm; 8-channel head RF coil; 32 directions of diffusion weightings). Analysis included correction of eddy current distortion, local fitting of diffusion tensors, and bayesian estimation of diffusion parameters. Probabilistic tractography was performed which repetitively samples from the distributions on voxel-wise principal diffusion directions, computing a streamline through samples to generate a probabilistic streamline. A connectivity distribution map was constructed of the whole thalamus as well as the VIM. Further analysis included a thalamic connectivity classification of cortical connectivity probability.

**IMAGING FINDINGS**

Using probabilistic tractography, VIM demonstrated greater connectivity with the primary somatosensory cortex than motor cortex. (Figure: MNI brain showing OT (red) and control subjects (blue) projections of VIM) A connectivity classification which computes the probability of each voxel’s connection with the primary motor and sensory cortices showed that significant areas of the thalamus including VIM had a higher probability to connect to primary somatosensory cortex than motor cortex in OT. In contrast, control subject probability classification was consistent with known thalamic cortical projections.

**SUMMARY**

The diffusion tensor imaging characteristics of the thalamus in this tremor syndrome suggest an altered connectivity organization of the VIM. An increased connection with the somatosensory cortex of VIM may explain the subjective feeling of postural instability in this disease, which is alleviated by deep brain stimulation of the VIM.

**KEY WORDS:** Orthostatic tremor, thalamus, connectivity

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**Tuesday Afternoon**

**3:30 PM - 5:00 PM**

**Room 207**

(25) Synaptic Junction Programming - Workshop: Post Processing

(280) Postprocessing Introduction and Overview

— John L. Go, MD

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Postprocessing Introduction and Overview

John L. Go, MD
Postprocessing Introduction and Overview

Wendy R.K. Smoker, MS, MD, F ACR

LEARNING OBJECTIVES
Upon completion of this presentation, participants will be able to:
1) Review the common sites of OC and OP Ca.
2) Learn the primary nodal draining pathways for the major sites of OC and OP Ca.
3) Discuss a checklist for complete assessment of OC and OP carcinomas.

Imaging of Laryngeal and Hypopharyngeal Cancer

Christine Glastonbury, MBBS

LEARNING OBJECTIVES
Upon completion of this presentation, participants will be able to:
1) Define the key staging landmarks for imaging evaluation of larynx and hypopharynx SCCa.
2) Recognize the complementary role of imaging modalities in staging laryngeal/hypopharyngeal SCCa.
3) Review the treatment strategies and therefore the role of imaging in patient care for these tumors.

PRESENTATION SUMMARY
Over the last 20 years there have been many changes in the treatment of laryngeal squamous cell carcinoma (SCCa), with an increasing use of surgical and chemo-radiation organ preservation techniques. These are aimed at retaining speech and swallowing and avoid a stoma that otherwise ensues with total laryngectomy. During these last 2 decades the incidence of laryngeal carcinoma has not increased significantly although there is an increasing proportion of minorities (both Hispanic and blacks) affected by this tumor with an overall decline in the white population, reflecting altering cigarette smoking patterns. While the cure rates for early stage (I & II) tumors remains of the order of 75-90%, the SEER and NCDB (USA) data both show a declining survival for advanced (stage III & IV) laryngeal SCCa. Our role as radiologists in managing these patients is to aid our clinicians in accurately staging the primary tumors. To this end it is important that we recognize the critical imaging landmarks that distinguish the T-stages of laryngeal and hypopharyngeal SCCa. We also should be able to guide our clinicians to the correct imaging tool to best evaluate the primary tumor and nodal disease.

REFERENCES
**PET/CT in Head and Neck Cancer**  
*Barton F. Branstetter IV, MD*

**LEARNING OBJECTIVES**
Upon completion of this presentation, participants will be able to:
1) Identify frequent sources of false positive PET/CT interpretation in the head and neck.
2) Identify frequent sources of false negative PET/CT interpretation in the head and neck.
3) Specify clinical situations in which PET/CT can be misleading.

**PRESENTATION SUMMARY**
PET/CT has become a critical element in staging, monitoring, and surveillance of head and neck cancer. Unfortunately, there is ample opportunity for false positive and false negative interpretations. This portion of the Head and Neck SAM will focus on potential pitfalls encountered during the interpretation of Head and Neck PET/CT performed on patients with upper aerodigestive malignancies.

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**Amyloid Imaging in Alzheimer's Disease**
*Chester A. Mathis, PhD*

**LEARNING OBJECTIVES**
Upon completion of this presentation, participants will be able to:
1) Specify the importance and limitations of amyloid imaging in the progression of Alzheimer's disease.
2) Describe the prevalence of positive amyloid load in elderly normal control and mild cognitive impairment subjects.
3) Report the status of using amyloid imaging agents for clinical diagnosis.

**PRESENTATION SUMMARY**
Imaging agents capable of assessing amyloid-beta (Aβ) plaque content in vivo in the brains of Alzheimer disease (AD) subjects likely will be important as diagnostic agents, as surrogate markers to assess the efficacy of antiamyloid therapeutics currently under development and in clinical trials, and for testing the amyloid cascade hypothesis of AD. We identified a variety of candidate compounds for positron emission tomography (PET) imaging studies of Aβ deposition in human subjects and reported the first PET studies of carbon-11-labeled Pittsburgh Compound B (PiB) in AD and normal subjects in 2002. Our work with PiB has been extended to PET studies of mild cognitive impairment (MCI) and healthy elderly control subjects. The ability to quantify regional Aβ plaque load in living human subjects has provided some interesting and unexpected findings, particularly in MCI and elderly normal control subjects. The usefulness of PET amyloid imaging methodology as a diagnostic agent for Aβ plaques in the brain, as a surrogate marker of therapeutic efficacy in antiamyloid drug trials, and to assist in testing the amyloid cascade hypothesis of AD will be highlighted.

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**Amyloid, Memory Dysfunction and fMRI**
*Randy L. Buckner, PhD*

**LEARNING OBJECTIVES**
Upon completion of this presentation, participants will be able to:
1) Discuss about PET, structural MRI, and functional MRI alterations that are characteristic of early-stage Alzheimer's disease.
2) Review the unique utility of combining multiple imaging modalities to characterize a disease.
**PRESENTATION SUMMARY**

Enabled by recently developed PET ligands, studies of amyloid deposition in Alzheimer disease (AD) reveal a stereotypic pattern of vulnerability. The cortical regions with early and pronounced deposition are linked to a specific brain network that is associated with the medial temporal lobe memory system and a wider brain system that has come to be known as the “default network”. Recent PET and MR imaging (MRI) observations will be reviewed that suggest properties of activity and metabolism within the default network set the context for the pathologic cascade of AD. At the earliest stages of the disease, atrophy (visualized with MRI), metabolism disruption (visualized by FDG PET), and functional disturbances (visualized with functional MRI) can be observed in the default network, including in clinically normal individuals who show amyloid deposition. I will conclude by speculating on why regions within the default network might be particularly vulnerable to AD pathology and the implications for study of disease risk and intervention.

**REFERENCES**


**What We Have Learned from ADNI**

*Clifford R. Jack, Jr., MD*

**LEARNING OBJECTIVES**

Upon completion of this presentation, participants will be able to:
1) Describe the major biomarkers of Alzheimer's disease.
2) Review a biomarker-based model of disease progression.

**PRESENTATION SUMMARY**

Prevailing evidence strongly supports the position that the initiating event in Alzheimer disease (AD) is related to abnormal processing of Aβ peptide ultimately leading to formation of Aβ amyloid plaques in the brain. This process occurs while subjects are still cognitively normal. Biomarkers of brain Aβ amyloidosis are reductions in CSF Aβ42 and increased amyloid PET tracer retention. After a lag period which is variable from subject to subject, neuronal dysfunction and neurodegeneration become the dominant pathologic processes. Biomarkers of neuronal injury and neurodegeneration are elevated CSF tau and structural MR imaging measures of cerebral atrophy. Neurodegeneration is accompanied by synaptic dysfunction, which is reflected by decreased fluorodeoxyglucose uptake on positron emission tomography. Currently available data from ADNI support a model relating disease stage to AD biomarkers in which (1) Aβ amyloid biomarkers become abnormal first, before neurodegenerative biomarkers and before cognitive symptoms, (2) neurodegenerative biomarkers become abnormal later and correlate with clinical symptom severity. Future studies are needed to either validate or refute various aspects of this biomarker-based model of disease.

**Tuesday Evening**

5:00 PM - 6:30 PM

Room 210

(28) General Session: Radiation Dose Reduction for the Neuroradiologist: What You Need to Know!

(287) A Simplified Approach to Radiation Dose Measurements

— Suresh K. Mukherji, MD, FACR

(288) Strategies for Dose Reduction

— Mohammed Ibrahim, MD

(289) Recommendations for Best Practices in CT Scanning

— Pina C. Sanelli, MD, MPH

Moderators: Pina C. Sanelli, MD, MPH
Suresh K. Mukherji, MD, FACR

**A Simplified Approach to Radiation Dose Measurements**

*Suresh K. Mukheji, MD, FACR*

**LEARNING OBJECTIVES**

Upon completion of this presentation, participants will be able to:
1) Define the terms used for describing radiation exposure.
2) Review pitfalls in using CTDI and DLP measurements.
3) Discuss quality control methods used in accordance with ACR accreditation.

**PRESENTATION SUMMARY**

Provide an overview of the terms used in describing radiation exposure to patients from CT scanning. Include the pitfalls in using CTDI and DLP measures. Discuss quality control methods used in accordance with ACR accreditation.
Strategies for Dose Reduction

Mohammed Ibrahim, MD

LEARNING OBJECTIVES
Upon completion of this presentation, participants will be able to:
1) Review the imaging parameters of CT image.
2) Cite the basic strategies in minimizing radiation dose.
3) Review advanced strategies in minimizing radiation dose

PRESENTATION SUMMARY
To outline the basic principles of radiation dose in computed tomography (CT) and the different strategies in minimizing the radiation dose in neuroimaging. The basic strategies in minimizing radiation dose involve changes in the acquisition parameters of the CT scan. Such parameters includes tube current, peak voltage, tube rotation time, pitch, and collimation. Typically, if one of these parameters is to be decreased, another needs to be increased to maintain image quality. A complete understanding of the imaging parameters is essential to optimize the quality of CT image while minimizing radiation dose. Automatic tube current modulation (ATCM) and adaptive statistical iterative reconstruction (ASIR) are many of the technical innovations to help reduce radiation dose. Employing these techniques along with good patient centering is valuable in minimizing radiation dose.

Recommendations for Best Practices in CT Scanning

Pina C. Sanelli, MD, MPH

Tuesday Afternoon

5:00 PM - 6:30 PM
Room 312

(29) Advanced Imaging Seminar: New Developments in Diffusion MRI

(290) Diffusion MRI: Clinical Applications
— Elias R. Melhem, MD, PhD

(291) Diffusion Tensor Imaging: Beyond Two b-Values and Six Directions
— Robert C. McKinstry, III, MD, PhD

(292) Diffusional Kurtosis Imaging in DKI
— Joseph A. Helpern, PhD

Moderator: Peter B. Barker, Phil, PhD

Diffusion MRI: Clinical Applications

Elias R. Melhem, MD, PhD

LEARNING OBJECTIVES
Upon completion of this presentation, participants will be able to:
1) Describe the principles of diffusion contrast and anisotropy.
2) Recognize the acquisition, processing, and analysis of diffusion tensor imaging plus the main white matter tracking algorithms.
3) Identify potential clinical applications of diffusion tensor imaging in central nervous system disease.

PRESENTATION SUMMARY
By incorporating directionality into a diffusion-weighted measurement, diffusion tensor images can be obtained. Rather than probe cellular pathophysiology, diffusion tensor imaging (DTI) provides a unique means of investigating tissue microstructure and brain anatomy. In this presentation, the principles of diffusion contrast and anisotropy will be discussed. Image acquisition, processing, and analysis plus the main white matter tracking algorithms will be presented. Clinical applications in developmental, neurodegenerative, neoplastic, demyelinating, and other types of disease will be discussed.

Diffusion Tensor Imaging: Beyond Two b-Values and Six Directions

Robert C. McKinstry, III, MD, PhD

LEARNING OBJECTIVES
Upon completion of this presentation, participants will be able to:
1) Review the impact of the diffusion sensitivity (b value) and diffusion sampling pattern on the resulting DTI images.
2) Define the role of ADC, FA and the Directionally Encoded Color map in clinical diagnosis.
3) Utilize DTI to refine the process of differential diagnosis.
4) Evaluate the utility and limitations of tractography in clinical practice.

PRESENTATION SUMMARY
This presentation will review the rationale for measuring the diffusion tensor with two b-values and six directions. The motivation for using multiple b-values and high angular resolution gradient sampling patterns will be presented. The impact of advanced sampling strategies on computation of the diffusion tensor will be discussed. Computational approaches beyond a single diffusion tensor will be introduced. Research and clinical applications of advanced diffusion sampling schemes will be highlighted.
Diffusional Kurtosis Imaging in DKI

Joseph A. Helpern, PhD

LEARNING OBJECTIVES
Upon completion of this presentation, participants will be able to:
1) Illustrate advances in diffusion-weighted MRI.
2) Describe a new diffusion imaging technique.

PRESENTATION SUMMARY
Diffusion-weighted imaging (DWI) provides a powerful tool for probing tissue microstructure. Brain tissue microstructure strongly influences water diffusion and it is well known that tissue microstructure is closely associated with function. Hence, the study of brain water diffusion properties provides a unique opportunity to noninvasively study disease processes. By far the most widely applied DWI technique to date is diffusion tensor imaging (DTI) and well established diffusion metrics, such as mean diffusivity (MD) and fractional anisotropy (FA), have proved useful in assessing a number of diseases. It is well recognized, however, that DTI yields only a fraction of the information potentially accessible with DWI. This is mainly due to the fact that DTI is based upon a Gaussian approximation of the diffusion displacement probability distribution. Particularly in brain, non-Gaussian diffusion effects are known to be substantial and are believed to arise from diffusion barriers, such as cell membranes and organelles, as well as water compartments with differing diffusion properties. Hence, non-Gaussian diffusion effects are natural indicators of tissue microstructural complexity and may be used to improve the evaluation of tissue morphology along with changes that may occur with disease processes. To fully exploit non-Gaussian diffusion for the investigation of brain function and disease processes, however, a time-efficient protocol for use in humans is needed. Although several techniques for assessing non-Gaussian diffusion have been proposed, they require relatively long scanning times (from a clinical perspective) and/or advanced hardware (gradients), which has limited their wide-spread application in humans. Recently, our laboratory introduced a new clinically feasible DWI technique called diffusional kurtosis imaging (DKI) where the diffusional kurtosis (DK) is a quantitative measure of the non-Gaussianity of the diffusion process (1-3). Diffusional kurtosis imaging is the minimal extension of DTI that enables the precise quantification of diffusional non-Gaussianity. With DKI one also obtains all of the standard DTI metrics. The fundamentals of DKI along with preliminary data from normal brain development and aging, attention deficit hyperactivity disorder (ADHD), schizophrenia, stroke and Alzheimer disease (AD) will be presented.

REFERENCES
Notes
**LEARNING OBJECTIVES**
Upon completion of this presentation, participants will be able to:
1) Identify key imaging features of various lesions in the head and neck.
2) Identify and list the top radiographic differential considerations for each diagnosis.

**PRESENTATION SUMMARY**
Case presentations will review common head and neck pathology on CT and MR imaging. The cases will be designed to help audience members prepare for the CAQ examination, but also review diagnoses relevant to the practicing radiologist.

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**Note about scanned images:** Scanned images are included in the proceedings book. Some submitted images were reduced during the printing process, thereby decreasing clarity. The images as originally submitted can be viewed within the abstract on the ASNR website at www.asnr.org/2010.

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**Wednesday Morning**

7:30 AM – 8:30 AM
Ballroom ABC

(30) Maintenance of Certification (MOC) – Review Session (AR+)*
Head and Neck

(293) Head and Neck
— Hilda E. Stambuk, MD

(294) Head and Neck
— Ashley H. Aiken, MD

Moderator:  Laurie A. Loevner, MD

*An educational grant was received by Bayer Healthcare Pharmaceuticals, Inc. in support of the Audience Response Plus+ (AR+) technology in the Maintenance of Certification (MOC) Review Sessions.

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**Wednesday Morning**

8:30 AM – 10:00 AM
Ballroom ABC

(31) General Session: Future Perspectives

(295) Neuroradiology, Technology and Neuroscience
— R. Nick Bryan, MD, PhD

(296) Applications of Nanotechnology to Central Nervous System Imaging and Therapy
— James M. Provenzale, MD

(297) Futuristic Technology for Radiology
— Eliot L. Siegel, MD

Moderator:  Richard H. Wiggins III, MD, CIIP

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**Head & Neck**

Hilda E. Stambuk, MD
Ashley H. Aiken, MD

**LEARNING OBJECTIVES**
Upon completion of this presentation, participants will be able to:
1) Identify key imaging features of various lesions in the head and neck.
2) Identify and list the top radiographic differential considerations for each diagnosis.

**PRESENTATION SUMMARY**
Case presentations will review common head and neck pathology on CT and MR imaging. The cases will be designed to help audience members prepare for the CAQ examination, but also review diagnoses relevant to the practicing radiologist.

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**Neuroradiology, Technology and Neuroscience**

R. Nick Bryan, MD, PhD

**LEARNING OBJECTIVES**
Upon completion of this presentation, participants will be able to:
1) Review the role of the 'observer' in medical imaging.
2) Report the role of computers in image analysis.
3) Analyze the evolution from human to computer observers.

**PRESENTATION SUMMARY**
Evidence of the principle that advancement in biomedical research and clinical practice is driven by technology is nowhere more evident than in neuroimaging. From the early CT scanners of the 1970s to modern MR and PET scanners, advances in imaging technologies have made the previously invisible living human brain not only visible, but exquisitely so. In general, sensitivity to novel signals from the brain drove these technologic advances. However, central to all of these technologies has been the computer, without which the images can not be created. Simplistically summarized, contemporary neuroimaging devices collect signals from the
brain that computers reconstruct into pictures for human interpretation. Until recently the critical information contained in these images was perceptible by the human eye because of relatively high tissue signal contrast and simple, intuitive spatial displays. However, some recent neuroimagers, such as those of fMRI, contain information that is not perceptible by direct human observation. Signal events are so subtle that sophisticated statistical analysis of raw data by computers is necessary to create summary images for human observation. The computer is extracting information from the images that we cannot see. Not only can computers extract useful information in this fashion but they explicitly apply numbers to this information, a critical scientific task that humans perform poorly. While the past generation of neuroimaging advances was driven by the detection of new types of signals, the next generation of advances will probably be driven by the increasing role of computers in image analysis. In effect, computers will increasingly replace humans as the "observer" of most medical images. This technologic advance will drastically change how we do research and practice medicine. The focus of this presentation will be the nature of this change and the challenges and opportunities it presents.

Applications of Nanotechnology to Central Nervous System Imaging and Therapy

James M. Provenzale, MD

LEARNING OBJECTIVES
Upon completion of this presentation, participants will be able to:
1) Describe the various types of nanoparticles available for medical uses
2) Identify difficulties involved in delivering nanoparticles to the CNS
3) Identify forms of therapy that could be delivered via nanoparticles
4) Propose ways in which nanoparticles could be used to re-engineer damage of diseased CNS tissue

PRESENTATION SUMMARY
In the past decade, rapid advances have been seen in applications of nanotechnology for medical uses with the emergence of a field termed nanomedicine. Nanotechnology refers to the development of materials and devices on the nanometer scale (i.e., 1-100 nanometers) for manipulation of physical, chemical or biological processes. The purpose of this review is to acquaint the neuroradiologist with principles and challenges associated with nanoparticle design and function, and to discuss ways in which nanotechnology may be applied to central nervous system (CNS) imaging and treatment of CNS diseases. Nanoparticles should provide a means to image disease processes, monitor therapeutic response, delivery therapy and re-engineer CNS tissue.

Futuristic Technology for Radiology

Eliot L. Siegel, MD

Wednesday Morning
10:30 AM – 10:45 AM
Ballroom ABC

(32) ASNR Presidential Address

— John R. Hesselink, MD, FACP

Wednesday Morning
10:45 AM – 10:55 AM
Ballroom ABC

(33) ASNR Award Announcements

• Gold Medal Award
• Honorary Member Award
• Cornelius G. Dyke Memorial Award
• 2009 Outstanding Presentation Awards
• NER Foundation Scholar Award in Neuroradiology Research
• NER Foundation Award for Outstanding Contributions in Research
• NER Foundation Award in Basic Science Research
exacerbate, other problems in our healthcare system, including physician shortages and unsustainable costs. From an ethical perspective, this challenge raises important questions. The core principles of medical ethics are beneficence, non-maleficence, autonomy, and justice. Providing people with health insurance coverage certainly aids in adhering to these principles, but it is by no means sufficient to correct all the problems experienced by so many patients in the U.S. health care system. Whether we succeed in achieving universal health care coverage, the debate of 2009 demonstrated how difficult it is for government to redesign health care delivery. The presentation will discuss how physicians can lead the remaining changes required and how their actions can be guided by ethical, rather than political, considerations.

**Wednesday Morning**

10:55 AM – 11:45 AM
Ballroom ABC

(34) Keynote Speaker

(299) The Politics and the Ethics of Healthcare Reform

— Darrell G. Kirch, MD

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**The Politics and the Ethics of Healthcare Reform**

Darrell G. Kirch, MD

Dr. Kirch is president and CEO of the Association of American Medical Colleges (AAMC), which represents the nation’s medical schools, teaching hospitals, and academic societies. A member of the Institute of Medicine of the National Academies, Dr. Kirch is a distinguished physician, educator, and medical researcher. Prior to becoming AAMC president in 2006, Dr. Kirch served for 6 years as senior vice president for health affairs, dean of the college of medicine, and CEO of the Milton S. Hershey Medical Center at The Pennsylvania State University. Before joining Penn State, Dr. Kirch served as dean and senior vice president for clinical activities at the Medical College of Georgia from 1994 to 2000. In addition to these leadership roles, he also co-chaired the Liaison Committee on Medical Education, the accrediting body for U.S. medical schools, and he now serves as a member-at-large of the National Board of Medical Examiners. A psychiatrist and clinical neuroscientist by training, Dr. Kirch began his career at the National Institute of Mental Health, becoming the acting scientific director of the institute in 1993 and receiving the Outstanding Service Medal of the United States Public Health Service. A native of Denver, he earned his BA and MD degrees from the University of Colorado, which in 2002 recognized him with its Silver and Gold Alumni Award.

**Learning Objectives**

Upon completion of this presentation, participants will be able to:

1) Review the limitations of healthcare legislation.
2) Discuss steps that can be taken directly by physicians to promote further reform of the healthcare system.
3) Elide the need for alignment between core ethical principles and future health system change.

**Presentation Summary**

The healthcare debate of 2009 began as a broad discussion of “reforming” the system, but rapidly shifted its focus to the narrower task of expanding health insurance coverage. While many see the latter as an ethical imperative, simply insuring more Americans will not correct, and may even...
Cross-Sectional Imaging of Cervical Adenopathy
Richard H. Wiggins III, MD, CIIP

Imaging of Thyroid Cancer and Thyroid Nodule
Yoshimi Anzai, MD

Imaging of Pediatric Head and Neck Cancer
Caroline Robson, MB, ChB

LEARNING OBJECTIVES
Upon completion of this presentation, participants will be able to:
1) Identify the typical imaging appearance of the most common malignant pediatric head and neck tumors.
2) Identify atypical imaging characteristics that should prompt a differential diagnosis.

PRESENTATION SUMMARY
Imaging is utilized for diagnosis and follow up of pediatric head and neck (HN) cancer. Lymphoma (~ 50% of cases) and rhabdomyosarcoma (~ 20% of cases) account for most cases. Thyroid, nasopharyngeal and salivary gland carcinomas are the most common carcinomas. Typical and unusual appearances for commonly encountered tumors and typical appearance of some uncommon tumors will be described. Important features include patient age, symptoms, tumor location, imaging features and known oncogenic mutations. CT characterizes bony changes. MR imaging demonstrates soft tissue characteristics of tumors and detects parameningeal disease. FDG PET and PET CT are useful for staging and follow up. RHABDOMYSARCOMA (RMS) 1. Second most common HN malignancy; ~1/3 RMS are HN. 2. Bimodal age distribution. 3. Common histological subtypes: Embryonal, alveolar. 4. Imaging: Soft-tissue tumor, lytic bone destruction or bony remodeling. 5. Well circumscribed borders. 6. Variable T2 relaxation, ~ iso to hypointense with brain, variable enhancement. 7. Treatment: Surgery, radiation, chemotherapy. 8. Prognosis: better for embryonal, localized disease + complete surgical resection. LYMPHOMA 1. Most common pediatric HN malignancy, HL > NHL. 2. HL: Various etiologies including prior EBV infection. 3. NHL: Predisposing factors: Severe immunocompromise, oncogenic infections (e.g., EBV, Chlamydia psittaci). 4. CT: Enlarged nodes, variable enhancement. Enlarged Waldeyer’s ring tissue. 5. Burkitt lymphoma: Soft tissue mass, mandibular erosion, “floating teeth”. 6. MR: enlarged lymphoid tissue, ± lower signal than reactive adenopathy on T2WI, variable enhancement. 7. F-18 FDG PET whole body imaging. CARCINOMA (CA) 1. Thyroid CA and EBV-associated nasopharyngeal CA (NPC) are most common. 2. CT and MR NPC: Nasopharyngeal mass, cervical lymphadenopathy, bony destruction, intracranial extension. RETINOBLASTOMA (RB) 1. Commonest pediatric ocular malignancy; peak incidence < 3 years. 2. Presentation: Leukocoria. 3. Bilateral RB: ~30%; present at earlier age, sometimes multifocal. 4. Bilateral RB: Mutations in RB1 gene (chromosome 13q), predisposition other sarcomas. 5. Differential diagnosis leukocoria: Infection, PHPV, Coats disease. 6. Imaging: Intraocular calcified mass ± retinal detachment, globe normal or large. 7. MR bilateral RB: Extraocular extension, hypothalamic and pineal tumors, sarcoma surveillance. 8. Rx: Unilateral - Surgical enucleation; Bilateral - chemotherapy, focal radiotherapy. METASTATIC DISEASE 1. Most common: Neuroblastoma and leukemia. 2. CT: Lytic, permeative bony destruction, spiculated periosteo reaction, soft tissue masses. 3. MR: Relatively low signal on T2-weighted images, variable enhancement patterns. 4. Neuroblastoma: Diffuse diploic space expansion (marrow involvement).

REFERENCES

Wednesday Afternoon
1:15 PM – 2:45 PM
Room 302-304-306

(37) SNIS Programming: Stents for Everything?

(303) Stents for Acute Stroke
— Adnan H. Siddiqui, MD, PhD

(304) Stents for Venous Sinus Disease
— Felipe C. Albuquerque, MD

(305) Stents for Intracranial Stenosis
— Aquilla S. Turk, DO

(306) Stents for Intracranial Aneurysms
— Ajay K. Wakhloo, MD, PhD

(307) Vascular-Endoluminal Reconstruction for the Treatment of Complex Cerebral Aneurysms
— Peter Kim Nelson, MD

(308) Stents for Extracranial Carotid Disease
— Stephen P. Lownie, MD, FRCSC
— David M. Pelz, MD, FRCPC

Moderator: Donald V. Heck, MD
Stents for Acute Stroke
Adnan H. Siddiqui, MD, PhD

LEARNING OBJECTIVES
Upon completion of this presentation, participants will be able to:
1) Review indications and patient evaluation for intracranial stenting in the setting of acute stroke.
2) Cite imaging nuances in the performance of intracranial stenting for acute stroke.
3) Discuss antiplatelet therapy, perioperative imaging, and device considerations.
4) Review existing outcomes data to support the use of intracranial stents as salvage therapy in failed mechanical recanalization or as primary therapy.

PRESENTATION SUMMARY
Acute ischemic stroke inflicts tremendous morbidity and mortality in the United States. With 750,000 cases per year and over $50 billion economic cost, stroke represents one of the gravest epidemiological threats and health care delivery challenges of our time. With the recent expansion of iv TPA time window to 4.5 hours notwithstanding, medical options for large vessel occlusion remain limited. MERCI and Penumbra mechanical recanalization devices, the subject of extensive prospective trials, exhibit improved technical outcomes, but often require time-consuming iterative deployment in the face of ongoing ischemia. Initially introduced as a salvage strategy in these failed mechanical recanalization cases, intracranial stenting for acute stroke now offers a promising line of inquiry in the management of these patients. At the University of Buffalo, we have accumulated substantial experience in this regard. Data from the SARIS trial, including updates from the second phase of the study, will be presented. The presentation will review the clinical evaluation of the patient with NIHSS, ictus onset, and comorbidities including atrial fibrillation that may imply stroke etiology. Imaging review of CT perfusion studies to establish completed infarct and salvageable penumbra will be discussed. Finally, CT angiogram identification of the arch and obstructive lesion will be emphasized with an eye to therapeutic potential and prognosis. Dual run angiographic strategies, lesion crossing and measurement for device selection, and perioperative medication will be reviewed. Finally, special cases of intracranial dissection and ischemic symptoms from fusiform aneurysms requiring flow diversion will be presented. Overall, the presentation will review the Buffalo experience in the clinical and imaging work up of the acute stroke patient, discuss the technical nuances of intracranial data, and review our published experience and ongoing trials on clinical outcomes.

Stents for Venous Sinus Disease
Felipe C. Albuquerque, MD

LEARNING OBJECTIVES
Upon completion of this presentation, participants will be able to:
1) Cite the indications for venous sinus stenting.
2) Review the basics technique of stenting.
3) Measure the results of this treatment.

PRESENTATION SUMMARY
I will discuss the technique, indications and results of venous sinus stenting for the treatment of benign intracranial hypertension.

Stents for Intracranial Stenosis
Aquilla S. Turk, DO

Stents for Intracranial Aneurysms
Ajay K. Wakhloo, MD, PhD

LEARNING OBJECTIVES
Upon completion of this presentation, participants will be able to:
1) Cite the indication for the use of intracranial stents.
2) Review potential risks associated with the use of intracranial stents.
3) Discuss long-term outcomes of stent-assisted coil embolization in intracranial aneurysms.

PRESENTATION SUMMARY
Stent-assisted coiling has improved the endovascular treatment of wide necked (neck > 4 mm or dome-to-neck ratio < 2) and fusiform dissecting intracranial aneurysms. Here we review our center’s results with long-term stent-assisted coil embolization from early experience with coronary vascular stents to the current neurovascular devices. In our early experience dating back to 1996, coronary vascular stents and some first generation of intracranial stents were implanted to assist coiling of inoperable fusiform atherosclerotic and dissecting aneurysms (1). Thirty aneurysms in 28 patients (20 females; mean age, 52.6 years) were treated with these devices. Twenty-one (70%) originated from arterial dissection and four aneurysms (13%) presented with subarachnoid bleeding. Twenty-four (80%) aneurysms were treated with stents and coils, whereas 6 (20%) were treated with stents alone. In all cases, patients failed balloon test occlusion and therefore a reconstructive technique was used. A clinical improvement or stable outcome was achieved in 25 patients (89%). The two cases of permanent morbidity included a patient with a finger dysesthesia associated with a perforator stroke and another patient with hemiparesis and aphasia due to a delayed in-stent thrombosis. One patient died after treatment of a giant vertebrobasilar junction aneurysm. Angiographic follow up was available in 23 of the 27 surviving patients (85%) at a mean of 16.2 months (range, 1 to 108 months). Recanalization in four patients (17%) at 3, 5, 24, and 36 months required retreatment in three. In-stent stenosis of < 50% was found in three patients. Between February 2003 and February 2010, 131 wide-necked and fusiform dissecting intracranial aneurysms in 120 patients were treated endovascularly using the newer generation of neurovascular, self-expanding stents. Fourteen aneurysms (10.7%) were treated acutely following subarachnoid hemorrhage, 25 (19%) were recurrent aneurysms following primary embolization with coils, three (2.3%) were recurrent aneurysms after surgical clipping, and 89 (68%) were treated as de novo aneurysms. The mean aneurysm diameter and neck size were 6.8 mm and 4.9 mm, respectively. The mean
dome-to-neck ratio was 1.3. Follow-up catheter angiography was available for 68 aneurysms (57%) at a mean of 11.5 months. These newer generations of neurovascular stents were user-friendly and showed an significant improvement of the deliverability and trackability. Out of this series, one patient suffered a fatal rebleed, eight patients had a subsequent ischemic stroke (6.7%), and two patients had parenchymal hemorrhage within 30 days of the procedure (1.7%). Mortality resulting from rebleed (n = 1) or acute ischemic stroke (n = 2) was 2.5%. During the follow-up period, the recanalization rate was 5.9%, with retreatment needed in 4.4%. Mild, asymptomatic in-stent stenosis has been observed in four cases (5.9%). The immediate control angiography showed dome or neck remnants in 62% of patients, whereas at follow-up angiography only 18% of aneurysms were not completely occluded. Stent-assisted coil embolization facilitated tight coil packing, with a mean packing density of 44%. In summary, excellent technical and clinical results were obtained for devastating inoperable fusiform aneurysms with coronary stent-assisted embolization, this procedure was not commonly available due to poor navigability of these devices. The newer generation of neurovascular stents has enabled the endovascular embolization of a broad class of wide-neck aneurysms. Preliminary experience indicates that these devices may improve the long-term durability of aneurysm occlusion. However, the risk of thromboembolic complications and bleeding remains (2, 3) and needs to be addressed by a better understanding of the antiplatelet regiment for the neurovascular realm.

References

**Vascular-Endoluminal Reconstruction for the Treatment of Complex Cerebral Aneurysms**

*Peter Kim Nelson, MD*

**Stents for Extracranial Carotid Disease**

*Stephen P. Lownie, MD, FRCSI*

*David M. Pelz, MD, FRCPc*

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**Wednesday Afternoon**

**1:15 PM – 2:45 PM**

**Room 311**

(38) ASSR Programming: The Facet Joint

— *Walter S. Bartynski, MD*

(309) Normal Anatomy of the Facet Joint

— *Walter S. Bartynski, MD*

(310) Inflammatory Facet Arthropathy: Diagnostic Evaluation and Injection Therapy

— *Leo F. Czervionke, MD*

(311) Medial Branch Blocks and Facet Denervation

— *Blake A. Johnson, MD*

(312) Percutaneous vs Surgical Fusion

— *Kent B. Remley, MD*

**Discussion**

Moderators: *Blake A. Johnson, MD*  
*Douglas S. Fenton, MD*

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**Normal Anatomy of the Facet Joint**

*Walter S. Bartynski, MD*

**LEARNING OBJECTIVES**

Upon completion of this presentation, participants will be able to:
1) Review the relevant normal anatomy of the facet joint.
2) Illustrate how the intrinsic anatomy of the facet joint affects the development of axial or radicular spine-related pain.
3) Illustrate how the intrinsic anatomy of the facet joint affects the expression of axial or radicular spine-related pain.

**PRESENTATION SUMMARY**

The facet joint is a very important element of the spine. As a component of the “Functional Spinal Unit” it is involved in critical functions including axial weight-bearing support, maintaining spine alignment, regulating spine motion and resistance to subluxation. The facet can be affected by many processes including trauma, infection, systemic inflammatory arthritis or directly contribute to axial back pain or referred pain through spine instability or age-related degeneration. This lecture will review the embryologic, developmental and normal anatomy of the facet joint. As part of the
developing spine, the facet joint has intrinsic anatomical variation and is affected by the embryologic process of segmentation. As a true synovial joint, the facet has complex geometry and anatomy with bone-related components, hyaline cartilage and soft tissue-related components contributed by the joint capsule and synovial lining. Fundamental, classically recognized shape variations of the facet exist that, in combination with the pedicle, affect the risk of central spinal stenosis or nerve compression in the spinal canal in particular within the lateral recess. As part of the "Functional Spinal Unit", the facet joint plays a critical role in regulating spine motion including flexion, extension, lateral bending and axial rotation. While facet-origin pain and the "Facet Syndrome" are controversial, the facet joint and joint capsule is richly innervated by sensory nerves including pain nociceptors. Recent evidence points to complex nociceptor innervation of the facet that likely plays an important role in the patient’s clinical perception of facet-related axial low back pain.

Inflammatory Facet Arthropathy: Diagnostic Evaluation and Injection Therapy
Leo F. Czervionke, MD

LEARNING OBJECTIVES
Upon completion of this presentation, participants will be able to:
1) Review active inflammatory facet arthropathy in the cervical, thoracic and lumbar spine is readily detected with MR imaging using fat saturation techniques.
2) Identify actively inflamed facets is important since these facets are most likely to be symptomatic and therefore most likely to respond to percutaneous intra-articular and periarticular facet injection.
3) Discuss fat saturation MR techniques should be incorporated into routine MR imaging protocols.

PRESENTATION SUMMARY
Conventional radiographic, CT and MR imaging techniques provide morphologic information regarding the articular facets and zygapophyseal joints (facet joints). The presence of excessive facet joint fluid alone is not a reliable indicator of symptomatic facet disease, since chronic facet joint effusions commonly occur. Noninfectious active inflammatory facet arthropathy (facet synovitis) is exceedingly common and is not readily visible on conventional MR images obtained without the use of fat suppression or water excitation techniques. Active inflammation in the facet joints and articular facets frequently causes an inflammatory response affecting the facet joint capsules and often involves other adjacent bone structures including the articular pillars, laminae, pedicles and sometimes in the adjoining vertebral body. This periarticular inflammatory process correlates with facetogenic pain. If the process extends into the adjacent neural foramen, radicular symptoms also may be present. Posterior extension of the inflammatory process frequently will involve the paraspinal soft tissues causing myofascial pain, which clinically may be difficult to distinguish from other types of back pain. The parafacetal inflammation also may extend posteriorly to involve the interspinous ligaments. Inflammatory facet arthropathy may be seen on unenhanced fat-saturated T2-weighted or STIR images due to presence of marrow edema in the affected articular facets. However, the full extent of the inflammatory process is best demonstrated on contrast-enhanced fat saturated T1 weighted images. The earliest finding of facet synovitis is contrast enhancement of the posterior facet joint capsule, usually inferiorly. Identifying actively inflamed facets allows one to determine facets most likely to be symptomatic and therefore most likely to respond to therapeutic percutaneous facet injection.

Medial Branch Blocks and Facet Denervation
Blake A. Johnson, MD

LEARNING OBJECTIVES
Upon completion of this presentation, participants will be able to:
1) Analyze the pathophysiology of facet origin spine pain.
2) Review the facet joint and medial branch block techniques.
3) Review the technique for performing RF facet joint denervation.

PRESENTATION SUMMARY
Degenerative arthropathy of the zygapophyseal (facet) joints is an important source of neck, head and back pain. Isolating facet joints as the cause of symptoms is difficult, however, because there are no specific markers of facet joint related pain. Further, imaging studies do not always correlate with clinical findings. Diagnosis and treatment of facet joint syndrome is most accurately accomplished using fluoroscopic or CT-guided procedures. Diagnostic blocks can be performed targeting either the facet joint or the median branch of the dorsal ramus (facet nerve). Before an intraarticular injection, facet arthrography is performed to document needle position and to evaluate the morphology of the facet joints. Following arthrography and filming, a local anesthetic and steroid are injected into the joint being investigated and the patient is monitored for relief of symptoms. As an alternative to injecting the joint space itself, the facet nerve (medial branch of the dorsal ramus) can be anesthetized. A facet nerve block is preferred to a joint injection for patients who are candidates for radiofrequency neurotomy (rhizotomy), as a positive response to a facet nerve block best predicts subsequent improvement following radiofrequency lesioning at the same location. Patients who respond with significant pain relief (75% or better) are considered candidates for a subsequent radiofrequency (RF) ablation procedure. The pathophysiology of facet joint pain, the technical aspects of facet blocks, radiofrequency neurotomy and radiographic anatomy will be emphasized in this session.
Percutaneous vs Surgical Fusion

Kent B. Remley, MD

**Learning Objectives**
Upon completion of this presentation, participants will be able to:
1) Review an overview of the history of posterior lumbar instrumentation for segmental fixation.
2) Summarize the biomechanical data for support of facet fixation in the lumbar spine.
3) Demonstrate the currently available instrumentation for minimally invasive/percutaneous facet fixation and fusion.
4) Describe future directions and applications for MIS facet joint fixation, including the cervical and thoracic spine.

**Presentation Summary**
Lumbar spinal fusion procedures are indicated for a variety of procedures including degenerative disk disease, degenerative spondylolisthesis, and segmental instability. Pedicle screw instrumentation for segmental fixation has been the traditional method for posterior spinal fixation, in conjunction with posterolateral fusion or interbody fusion. Facet joint fixation and fusion was first introduced in the 1950s by Dr. Boucher. Translaminar facet joint fixation has been the standard open approach for instrumented facet joint fixation, used in conjunction with anterior interbody fusion procedures. More recently, there has been increasing interest in minimally invasive and percutaneous techniques for facet joint fixation/fusion, providing an attractive option in this regard. Specifically, percutaneous techniques minimize soft tissue trauma and the associated morbidities common to open procedures. This presentation will review the history of facet joint fixation. Current MIS/percutaneous treatment options will be presented, and biomechanical testing comparison with pedicle screw fixation will be reviewed. Finally, future directions regarding facet joint fixation and facet joint replacement will be presented.

*Blue Stars Team*
A. James Barkovich, MD

*Learning Objectives*
Upon completion of this presentation, participants will be able to:
1) Show the audience how to approach difficult cases.
2) Describe similar findings in different disorders.

*Blue Stars Team*
Gary L. Hedlund, DO

*Wednesday Afternoon*

1:15 PM – 2:45 PM
Ballroom ABC

(39) ASPNR Programming: 2010
ASPNR Interesting Case Team
Competition: Blue Stars Versus Red Stars Versus Audience
Audience Response Plus (AR+)*

(313) Blue Stars Team
— A. James Barkovich, MD

(314) Blue Stars Team
— Gary L. Hedlund, DO

(315 Red Stars Team
— W. K. “Kling” Chong, MD, FRCR

(316) Red Stars Team
— Charles A. Raybaud, MD

Moderators: Charles Glasier, MD
L. Santiago Medina, MD, MPH

*An educational grant was received by Bayer Healthcare Pharmaceuticals, Inc. in support of the Audience Response Plus+ (AR+) technology in the Maintenance of Certification (MOC) Review Sessions.
LEARNING OBJECTIVES
Upon completion of this presentation, participants will be able to:
1) Describe the provided cases for the case-based review.
2) Illustrate the educational aspects of the case and have fun.

LEARNING OBJECTIVES
Upon completion of this presentation, participants will be able to:
1) Identify different approaches to diagnosis in neuroimaging.
2) Cite a coherent reporting template.

PRESENTATION SUMMARY
Interesting Case Conference: discussion of clinical cases with the panel and the audience.

Wednesday Afternoon
1:15 PM – 2:45 PM
Room 210

(39a) Research in Progress: An Interactive Forum

(317) Introduction: An Overview of the NER Foundation Awards
— Eric J. Russell, MD, FACR

(317a) Introduction of Panel Members: Carolyn Meltzer, MD, FACR, Colin Derdeyn, MD, Meng Law, MD, MBBS, FRACR, Yoshimi Anzai, MD, MPH

(318) Evolving Patterns of Functional Connectivity in the Developing Brain: An Arterial Spin Labeling Perfusion MRI and Computational Network Analytical Investigation
— Christopher Whitlow, MD, PhD

(319) Comparison and Statistical Validation of Cerebral Flow Results Obtained Using Phase-Contrast MRA and Computational Flow Dynamics in an In Vitro Cerebral Aneurysm Model
— Frank C. Tong, MD

(320) Optimizing Arterial Spin Label MRI for the Visualization of the Collateral Flow in Moyamoya Disease
— Greg Zaharchuk, MD, PhD

Moderators: Pina C. Sanelli, MD, MPH
Carolyn C. Meltzer, MD, FACR

An Overview of the NER Foundation Awards
Eric J. Russell, MD, FACR

Evolving Patterns of Functional Connectivity in the Developing Brain: An Arterial Spin Labeling
Christopher Whitlow, MD
Optimizing Arterial Spin Label MR Imaging for the Visualization of the Collateral Flow in Moyamoya Disease

Greg Zaharchuk, MD, PhD

LEARNING OBJECTIVES
Upon completion of this presentation, participants will be able to:
1) Identify the value of perfusion imaging
2) Define the various hemodynamic biomarkers
3) Select the best technique for a given indication

PRESENTATION SUMMARY
Collateral flow in the brain is poorly understood despite its importance in maintaining the cerebral circulation during acute stroke and chronic hypoperfusion. Arterial spin labeling (ASL) is a noncontrast MR method of measuring perfusion that is exquisitely sensitive to arterial arrival delays. This usually is considered a flaw, since it complicates the calculation of quantitative CBF. However, the bright intravascular signal known as “arterial transit artifact” actually contains important information about late-arriving flow. Arterial spin labeling can be made sensitive to different degrees of arterial arrival delay by varying the acquisition parameters [labeling time and postlabel delay (PLD)], enabling quantitative measures of delayed flow. This study aims to clarify the relationship between late-arriving ASL signal and collateral flow in a patient population of newly diagnosed moyamoya disease. The young, highly motivated moyamoya patients are an excellent, stable population of patients with advanced cerebrovascular disease, and as such, serve as a model for the larger population of patients with acute ischemic stroke. During this presentation, I will discuss the value of multiple PLD ASL to evaluate collateral flow in moyamoya disease and compare it with an angiographic collateral grading scale.
Germany). Two neuroradiologists with experience in fMRI (R1, R2) reviewed retrospectively and in consensus the fMRI images. The fMRI images were analyzed in conjunction with the presurgical T1 postcontrast images and FLAIR images to determine the distance of the fMRI signal, using the different paradigms, from the 1) enhancing portion of the tumor and 2) the perilesional FLAIR signal abnormality.

RESULTS
Fourteen of 23 patients had a distance of 1 mm or less between the enhancing portion of the tumor and the fMRI activated eloquent regions. Of those, 8/14 had residual focal neurologic deficit and 2/14 had new neurologic deficits. The remainder of patients (9/23) had a distance between the fMRI signal (at an eloquent area) and enhancing tumor of 2 mm and greater. Of these, 3/9 had no presurgical or postsurgical long-term focal neurologic deficit. And these 3/9 patients had a distance from fMRI signal to tumor ranging from 11 mm to 24 mm. Five of 9 had presurgical neurologic deficits, all which resolved after surgery.

CONCLUSION
Our results demonstrate that, in presence of tumor resection under stereotactic neuronavigation, the “Golden Rule” does not apply and a lower threshold distance should be used to predict subsequent neurologic deficits. A larger patient sample can be helpful to further confirm these findings.

KEY WORDS: Neoplasm, functional MR imaging, surgical planning

Paper 322 Starting at 3:23 PM, Ending at 3:31 PM
Serial Changes in Perfusion and Enhancing Surface Area in Glioblastoma Multiforme following Intensity Modulated Radiation Therapy and Chemotherapy: Preliminary Results
Lim, S. · Nguyen, T.
The Ottawa Hospital
Ottawa, ON, CANADA

PURPOSE
In patients with glioblastoma multiforme undergoing surgery, radiation and chemotherapy, assessment of tumor response using axial dimensions on contrast-enhanced MR images currently is used in most clinical trials. Recently, other MR imaging techniques such as perfusion-weighted imaging have been proposed as an alternate imaging biomarker. The purpose of this study is to determine if there is a correlation between tumor-enhancing surface area and perfusion parameters as obtained from dynamic T2* contrast enhancement MR perfusion in patients with GBM treated with surgery, chemotherapy and radiation.

MATERIALS & METHODS
We prospectively recruited 20 patients with glioblastoma who underwent surgery, accelerated radiation therapy with tomotherapy simultaneous integrated boost (ARTOSIB) and Temozolomide from May 2008 - Nov 2010. MR perfusion was performed using a gradient-echo T2 EPI acquisition following a bolus of 20 ccs of gadolinium. Serial MR studies were performed 1 month postsurgery and two monthly thereafter. Eleven patients with 6-month follow-up studies are available for review at the time of this abstract. For those patients, relative cerebral blood flow (CBF), cerebral blood volume (CBV), mean transit time (MTT) and cystic enhancing area (obtained by multiplication of axial dimensions) were calculated from enhancing areas of the brain at each follow-up study. In each patient, the serial differences in perfusion parameters and surface-enhancing area between the last and first follow-up studies were calculated. We use Spearman’s rho correlation to determine if there is any significant correlation between the change in enhancing area (EA) and perfusion parameters.

RESULTS
In comparison to the prior study, there is a serial decrease in the rCBV (median -126%), rCBF (median -95%), rMTT (median -34%) and enhancing surface area (median +71.8). There is no statistical correlation between the percent change in enhancing area (EA) and each perfusion data [EA% and rCBV% (r = -0.26, p = 0.433), EA% and rCBF% (r = 0.12, p = 0.71), EA% and rMTT% (r = -0.36, p = 0.27)].

CONCLUSION
Preliminary results show a poor correlation between the change in enhancing area and perfusion data (rCBV, rCBF and rMTT). The inverse relationship between the enhancing surface area with rCBV and rCBF could be due to the fact that the enhancing areas represent residual tumor, radiation changes or pseudoprogression. Further studies need to be done if one would like to incorporate perfusion parameters into the tumor response criteria [Response Evaluation Criteria in Solid Tumours (RECIST)].

KEY WORDS: Adult brain, MR spectroscopy, brain tumor

Paper 323 Starting at 3:31 PM, Ending at 3:39 PM
Conventional Contrast-Enhanced MR Imaging in Differentiation of Glioma Recurrence from Treatment-Induced Changes: A Prospective Study
Kumar, A.1 · Goenka, A. H.1 · Sharma, R.1 · Seith Bhalla, A.1 · Julka, P. K.2
1All India Institute of Medical Sciences, New Delhi, INDIA, 2Dr. Babasaheb R. Ambedkar Institute Rotary Cancer Hospital, All India Institute of Medical Sciences, New Delhi, India, New Delhi, INDIA

PURPOSE
Patients with high-grade gliomas routinely undergo contrast-enhanced MR imaging (CE-MR) as the first line investigation for both surveillance and clinical problem-focused evaluation. Our objectives were: 1) To assess the diagnostic performance of CE-MR in differentiating recurrent tumor from treatment-induced changes based on the features described in literature and 2) To identify the most reliable imaging predictors of recurrent tumor.

MATERIALS & METHODS
Seventy consecutive patients, previously treated as per Stupp’s Protocol for high-grade gliomas (WHO grade III/IV), were examined prospectively with CE-MR on a 1.5 T scanner (Siemens Avanto, Erlangen, Germany). Inclusion criteria for this study was presence of new enhancing lesion/s within the radiation field. Thirty-six new contrast-enhancing
lesions in 33 patients satisfying the inclusion criterion constituted the study group. Lesions were classified as recurrent tumor or treatment-induced changes based on the consensus opinion of three experienced radiologists (A.K., R.S., A.S.B), who were blinded to clinical details. The features that were studied included location in relation to the side and the site of the primary tumor, multifocality, size, margin definition, necrosis, edema, spread across midline, corpus callosum involvement, enhancing solid component and contiguous subependymal enhancement. Composite gold standard consisting of histopathology and clinico-radiologic follow-up was used for final categorization. In addition, prevalence of these imaging features within the two groups were analyzed retrospectively to assess statistically significant differences (p < 0.05).

RESULTS
Based on the composite gold standard, 24 lesions in 23 patients were classified as tumor recurrence and 12 lesions in 10 patients were classified as postradiotherapy changes. Consensus analysis of CE-MR features enabled correct classification of all 24 lesions (100% sensitivity) due recurrent tumor and of five lesions (58% specificity) due to treatment-induced changes. The positive and negative predictive values were 83% and 100% respectively while the accuracy was 86%. Features that were found to have significant prevalence in the recurrent tumor group included enhancing solid component (p = 0.0001), spread across the midline (p = 0.006), corpus callosum involvement (p = 0.01) and well defined margins (p = 0.01). As an imaging predictor, enhancing solid component had the most optimal diagnostic performance (sensitivity 88%, specificity 92%, PPV 95%, NPV 86% and accuracy 89%). Combination of enhancing solid component with features such as spread across the midline, corpus callosum involvement and well defined margins escalated the PPV and NPV to 100%. However, the sensitivity of any of the combinations was unsatisfactory (< 50%).

CONCLUSION
Systematic analysis of CE-MR features enables accurate differentiation of recurrent tumor from treatment-induced changes in a high proportion of patients. Enhancing, solid component, in isolation as well as in combination with spread across the midline, corpus callosum involvement and well defined margins, is the most reliable imaging predictor for recurrent tumor. In combination with clinical details, these imaging features may enable us to better determine the need for additional advanced imaging in patients with treated gliomas.

KEY WORDS: Glioma recurrence, contrast-enhanced MR imaging

Paper 324 Starting at 3:39 PM, Ending at 3:47 PM
Using Diffusion Tensor Imaging to Differentiate between Meningiomas and Intracranial Dural Metastases
Liu, X. · Tian, W. · Ekholm, S.
University of Rochester School of Medicine & Dentistry Rochester, NY

PURPOSE
It is important, however sometimes difficult to preoperatively differentiate between intracranial meningiomas and dural metastases on conventional MR imaging. The purpose of this study was to evaluate the utility of diffusion tensor imaging in this differentiation.

MATERIALS & METHODS
Sixteen patients with histology-confirmed meningiomas and 12 with intracranial dural metastases were included in this study. The precontrast DTI protocol included TR/TE = 12000/101.7 ms, FOV = 24 x 24 cm². Matrix = 128 x 128, thickness = 3 mm and gap=0 mm (or thickness = 5 mm with gap = 1 mm) using 25 noncollinear gradient directions and a b value of 1000 sec/mm². Another three images were acquired without the use of a diffusion gradient, b = 0 sec/mm²). The mean trace apparent diffusion coefficient (trace ADC), minimum ADC, mean fractional anisotropy (FA) and maximal FA of these tumors were measured and the results were compared using Mann-Whitney U test.

RESULTS
The mean FA and maximal FA values of the meningiomas (0.239 ± 0.091, 0.375 ± 0.111, respectively) were significantly higher than values of intracranial dural metastases (0.152 ± 0.05, 0.193 ± 0.071, respectively). The p values were 0.018 and p < 0.001, respectively. However, no significant difference was found for mean ADC and minimal ADC values (p > 0.05).

CONCLUSION
The results indicate that, when in doubt, the mean and maximal FA values may be helpful to differentiate between intracranial meningiomas and dural metastases.

KEY WORDS: Diffusion tensor imaging, meningioma, dural-based metastases
Spin-Echo Echo Planar Perfusion MR Imaging in the Differentiation of Solitary Brain Metastasis from High-Grade Glioma

You, H.1,2 · Setayesh, K.3 · Wong, K.4,5 · Young, G.1,6

1Brigham and Women’s Hospital, Boston, MA, 2Peking Union Medical College Hospital, Beijing, CHINA, 3Tulane University, New Orleans, LA, 4The Methodist Hospital Research Institute, Houston, TX, 5Weill Cornell Medical College, Houston, TX, 6Harvard Medical School, Boston, MA

PURPOSE
Reliable preoperative distinction of brain metastasis (MET) from enhancing high-grade glioma (HGG) remains a significant unsolved problem in diagnostic imaging. Most previous studies using perfusion-weighted imaging (PWI) to address this problem have employed gradient-echo echo planar imaging (GE-EPI) dynamic susceptibility contrast PWI, and reported no significant difference in tumor normalized cerebral blood volume (nCBV). We recently published a preliminary technical note describing significant differences in spin-echo (SE) EPI nCBVmax in patients with treated MET and HGG (1). To test whether the observed effect could be due to intrinsic or chemoradiation-induced differences in vascular permeability or chemoradiation induced changes in nCBV we report addition of formal leakage correction to the method and successful application to a clinically relevant group of treatment-naive MET and HGG patients.

MATERIALS & METHODS
1.5 T or 3.0 T SE-EPI PWI was retrieved from 15 subjects with MET and 21 with HGG who underwent PWI prior to any medical or radiation therapy. After leakage correction (2), without prebolus, tumor rCBVmax measured were divided by the rCBV of contralateral normal-appearing white matter to generate nCBV. The Mann-Whitney test and receiver operating characteristic (ROC) curve were used.

RESULTS
MET nCBV (median 1.571; 1.110-5.152) was significantly lower than HGG (median 2.900; 1.086-5.730) (Figure 1a) (Z = -3.321, P = 0.001). The area under the ROC curve (Figure 1b) was 0.829 (SE = 0.078, P = 0.001). Optimal threshold nCBV of 2.145 produced 93.3% sensitivity and 81.0% specificity. Only 1 MET from sacral sarcoma had nCBV > 2.145. Four HGG had nCBV < 2.145.

CONCLUSION
Normalized cerebral blood volume measured with SE-EPI PWI can help differentiate MET from HGG in treatment-naive patients, extending our previous initial technical report to a clinically relevant population and suggesting that the utility of SE-EPI PWI is related to vessel size differences between the smaller mean neovessel diameter of HGG, characterized by florid neocapillaries of smaller than 20μm (3) and the larger mean neovessel diameter of MET (4, 5) rather than intrinsic or treatment-induced permeability differences. The superiority of SE-EPI technique to GE-EPI PWI seems likely to reflect the selective sensitivity of SE-EPI PWI to vessels less than 25 μm diameter (6), in contrast to sensitivity of GE-EPI PWI to vasculature of all sizes.

REFERENCES

KEY WORDS: Perfusion, MR imaging, glioma, metastasis

Perfusion, MR imaging, glioma, metastasis

Perfusion and Permeability Characteristics in True Early Progression of Disease vs Pseudoprogression in Patients with High-Grade Glioma following Chemoradiotherapy

Shiroishi, M. S. · Lacerda, S. · Gu, H. · Mehta, P. · Kim, A. · Habibi, M. · Rajderkar, D. · Mogensen, M. A. · Lerner, A. · Kim, P. E. · Go, J. L. · Boyko, O. B. · Law, M.
Keck School of Medicine, University of Southern California
Los Angeles, CA

PURPOSE
To demonstrate the perfusion and permeability characteristics in true early disease progression vs pseudoprogression in patients with high-grade glioma following chemoradiotherapy.

MATERIALS & METHODS
A total of 10 patients with high-grade glioma treated with maximal safe resection and chemoradiotherapy with temozolomide were examined including: four patients with true early progression of disease, two patients with delayed radiation necrosis, and four patients with pseudoprogression. All patients underwent multiplanar contrast-enhanced MR imaging including steady-state T1-weighted DCE MR imaging using a 2D fast spin-echo sequence with a temporal resolution of 6 seconds acquired over 3 minutes to obtain steady-state vascular permeability data, followed by a first pass T2* DSC MR imaging to obtain rCBV measurements.

RESULTS
Permeability measurements in those with true early progression of disease demonstrated a very rapid initial slope of the permeability curves, consistent with highly vascular, high-grade glioma. Relative cerebral blood volume was elevated.
PURPOSE
Rochester, MI
1Henry Ford Hospital, Detroit, MI, 2Oakland University, CTP and DSC-MRP techniques.

The study was to compare perfusion parameters estimated by times, but with the cost of some radiation dose. The aim of providing unbiased estimates of perfusion parameters. CT perfusion has been used recently for brain tumor assessment. It has the advantage of wider availability and faster acquisition times, but with the cost of some radiation dose. The aim of the study was to compare perfusion parameters estimated by CTP and DSC-MRP techniques.

CONCLUSION
Contrast enhancement depicts damage to the blood-brain barrier and viable tumor and treatment-related effect may appear similar on conventional MR imaging. This preliminary study appears to demonstrate that rCBV is elevated (> 1.75) in true early progression and decreased in delayed radiation necrosis and pseudoprogression. The permeability characteristics in both delayed radiation necrosis and pseudoprogression appear similar. Histologically, radiation necrosis is an occlusive vasculopathy where endothelial injury eventually leads to fibroid necrosis of small vessels, endothelial thickening, hyalinization, and eventually vascular thrombosis. The mechanisms underlying pseudoprogression are not entirely clear. It may represent and continuum between subacute radiation encephalitis/reaction and treatment-related necrosis. This may result in a high degree of desired tumor-cell and endothelial-cell killing. A consequence of this may be edema and abnormal vascular permeability, mimicking tumor progression. Further study with a larger patient cohort as well as inclusion of K trans measurements to better characterize permeability changes in pseudoprogression and true early progression may serve as a valuable adjunct to rCBV in differentiating the two phenomena.

KEY WORDS: Permeability, perfusion, glioma

PAPER 327 STARTING AT 4:03 PM, ENDING AT 4:11 PM
Direct Comparison of Dynamic Susceptibility-Weighted MR Perfusion with CT Perfusion in Brain Tumors

Narang, J.1 · Jain, R.1 · Bagher-Ebadian, H.1,2 · Saksena, S.1 · Mikkelsen, T.1 · Patel, S. C.1 · Ewing, J. R.1,2
1. Henry Ford Hospital, Detroit, MI, 2Oakland University, Rochester, MI

RESULTS
The results suggest that compared to the CTP, DSC-MRP using SVD underestimates all the perfusion parameters. These results are tabulated in Table 1.

Table 1 - Results

<table>
<thead>
<tr>
<th></th>
<th>WM</th>
<th>GM</th>
<th>CEL</th>
<th>NEL</th>
</tr>
</thead>
<tbody>
<tr>
<td>CT CBV(ml/100gms)</td>
<td>1.46</td>
<td>1.17</td>
<td>1.76</td>
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<td>MR CBV (ml/100gms)</td>
<td>1.09</td>
<td>1.22</td>
<td>1.59</td>
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<td>CT CBF (ml/100gms-min)</td>
<td>28.48</td>
<td>36.80</td>
<td>40.22</td>
<td>37.17</td>
</tr>
<tr>
<td>MR CBF (ml/100gms-min)</td>
<td>23.88</td>
<td>29.77</td>
<td>33.02</td>
<td>27.95</td>
</tr>
<tr>
<td>CT MTT (Sec)</td>
<td>4.46</td>
<td>2.25</td>
<td>4.4</td>
<td>4.43</td>
</tr>
<tr>
<td>MR MTT (Sec)</td>
<td>2.59</td>
<td>2.05</td>
<td>3.11</td>
<td>2.89</td>
</tr>
</tbody>
</table>

CONCLUSION
The discrepancies in measurements of CTP and DSC-MRP may be due to differences in the intrinsic sensitivity of each imaging technique for detecting different vascular components. Cerebral blood volume by CTP technique is equally sensitive to all vascular components; whereas CBV by DSC-MRP originates primarily from the microvasculature in brain. Another factor leading to underestimation of CBV could be due to the nonlinearity of arterial input function with CA concentration in DSC-MRP apart from lower temporal resolution and arrival time delays. Despite having the limitations of radiation exposure, and need for a separate examination CTP can be used either as a standard reference to improve on the limitations of DSC-MRP or more importantly could be used as a more robust alternative to assess perfusion parameters in brain tumors.

REFERENCES

KEY WORDS: DSC MR perfusion, CT perfusion, brain tumors
Comparison of Gadobutrol and Gadoterate at Single Dose (0.1 mmol Gd/kg Body Weight) in Contrast-Enhanced MR Imaging Examination of Cerebral Neoplastic-Enhancing Lesions: Results of a Multicenter Intraindividual Clinical Trial

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PURPOSE
To prospectively compare the diagnostic efficacy and safety of gadobutrol and gadoterate for contrast-enhanced MR imaging (CE MRI) of neoplastic cerebral lesions.

MATERIALS & METHODS
Multicenter, randomized, intraindividual comparison study to evaluate the efficacy and safety of gadobutrol in comparison to gadoterate after a single intravenous dose. Adult patients with known contrast enhancing brain lesions were to be included and to undergo two CE MRIs. Contrast agent administration (dose), imaging parameters before and after injection, and time between injections and postinjection acquisitions were identical for both examinations. Three independent blinded readers evaluated the images regarding the overall qualitative evaluation of enhancing cerebral tumors. An additional reader quantified signal intensity of enhancing lesions using ROI analysis. The primary efficacy was the overall qualitative assessment of contrast enhancement on a three-point scale (better, equal, worse) in a matched-pair approach. Secondary objectives included the comparison of the quantitative evaluation in terms of SI measurements and safety.

RESULTS
From 166 randomized patients, 135 subjects were included and underwent two CE MRIs in a randomized order. The primary endpoint which was the overall assessment of contrast enhancement on a three-point scale (better, equal, worse) in a matched-pairs assessment from MR imaging examinations of all postcontrast T1-weighted images comparing MR images after Gd-D3A-Butrol and Gd-DOTA administration of the study was met. Significant preference for gadobutrol was demonstrated for overall enhancement of the lesion, information on internal structure of the lesion and signal intensity of the lesion to brain ratio and the relative enhancement. With regard to the numbers of lesions per patient there was no significant difference between the gadobutrol and gadoterate. No significant difference was found for the contrast-to-noise ratio and for the assessment of lesion delineation from surrounding tissue and edema. Nine adverse events were reported in seven patients, five AEs after gadoterate administration and four AEs after gadobutrol administration; none of the AEs were considered drug related.

CONCLUSION
Gadobutrol proved to be significantly superior over gadoterate at single dose 0.1 mmol/kg BW providing better enhancement and diagnostic information in CE MRI of CNS lesions with a similar safety profile.

Key Words: Contrast media, enhancement

Glioblastoma Multiforme: A Study on the Radiographic Appearance and Changes on Intracavitary Gliadel Wafer Placement

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PURPOSE
To describe MR imaging changes associated with intracavitary placement of Gliadel wafers (Eisai) in patients with recurrent glioblastoma multiforme (GBM).

MATERIALS & METHODS
Eight patients (6 males, 2 females; age range 29-67 years old) with recurrent GBM were imaged for a period of 20 to 194 days after tumor resection and Gliadel wafer placement with 1.5 T MR unit (GE Healthcare). Two radiologists (R1, R2) retrospectively reviewed the FLAIR and T1 postcontrast images.

RESULTS
Four patients (with follow-up MR imaging ranging from 80-194 days postGliadel wafer placement), showed initial increased enhancement and FLAIR hyperintensity until postop day 24 to 131 (average: 78.5 days) and subsequent decrease or stability of enhancement and FLAIR hyperintensity. One patient showed no enhancement and stable perilesional FLAIR hyperintensity until 80 days; however imaging at 135 days postGliadel wafer placement showed new areas of enhancement and FLAIR hyperintensity. One patient with residual tumor showed progressive increase enhancement and FLAIR hyperintensity until death at 123 days. Two patients were imaged only at 20 days and 30 days postop; and both demonstrated increased area of enhancement and FLAIR hyperintensity. In summary, four out of six patients who had imaging follow up more than 80 days after Gliadel wafer placement demonstrated initial increase and subsequent decrease or stability of area of enhancement and FLAIR hyperintensity and the other two demonstrated recurrence and/or growth of residual tumor.

CONCLUSION
Initial increase in area of enhancement and FLAIR signal abnormality is common after intracavitary placement of Gliadel wafers and should not be interpreted necessarily as a sign of recurrence or tumor progression. Larger population studies are needed to possibly determine a time point where increased area of enhancement and FLAIR signal abnormality should be considered a sign of tumor progression.

Key Words: Neoplasm, chemotherapy, pseudoprogression
PURPOSE

Radiation necrosis (RN) following treatment of brain tumors is an unwanted effect which is difficult to differentiate from recurrent tumors (RT). Perfusion imaging including MR (1) and CT (2) has been done in the past to differentiate the two entities, as their management and prognosis can be substantially different, however focusing mostly on the blood volume estimates. A radiation dose latency relationship for the breakdown of blood-brain barrier (BBB) with a dose-dependent effect on endothelial cell damage and survival has been considered as the cause of delayed loss of BBB integrity. This leads to increased permeability in RN; however, is probably not as prominent as seen with the leakiness of tumor neoangiogenesis in RT. The purpose of our retrospective study was to use permeability surface area-product (PS) measured using perfusion CT (PCT) to differentiate RN from RT in previously irradiated brain tumor patients who presented with a recurrent/progressive enhancing lesion.

MATERIALS & METHODS

Fifty-eight patients underwent PCT for assessment of recurrent/progressive enhancing lesion from Jan 2006 to Nov 2009. Perfusion CT was done using a 64-slice CT scanner and a total acquisition time of 199 seconds to estimate PS. Twenty-five patients who underwent surgery and histopathology diagnosis were included for this analysis. Perfusion CT maps were generated using perfusion 3.0 software (GE). Perfusion parameters such as PS, cerebral blood volume (CBV), cerebral blood flow (CBF) and mean transit time (MTT) were obtained from the enhancing lesion as well as from the normal-appearing white matter (NAWM). Statistical analysis was done using Wilcoxon two sample tests for comparing the two groups.

RESULTS

Out of 25, 11 patients had pure RN and 14 patients had RT. All patients were treated with radiation and chemotherapy for brain tumors. Mean time interval between development of recurrent/progressive enhancing lesion and radiation therapy was 21 months (3 - 68 months). There was a statistically significant difference between the two groups with the RN group showing significantly lower PS values than RT group (1.8 ± 0.8 vs 3.5 ± 1.1 ml/100g/min; p value 0.004). Relative CBV of RN group was also lower as compared to RT group (1.2 ± 0.3 vs 2.1 ± 0.6 ml/100g; p value 0.002). Relative CBF was also lower in RN group (1.2 ± 0.5 vs 2.1 ± 1.4 ml/100g/min; p value 0.036). Results for MTT were not significantly different for the two groups.

CONCLUSION

Perfusion CT and particularly lesion leakiness estimates, permeability surface area-product, can be used in previously treated brain tumor patients who present with recurrent/progressive enhancing lesion to differentiate RN from RT. Radiation necrosis showed lower PS as compared to RT and PS estimates can help increase the accuracy of PCT in differentiating these two entities adding to the blood volume estimates. More importantly, in vivo estimates of PS and CBV in previously treated lesions may help in better characterization of these heterogeneous lesions, as most of the recurrent tumors are also usually tumor cells mixed with variable degree of necrosis and treatment effects.

REFERENCES


KEY WORDS: Radiation necrosis, perfusion CT

Paper 331 Starting at 4:35 PM, Ending at 4:43 PM

Dual-Room 1.5 T Intraoperative MR Imaging Suite with a Movable Magnet: Implementation and Preliminary Experience

Xu, B. · Chen, X. · Zhang, J. · Meng, X. · Hou, Y.
Chinese PLA General Hospital
Beijing, CHINA

PURPOSE

A dual-room 1.5 T intraoperative MR imaging (MRI) suite with a movable magnet was developed for intraoperative MRI and for independent diagnostic use. Our objective was to evaluate the clinical practicability and efficacy of this system.

MATERIALS & METHODS

From February to July 2009, 120 patients (range, 6-81 years; mean age, 40.8 years) were operated in the operating room of the 1.5 T intraoperative MR suite, while in the same period of time, 500 diagnostic scans were done in the diagnostic room of the suite. A microscope in combination with a ceiling-mounted navigation system was used for microscope-based functional neuronavigation.

RESULTS

Ninety-one craniotomies and 29 transsphenoidal surgeries were performed. In 48 (40.0%) of 120 patients, intraoperative MR imaging had revealed residual lesions and resulted in the change of the surgical strategy (e.g., further resection of the tumor). Eventually, 50 gliomas, 26 pituitary adenomas, 6 vascular lesions and 17 miscellaneous lesions were totally removed. Only five cases with deep located lesions developed new neurologic deficits postoperatively, while four of them improved or returned to normal neurologic function after 1-5 months follow up respectively. With the MR suite, high-quality images, together with functional data, could be obtained intraoperatively, while the normal workflow of surgery, nursing or anesthesia was not compromised.
CONCLUSION
The intraoperative 1.5 T MR imaging and functional neuronavigation can be integrated successfully into standard neurosurgical workflow. Intraoperative MR imaging can provide high-quality images and valuable information which enable intraoperative modification of the surgical strategy. And the dual-room setting can maximize the efficiency of the system.

KEY WORDS: Intraoperative imaging, MR imaging, neurosurgery

Wednesday Afternoon

3:15 PM – 4:45 PM
Room 302-304-306

(40b) Interventional: Aneurysms I
(Scientific Papers 332 - 342)

See also Parallel Sessions
(40a) Adult Brain: Neoplasms II
(40c) Spine: New Techniques and Degenerative
(40d) Adult Brain: New Techniques
(40e) Quality/Socioeconomic

Moderators: Mary E. Jensen, MD
Alessandra Biondi, MD

Paper 40b Starting at 3:15 PM, Ending at 3:25 PM
State-of-the Art on Aneurysms: New Developments and Questions
Jacques E. Dion, MD
Emory University Hospital
Atlanta, GA

Paper 332 Starting at 3:25 PM, Ending at 3:33 PM
Development of a Computerized Decision Support System for Treatment Planning and Outcome Prediction in Aneurysmal Subarachnoid Hemorrhage

Stivaros, S. M. 1 · Nenadic, G 2 · Zeng, X-I 3 · Laitt, R. 3
Hughes, D. 3 · Williams, T. 3 · Herwadkar, A. 3 · Hutchinson, C. E. 3 · Keane, J. A. 3 · Jackson, A. 3

1University of Manchester, Wolfson Molecular Imaging Centre, Manchester, UNITED KINGDOM, 2University of Manchester, Manchester, UNITED KINGDOM, 3Salford Royal NHS Foundation Trust, Manchester, UNITED KINGDOM

PURPOSE
The United States Academy of Engineering has stated that the provision of healthcare systems to provide “just in time, just for me” advice at the point of care is one of the great engineering challenges of the 21st century. Nowhere is the provision of such systems more important than in interventional neurovascular radiology. The rapid pace of change in the treatment of aneurysmal subarachnoid hemorrhage (ASAH) leads to significant problems in the assessment and validation of new therapeutic techniques and allocation of treatment resources. It is incumbent on the physician to assimilate vast quantities of rapidly changing literature in order to make informed treatment decisions and give tailored outcome predictions for individual patients. The current state of the art computerized decision support systems (DSS) are based upon Bayesian networks. The “just in time, just for me” support scenario is now becoming a reality with developments in information management, data analysis and multicore processor technology. However, the development of such systems is hampered by the techniques necessary to capture expert knowledge. The purpose of this project is to develop and validate a Bayesian DSS to provide real-time clinical advice regarding ASAH to clinicians in both neuroscience centers and primary referral sites.

MATERIALS & METHODS
We have developed a novel language-based software tool that is capable of capturing data from various knowledge bases. This includes sources as disparate as prospective studies and single case reports. It enables the assimilation of these disparate data streams into one searchable repository. The performance of the system to extract knowledge from different data sources was assessed by comparison with six experienced interventional neuroradiologists. Additional system testing looked at comparison between the system and domain experts performance regarding outcome prediction related to aneurysm morphology.

RESULTS
The system has been populated with 298 papers giving a knowledge base representing 44,364 patients with a total of 10,644 aneurysms all with associated outcome metrics. We found a mean rate of 125 data variables/publication (range 47-261 S.D. 47). Comparison of domain experts to DSS saw a mean data extraction gain of 35% /paper (range 2%-91% S.D. 22.6) and a mean gain of 8% (range 0-11% S.D. 4.6) over a synthesized domain expert created by amalgamation of all experts. The system identified over 300 separate aneurysmal descriptors with associated outcome metrics as defined in the literature, compared to 32 specific descriptors defined by domain experts.

CONCLUSION
We have shown that we can capture and assimilate information regarding ASAH into a single data repository with a system that can improve the neuroradiologist gold standard. Analysis of the data generated by this tool has allowed us to develop a formal set of descriptive terms pertaining to cerebral aneurysms and define how these relate to the outcome of the disease process. This is an important step in the advancement of e-medicine resources. Such DSS need validation for their accepted use in clinical practice and a system such as the one presented here represents an important early step in their development, validation and general acceptance.

KEY WORDS: Decision support system, aneurysm, subarachnoid hemorrhage
Paper 333 Starting at 3:33 PM, Ending at 3:41 PM
Treatment of Wide-Necked Intracranial Aneurysms Using the Enterprise Stent: Midterm Clinical and Angiographic Results

Gounis, M. J. · De Leo, M. J. · Patel, N. V. · Segal, E. · Wakhloo, A. K.
University of Massachusetts
Worcester, MA

PURPOSE
Stent-assisted coiling techniques have improved the endovascular treatment of wide-necked (neck > 4 mm or dome-to-neck ratio < 2) and fusiform/dissecting intracranial aneurysms. The Enterprise stent (Cordis Endovascular, Miami Lakes, FL) is the first commercially available closed-cell stent specifically designed for the treatment of wide-necked intracranial aneurysms. We evaluate the safety and efficacy of the Enterprise stent at our center.

MATERIALS & METHODS
Between June 2007 and December 2009, 90 wide-necked and fusiform/dissecting intracranial aneurysms in 83 patients were treated endovascularly using the Enterprise stent. The aneurysms were in the following locations: ophthalmic/paraophthalmic (11 aneurysms, 12%), posterior communicating artery (17, 19%), basilar apex (8, 9%), vertebral artery/posterior inferior cerebellar artery/superior cerebellar artery (6, 7%), internal carotid artery (17, 21%), superior hypophyseal artery (7, 8%), anterior communicating/anterior cerebral artery (12, 13%), and middle cerebral artery (10, 11%). Ten (11%) were treated acutely following subarachnoid hemorrhage, 20 (22%) were recurrent aneurysms following primary embolization with coils, 2 (2%) were recurrent aneurysms after surgical clipping, and 68 (76%) were treated as de novo aneurysms. The mean aneurysm neck size was 4.6 mm (SD 2.5 mm, range 2-15 mm), and the mean dome-to-neck ratio was 1.2. All patients were given loading doses of aspirin and clopidogrel and maintained on these medications in the follow-up period. Follow-up catheter angiography was available for 42 aneurysms (47%) at a median of 6 months (range 6-18 months). Immediate postprocedure control and follow-up angiograms were evaluated using the Raymond scale by investigators not involved in the coiling procedure. Clinical evaluations were performed using a modified Rankin scale.

RESULTS
Immediate control angiography demonstrated total aneurysm occlusion in 32 aneurysms (36%), neck filling was seen in 25 aneurysms (27%), and dome filling was seen in 33 aneurysms (37%). Two aneurysms (5%), both originating from dissections, required retreatment. There were nine (10%) intraoperative thromboembolic complications that were treated successfully with intraarterial thrombolytics (tPA and abciximab) with no permanent neurologic deficits. There was no periprocedural morbidity. One patient died from complications secondary to subarachnoid hemorrhage shortly after treatment. Angiography at follow up demonstrated total occlusion in 38 aneurysms (91%), 1 neck remnant (2%), and 3 residual aneurysms (7%). In the follow-up period, there have been no cases of stent migration, 1 case of mild in-stent stenosis, and 2 cases of delayed thromboembolic complications.

CONCLUSION
This large series adds to the growing body of literature that demonstrates the safety, effectiveness, and maneuverability of the Enterprise stent in the treatment of wide-necked intracranial aneurysms. Although initial complete occlusion rates determined from the Raymond scale were not favorable, most aneurysms (91%) imaged at a median of 6 month after stent-assisted coil embolization are completely occluded. Data on long-term occlusion and in-stent stenosis rates are pending.

KEY WORDS: Enterprise, stent-assisted coil embolization, intracranial aneurysm

Paper 334 Starting at 3:41 PM, Ending at 3:49 PM
Intraoperative Cone-Beam CT for Simultaneous Visualization of the Cerebrovasculature and Self-Expanding Stents

Patel, N. V. · Gounis, M. J. · Takhtani, D. · Noordhoek, N. J. · Blijd, J. · Babic, D. · Wakhloo, A. K.
1University of Massachusetts, Worcester, MA, 2Philips Healthcare, Best, NETHERLANDS

PURPOSE
To develop, optimize, and assess the clinical performance of a method for intraoperative visualization of intracranial stents and their relationship to the host vasculature.

MATERIALS & METHODS
Cone-beam computed tomography (CBCT) was performed using a flat-panel detector angiography system. Datasets were reconstructed from 620 projection images acquired over a 200° arc (rotation time 20.7 s) at 80 kVp and a total of 260 mAs. To maximize spatial resolution, projection images were obtained using a small detector format (22 cm) and reconstructions were performed without pixel binning. A contrast injection protocol was optimized for a balance between stent visualization host vessel opacification in a porcine model. Three commercially available intracranial stents were deployed in the internal maxillary arteries of two Yorkshire swine. Selective CBCT angiography was performed at contrast concentrations between 10 and 30% (Iopamidol 51%, by volume in normal saline) and flow rates between 0.5 and 3.5 ml/s. The CBCT datasets were reviewed and the optimal combination of contrast concentration and injection rate were used for clinical testing. The clinical study was approved by our Institutional Review Board. Forty-two CBCT examinations of implanted neurovascular stents were performed prospectively in 41 patients undergoing cerebral angiography. One patient received stents in two locations during treatments of separate aneurysms. Four cases were excluded from the study: three due to the use of balloon-mounted stents that have large struts and are visible with standard angiography, one due to failed contrast injection. The majority of included cases (35/38) were stents placed for treatment of intracranial aneurysms. Three stents were placed for vertebrobasilar insufficiency (n = 1), acute ischemic stroke (n = 1), and severe MCA stenosis (n = 1). For clinical evaluation, the CBCT dataset was reconstructed with a 512 x 512 matrix covering a cubic FOV of 36.4 mm in each dimension (67 µm isotropic voxels). The images were assessed through blinded review by two neuroradiologists.
using a structured questionnaire. Stent and host vessel visibility were rated on scales of 1 to 5, and the ability to assess stent apposition was rated “yes” or “no.”

RESULTS
The optimal injection protocol for carotid artery injections was 20% contrast at a flow rate of 3.0 ml/s. The flow rate was reduced to 2.0 ml/s for clinical vertebral artery injections. The median scores for stent and host vessel visibility were both 4, defined as visible with good detail. Agreement was moderate (intraclass correlation coefficient 0.53 for stent visibility, 0.51 for vessel visibility). Both raters were able to assess stent apposition in 89% of the cases (Cohen’s κ = 0.64). In 11/38 cases, CBCT identified important findings that could not be discerned on conventional angiography or multidetector computed tomography. These included: the relationship between the coil mass and important vessels originating in close proximity to an aneurysm, stent thrombosis, neointimal hyperplasia; “ovalization” of a closed-cell stent, and calcified atherosclerotic plaque underlying a stent.

CONCLUSION
Intraoperative CBCT is a reliable technique that provides good quality visualization of intracranial stents and their host vessels. This technique enables neuroradiologists to identify important findings that are not seen using standard techniques.

KEY WORDS: Brain aneurysm, stent-assisted embolization, cone-beam CT

Paper 335 Starting at 3:49 PM, Ending at 3:57 PM
Creation of Narrow-Neck Aneurysm with Predilation of Right Common Carotid Artery before Elastase Incubation
Ding, Y. · Kadirval, R. · Dai, D. · Lewis, D. · Kallmes, D.
Mayo Clinic
Rochester, MN

PURPOSE
To determine whether predilation of the right common carotid artery (RCCA) immediately prior to elastase incubation can induce narrow-neck aneurysms.

MATERIALS & METHODS
Twenty-four elastase-induced aneurysms were created in rabbits. Elastase incubation was performed after predilation of RCCA with angioplasty balloon (balloon diameter/length 3.5 mm/2 cm, inflation pressure 8 atm, inflation duration 60 seconds, inflations = 3). A small part of the Fogarty occlusion of balloon used for elastase incubation was allowed to herniate into the origin of RCCA during elastase incubation, a maneuver that usually yields narrow-necked and small aneurysms. Digital subtractive angiography (DSA) was performed for all these aneurysms at least 3 weeks after creation. Aneurysm sizes (neck diameter, width and height) were measured and calculated. Aneurysm dome/neck ratio was calculated. Narrow-neck aneurysm was defined as neck size less than 4 mm, width/neck ratio more than 2.

RESULTS
Mean aneurysm neck width was 1.7 ± .3 mm. Mean aneurysm width was 3.3 ± .5 mm. Mean aneurysm height was 8.4 ± 2.0 mm. Mean aneurysm dome/neck ratio was 2.0 ± .4 (see Figures).

CONCLUSION
Previous techniques for creation of narrow-necked, elastase-induced aneurysms also yielded very small aneurysms. Use of predilation of RCCA before elastase incubation can induce narrow-necked aneurysms that are relatively larger than previous narrow-necked elastase aneurysms.

KEY WORDS: Aneurysm, model, rabbit

Paper 336 Starting at 3:57 PM, Ending at 4:05PM
Preliminary Results in our First 39 Consecutive Patients Treated for Intracranial Aneurysms Using Pipeline Embolization Device
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¹Fondazione Policlinico Ospedale Maggiore Ma Re, Milan, ITALY, ²Neuroradiologia Diagnostica ed Interventistica, Milan, ITALY

PURPOSE
The general experience has demonstrated the high percentage of recurrence in treating wide-neck aneurysms with coils. Flow diverters stents, such as pipeline embolization device (PED), may be the key solution after several devices have been proposed in the last years in order to tackle this problem. Compared to covered stents, PED, due to its braid-ed structure, preserves perforating arteries as demonstrated with animal models. We want to share our experience with our first 39 cases.

MATERIALS & METHODS
From November 2008 and November 2009 we treated in our center 39 patients (gender: 6 males and 33 females), aged between 38 and 75 years old. Two patients suffered from previous subarachnoid hemorrhage. All the patients started double antiplatelets therapy 5 days before endovascular procedure, except for three patients who had loading dose just before delivering the stent. We performed an angiographic control in 33 patient after 1 week and a further angiography after 3 months in 14 patients. Twenty-four patients are still waiting the 3-month follow up.
RESULTS
During treatment we had neither hemorrhagic complications nor thromboembolic phenomena. In two cases we had rupture of the delivery wire, losing the tip but without clinical consequences. After 1 week we observed the complete resolution of the aneurysm in eight patients. Half of the 14 patients controlled after 3 months healed completely. We had one patient with initial complete disappearance of the aneurysm and recurrence during the second follow up. We lost one patient due to massive intraparenchymal hemorrhage which happened 48 hours after the stent deployment. We observed two asymptomatic and complete stent occlusion, in two different patients, respectively after 7 days and after 3 months. We never had ischemic phenomena due to perforating arteries occlusion.

CONCLUSION
Using PED, we could treat aneurysm with challenging anatomy or with high chance of recurrence. We are waiting long term follow up before reaching any final conclusion. The spontaneous occlusion of the parent vessel, despite the double antiplatelets therapy, must be considered.

KEY WORDS: Flow diverting stent

Paper 337 Starting at 4:05 PM, Ending at 4:13 PM
Angiographic and Clinical Outcomes in 346 Consecutive Cerebral Aneurysms Treated with Hydrogel-Coated Coils

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1Emory University Hospital, Atlanta, GA, 2McMaster University Hospital, Hamilton, ON, CANADA

PURPOSE
Endovascular coil embolization of intracranial aneurysms has been shown to improve clinical outcomes compared to surgical clip ligation in a large randomized multicenter trial (1). However, a significant number of coiled aneurysms recur and concern remains for the long-term durability of this treatment option. Denser coil packing of intracranial aneurysms is believed to result in lower recanalization rates. Hydrogel-coated expandable coils improve volumetric packing of aneurysms in animal models and clinical studies. Our initial experience using first generation HydroCoil systems for coiling intracranial aneurysms showed similar complication and retreatment rates compared to large treatment series using pure platinum coils (2). Our purpose was to evaluate whether complication, recurrence, and retreatment rates would change for patients treated with subsequent generations of HydroCoil and increased operator familiarity.

MATERIALS & METHODS
The initial 200 aneurysms in this series treated with HydroCoil from October 2002 to October 2005 have been reported previously. The next 146 sequential HydroCoil-treated aneurysms were placed between November 2005 and November 2007, consisting of 138 patients. The electronic medical records were reviewed for periprocedural complications and immediate and subsequent treatment results were graded using the Roy classification. Roy class 1 was defined as complete aneurysm occlusion, class 2 as residual neck filling, and class 3 as residual aneurysm filling. Recurrence was defined as a worsening Roy classification or further recanalization of a Roy class 3 aneurysm. There were 97 aneurysms with at least 6 months angiographic follow up averaging 11.5 months.

RESULTS
Of the most recent 146 aneurysms, there were 89 small (< 10 mm) and 57 large (> 10 mm) aneurysms with 71 unruptured and 75 ruptured. Three patients did not survive to initial discharge due to complications from subarachnoid hemorrhage. One patient sustained a hemorrhagic stroke while on clopidogrel after a stent-assisted coil embolization. The cumulative symptomatic complication, angiographic, recurrence, and retreatment data are summarized in the Table below. Symptomatic complications, initial treatment results and retreatment data

CONCLUSION
There was significant improvement in both hemorrhagic and thromboembolic complication rates in the second half of the series likely due to increased operator familiarity as well as incorporation of second generation coils. Allowing for differences in length of follow up, the recurrence and retreatment data appear similar for both the early and the late series.

REFERENCES

KEY WORDS: Aneurysm, hydrocoil
Comparison of Standard Coiling Standard and Remodelling in the Treatment of Ruptured Intracranial Aneurysms: Analysis in a Series of 768 Patients

Pierot, L.1 · Cognard, C.2 · Anxionnat, R.3 · Ricolfi, F.4 · and CLARITY investigators

1Hôpital Maison-Blanche, Reims, FRANCE, 2CHU Toulouse, Toulouse, FRANCE, 3CHU Nancy, Nancy, FRANCE, 4CHU Dijon, Dijon, FRANCE

PURPOSE
To analyze the safety and efficacy of the remodelling technique in comparison with the standard coiling technique in the endovascular treatment of ruptured aneurysms (CLARITY series).

MATERIALS & METHODS
In CLARITY series performed in 20 neurointerventional french centers, 768 patients (458 females and 310 males; age: 19-80 years, mean: 51.3 ± 13.1 years) having 768 ruptured aneurysms were treated by the standard coiling technique (608 patients, 79.2%) and the remodeling technique (160 patients, 20.8%). The characteristics of patients and aneurysms, complications related to the treatment and the SAH, morbidity, mortality, and anatomical results for each group were analyzed.

RESULTS
Adverse events, with or without complications, were 17.4% (106/608) in coiling group, and 16.9% (27/160) in remodeling group. Thromboembolic events, intraoperative ruptures, and early rebleeding were encountered in 12.7% (77/608), 4.4% (27/608) and 0.3% (2/608) respectively in coiling group, and 11.3% (18/160), 4.4% (7/160), and 1.3% (2/160) in remodeling group. The characteristics of patients and aneurysms, complications related to the treatment and the SAH, morbidity, mortality, and anatomical results for each group were analyzed.

CONCLUSION
In CLARITY series, the rate of therapeutic complications is not significantly different in the coiling and remodeling groups. The rate of adequate occlusion is significantly higher in the remodeling group.

KEY WORDS: Embolization, intracranial aneurysms

Morbidity and Mortality Due to Follow Up of Patients with Coiled Aneurysms: A Single-Center Retrospective Study

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Montreal, QC, CANADA

PURPOSE
To quantify the morbidity and mortality associated with systematic long-term imaging follow up of coiled aneurysms, including subsequent retreatment.

MATERIALS & METHODS
Using our database, the charts of all patients with endovascular coiled intracranial aneurysms between July 2002 and July 2009 were reviewed. Patients initially treated within the last 3 years were excluded to ensure at least 3 years follow up. Follow-up exams (defined as all intracranial vascular imaging studies performed at least 3 months after endovascular treatment) and subsequent retreatments (endovascular or surgical) were recorded. Using a prospective morbidity and mortality database, significant complications of more than 6 weeks’ duration (defined as any increase in modified Rankin Score, excluding mRS 0 to 1) due to follow-up studies and subsequent retreatments were analyzed.

RESULTS
Five hundred eleven patients with 565 endovascular coiled aneurysms were identified, with 386/511 (75.5%) undergoing at least one follow-up imaging study. In the followed cohort, 987 imaging studies were performed, including 702 digital subtraction angiographies, leading to two complications (2/386 = 0.5% per patient). Twenty-eight of 386 patients (7.3%) were retreated at least once for major recurrences (34 retreatments, (31 endovascular and 3 surgical)). Retreatment lead to complications in 2/28 (7.1%) of patients. The overall morbidity rate due to follow up was 1% (4/386), with no mortality.

CONCLUSION
The low overall related complication rate we observed suggests that a randomized controlled trial comparing combined clinical and imaging follow up to clinical follow up alone would not be feasible. Given the presumed risks of rupture from recurrent aneurysms, these results do not support a program of clinical follow up alone.

KEY WORDS: Aneurysm, coiling, follow up
Hemodynamic Characteristics Associated to Cerebral Aneurysm Rupture

Cebral, J. R., 1 Putman, C. M. 2
1 George Mason University, Fairfax, VA, 2 Inova Fairfax Hospital, Falls Church, VA

PURPOSE
To investigate the statistical association between hemodynamic characteristics and the rupture of intracranial aneurysms.

MATERIALS & METHODS
Computational fluid dynamics models of 172 cerebral aneurysms were constructed using the patient-specific geometries obtained from 3D rotational angiography images. Pulsatile flows measured in normal subjects were used to impose physiologic boundary conditions. Visualizations of the unsteady flow fields and hemodynamic forces (pressure and wall shear stress - WSS) were created and used to categorize the aneurysms according to the following qualitative characteristics: 1) flow impingement region (large, small), 2) flow pattern complexity (simple, complex), 3) flow pattern stability (stable, unstable), 4) inflow jet concentration (concentrated, diffuse). Additionally, a number of variables were quantified: a) min, max and mean WSS over the aneurysm sac, b) inflow rate (% of parent artery flow entering the aneurysm), c) inflow concentration (% aneurysm inflow/% inflow neck area), and d) aneurysm geometry (max diameter, neck diameter, depth, aspect ratio). The number of ruptured (R) and unruptured (U) aneurysms in each category were counted analyzed with 2 x 2 contingency tables. The average of these variables over the R and U groups was calculated and compared.

RESULTS
In the R group 75% of aneurysms had small impingement regions, 73% had concentrated inflow jets, 89% had complex flow patterns and 75% had unstable flow patterns. Odd ratios revealed that R aneurysms were 2.56 times more likely to have small impingement regions, 4.33 times more likely to have concentrated inflow jets, 6.89 times more likely to have complex flow patterns and 2.19 times more likely to have unstable flow patterns. All these associations reached statistical significance at a 95% confidence level using a Chi Square test. The average inflow concentration factors were 1.05 (R) and 0.65 (U), the average inflow rates were 37% (R) and 26% (U), the average mean WSS were 25.6 dyne/cm2 (R) and 17.4 dyne/cm2 (U), the average aneurysm sizes were 0.98 cm (R) and 0.67 cm (U), and the average aspect ratios were 1.45 (R) and 0.98 (U).

CONCLUSION
Ruptured aneurysms were found to be more likely associated with small impingement regions, concentrated inflow jets, complex and unstable flow patterns. Ruptured aneurysms also were found to have larger sizes, larger aspect ratios, higher inflow concentration factors, higher relative inflow rates, and higher mean wall shear stress. This analysis statistically confirms and extends trends identified in previous studies of the association of hemodynamic variables and aneurysm rupture.

KEY WORDS: Cerebral aneurysm, hemodynamics, rupture
Paper 343 Starting at 3:15 PM, Ending at 3:23 PM
“Thickened” Ligamentum Flava: Is It Buckling or Enlargement?
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PURPOSE
Thickening of the ligamentum flavum (LF), seen with degenerative lumbar spine disease, often is ascribed to buckling due to disk degeneration and disk space narrowing. Controversy exists concerning whether this thickening may occur in the absence of such changes. Therefore our primary hypothesis is that adjacent facet degenerative changes alone, in the absence of disk space narrowing, can cause thickening of the ligamentum flavum. Our secondary hypothesis is that inflammatory changes surrounding the degenerative facet joint may be the inciting etiology of this thickening.

MATERIALS & METHODS
Our MR database was searched for patients with LF thickening with or without disk space narrowing at L4/L5. In patients with normal L4/L5 disk height, we excluded patients with previous spine surgery, significant disk or metastatic bony/spinal canal disease, intraspinal synovial cysts, and spondylolisthesis at L4/L5. Thirty-one patients were divided into two groups; Group 1 had 18 patients with normal L4/L5 disk space height and Group 2 had 13 patients with decreased L4/L5 disk space height. LF thickening was measured on the T1- or T2-weighted axial image that was perpendicular to the spinal canal axis and parallel to the laminae. Two measurements were made: 1) LF width at half its length and 2) LF width was measured where it appeared the thickest. These values were compared to normal LF measurements. A student t-test was performed between both groups, with both means and standard deviations computed. Additionally, the degree of adjacent facet arthropathy was qualitatively assessed. In patients with gadolinium-based contrast studies, associated inflammatory enhancement of the facet joints and the LF was evaluated.

RESULTS
1. Average half-length LF thickening was 4.9 mm (Group 1) and 5.3 mm (Group 2) with standard deviations of 1.0 mm and 0.7 mm, respectively. The average maximal LF thickening was 5.6 mm (Group 1) and 5.8 mm (Group 2) with standard deviations of 1.0 mm and 0.9 mm, respectively. These measurements were significantly greater than the width of normal ligamentum flavum. 2. Patients with asymmetric LF thickening showed greater LF thickness on the side with worse facet degenerative disease. 3. No statistically significant difference in LF thickening was made at half-length \( p = 0.15 \) or maximal width \( p = 0.40 \) between both Groups 1 and 2. 4. Postcontrast studies showed more facet joint and LF enhancement on the side with greater facet degenerative disease.

CONCLUSION
The results support our primary hypothesis that LF thickening can be secondary to hypertrophic facet degenerative changes, independent of disk space narrowing. The results suggest support for the secondary hypothesis that inflammatory changes may be an inciting factor for LF thickening. As a corollary we found that in cases of asymmetric LF thickening, the thickness was greater on the side of worse facet disease, implying a spatial relationship between the thickening and the adjacent facet disease; moreover, on postcontrast studies in patients with asymmetric LF thickening there was more enhancement on the side with greater facet degeneration.

KEY WORDS: Ligamentum flavum, facet hypertrophy, lumbar spine

Paper 344 Starting at 3:23 PM, Ending at 3:31 PM
CT-Guided Bloodpatching for the Targeted Treatment of Intracranial Hypotension
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PURPOSE
Intracranial hypotension is an increasingly recognized syndrome characterized by positional headaches and other symptoms including cranial neuropathies, neck and back pain, and endocrinological disturbances. The underlying cause is hypothesized to be cerebrospinal fluid leaks from the nerve root sleeves, often at the site of irregular meningeal diverticula. Standard therapies have included conservative treatment, nontargeted lumbar epidural autologous blood patches, and surgery. We present the results of a CT-guided technique for the evaluation and targeted treatment of intracranial hypotension.
MATERIALS & METHODS
A retrospective review of patients treated between February 2005 and June 2009 found a total of 102 patients with clinically suspected intracranial hypotension who were referred for treatment. Eight patients had both pre and posttreatment brain MR imaging. Dynamic CT-myelography and immediate CT targeted bloodpatching of potential leak sites was performed on all patients. Pretreatment imaging findings on brain MR imaging, findings of CT myelography, and complications were recorded. Objective resolution of intracranial hypotension physiology was assessed with MR imaging.

RESULTS
In the eight patients in whom pre and posttreatment brain MR imaging was available, pretreatment imaging features included pachymeningeal enhancement in seven (88%) patients, cerebellar tonsillar ectopia in five (63%) patients, subdural collections in two (25%) patients, and cervical syringohydromyelia in one (13%) patient. Median time between initial imaging and CT-targeted bloodpatching was 19 days, and median time between bloodpatching and follow-up brain MR imaging was 48 days. On CT-myelography, irregular diverticula of the nerve roots were observed in eight (100%) patients, and a coexistent large extradural cyst was observed in two (25%) patients. All patients demonstrated resolution of imaging findings of intracranial hypotension on posttreatment imaging. No complications were observed.

CONCLUSION
Dynamic CT-myelography and immediate CT targeted bloodpatching is a safe and effective method for treating intracranial hypotension in this small series of patients. CT-guided targeting of irregular meningeal diverticula allows for the successful patching of potential leak sites and the reversal of the altered physiology associated with intracranial hypotension, as demonstrated by normalization of MR findings.

KEY WORDS: Intracranial hypotension, cerebrospinal fluid leak, blood patch

CEST and Sodium Imaging of Glycosaminoglycans Ex Vivo and In Vivo on the 3 T: Preliminary Results
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PURPOSE
Loss of glycosaminoglycans (GAGs) is a hallmark of degeneration of intervertebral disks. Quantitative assessment of GAGs can assist with assessment, treatment and prognosis of disk (IVD) degeneration. Several MR imaging techniques have been employed to assess the state of the GAG (1-4). One of these, gagCEST, utilizes endogenous molecules to create contrast based on chemical exchange saturation transfer (CEST) between GAG molecules and water. The method is implemented on the clinical 3 T scanner, and the study is aimed at the technical development and cross-validation of the results obtained using gagCEST and sodium imaging. Here we will present preliminary results of this study.

MATERIALS & METHODS
The imaging was performed on a clinical 3 T Signa GE scanner (GE, Waukesha, U.S.). For CEST contrast, a gradient-echo sequence with Fermi shaped presaturation pulse was employed. The CEST effect was measured at the -OH frequency (1 ppm from water). For Sodium imaging, a home-built quadrature coil and a 3D gradient-echo sequence were employed.

RESULTS
Figure displays CEST map acquired in the ex vivo specimen of a lumbar disk of a 39-year-old cadaver. The CEST effect increases with increasing GAG concentration. In the figure, the effect is substantially higher in the nucleus, in agreement with the reported relative concentration of GAG within the annulus and nucleus tissues (5). Additional asymmetry is observed in the saline surrounding the tissue, probably due to the B0 and B1 inhomogeneities. As part of the technique development and validation, in vivo CEST maps and Sodium images were acquired in the knee joints of healthy volunteers. Since Sodium reveals the fixed charge density in tissue, which in disk is dominated by GAG, we expected correlations between CEST maps and Sodium images. Indeed, our data shows high degree of agreement between CEST and Sodium imaging.
CONCLUSION
These findings support the potential for gagCEST in studies of GAG loss due to disk degeneration. The data display high degree of correlation between Sodium and CEST imaging. Work is in progress to extend gagCEST and Sodium imaging to in vivo IVD studies.

REFERENCES

KEY WORDS: IVD, CEST, sodium

Paper 346 Starting at 3:39 PM, Ending at 3:47 PM
T1-Weighted 3D Fast Spin-Echo Spine MR Imaging at Ultralow SAR

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PURPOSE
T1-weighted spine MRI is SAR intensive and is therefore prohibitive for imaging patients with active medical devices. For T2-weighted imaging SAR can be lowered by increasing TR. We have explored the limits to which SAR can be lowered while preserving image quality. Using optimized low refocusing flip angle trains (1), high quality T1-weighted 3D spine MRI was achieved at 1.5 T for SAR levels 50-100 times lower than those of conventional scans. The main goal here is to demonstrate adequate MRI quality at drastically reduced SAR perhaps allowing otherwise MR contraindicated patients to obtain spine MRI.

MATERIALS & METHODS
A pseudo-steady state approach for brain MRI (2) were followed, however with short TR and low refocusing RF pulse train of stretched pulses to create T1-weighted contrast in cervical and lumbar spine using a 3D FSE Cube sequence that has been demonstrated successfully at normal SAR levels in long TR 3D FSE imaging (1). The modifications were tested on fluid phantoms as well as on 3 normal volunteers (age 22-50) under IRB approval. 2 mm slices from 3D sagittal acquisition were compared with 3 mm clinical T1-weighted images and SNR and CNR values were computed for comparison.

RESULTS
Figure below shows a 2 mm T1-weighted low-SAR 3D FSE sagittal section of C-spine, left and of L-spine, right. SNR and CNR values for intrathecal CSF, cord, vertebral bodies and vertebral disks are reported in Table 1.

CONCLUSION
The primary issue addressed here is: spine imaging, particularly T1’s, can pose SAR problems for patients with active implants. The ability to acquire spine images at very low SAR in these cases is attractive. By significantly modulating the refocusing flip angles and the associated pseudo-steady state, one can achieve quality 3D images with two orders of magnitude lower SAR for 3D FSE T1 compared to clinical sequences (2 W/kg). This method may provide safe spine MRI options for patients with active implants and perhaps for those with pacemakers.

REFERENCES

KEY WORDS: T1-weighted, FSE, low SAR

Paper 347 Starting at 3:47 PM, Ending at 3:55 PM
Spinal Cord Stimulators: Normal Positioning and Postsurgical Complications

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PURPOSE
Spinal cord stimulators (SCS) are one option for pain management in those individuals with chronic low back or radicular pain. The expected positioning of stimulators, types of SCS, and potential complications have not been described in the radiologic literature. Our aim was to demonstrate the most common locations and types of SCS electrodes, lead wires and pulse generators. We defined the appropriate distance of the electrode from the posterior margin of the central spinal canal and identified postsurgical complications.

MATERIALS & METHODS
A five-year search of the radiology information system revealed 24 patients with images of 36 spinal cord stimulators. Those images were reviewed for identifying the loca-
tions and types of electrodes and lead wires within the spinal canal. Not all pulse generators were within the radiologic field of view. Complications, identified by reviewing the medical records, were correlated with imaging findings. Our Institutional Review Board approved the retrospective review of patient data for this study. Informed consent was waived by the Institutional Review Board, and the study was compliant with the Health Insurance Portability and Accountability Act.

RESULTS
Fourteen different types of electrodes were identified. Most were placed in the thoracic spine but six thoracolumbar and two cervical spine SCS also were present. We measured the position of the electrodes within the spinal canal on 26 CT studies in 24 patients. The electrodes were placed in the epidural space in the posterior 1/3 of the spinal canal on 22/26 CT studies. Complications included misplaced (Figure 1), migrated, broken, and retained electrodes and lead wires, puncture of the thecal sac, infection, and hematoma (Figure 2).

CONCLUSION
Radiologists should be familiar with the different types and expected locations of SCS employed in the spine to relieve pain. Improper placement of the electrode may lead to ineffective pain relief or other complications.

KEY WORDS: Spinal cord stimulator, epidural stimulator, epidural electrode

Paper 348 Starting at 3:55 PM, Ending at 4:03 PM
Molecular Imaging of Retrograde Neural Transport
Schellingerhout, D. · LeRoux, L. G. · Bredow, S. · Gelovani, J. G.
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PURPOSE
To develop an agent for imaging retrograde axonal transport in nerve tissues based on the optical labeling of a fragment of tetanus toxin protein.

MATERIALS & METHODS
A His-tagged recombinant tetanus toxin fragment (TTF) was produced in E.coli, purified, and labeled with a variety of Alexa fluorophors for optical imaging studies. Gel electrophoresis (SDS-PAGE) and quantitative immunodetection studies were performed. Cell uptake studies were performed to assess in vitro efficacy. Labeled TTF was injected into the soleus muscle of C57bl and Balb/C mice, and Wistar rats, and imaging performed with the IVIS 200 (Xenogen). In situ validation was performed with laser scanning confocal microscope FV 1000 (Olympus) utilizing intact glycerol mounted samples, and cryo-sections.

RESULTS
Gel electrophoresis and quantitative immunodetection indicated that the integrity and immune reactivity of the protein was preserved after labeling. Cell uptake assays indicated robust uptake in differentiated PC12 cells. In vivo optical imaging demonstrated the uptake of TTF-Alexa in the sciatic nerve and spinal cord. Progressive uptake and transport of the agent could be seen along the course of the sciatic nerve and spinal cord. Confocal microscopy studies on intact excised nerve segments and cryosections confirmed the compound uptake in nerve fascicles of the sciatic nerve. Axonal nerve uptake and superficial lymphatic uptake were clearly distinguishable, and transport was shown to be nerve-specific. Immunohistochemistry on cord sections demonstrated the presence of the agent in spinal cord neurons.

CONCLUSION
Fluorescently labeled TTF is taken up into motor nerve endings after intramuscular injection, and is retrogradely transported in nerve axons. This process can be demonstrated with noninvasive in vivo imaging, and allows nerve anatomy and function to be studied.

KEY WORDS: Neuronal transport, molecular imaging, retrograde transport
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G.1

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PURPOSE

Diffusion tensor imaging (DTI) of the spinal cord is technically challenging but may be useful to characterize many diseases, including spinal cord injury (SCI). However, DTI data are only as good as the underlying diffusion-weighted images (DWI), which are often suboptimal in the spinal cord. This study describes application of a reduced field-of-view (rFOV) DWI method to improve spinal cord DTI in normal subjects and patients with SCI. We also compare the rFOV method with conventional full FOV EPI.

MATERIALS & METHODS

Two young normal subjects and two SCI patients were imaged at 3 T using rFOV single-shot EPI (ssEPI) DWI, in which a 2D echo planar RF pulse is used to excite a smaller rectangular FOV (1). The SCI patients were: (1) a 61-year-old man with C6-7 trauma; (2) a 61-year-old woman with a T4 A VM. Imaging parameters were: rFOV = 18 x 4.5 cm²; eight axial and sagittal slices; voxel-size: 0.94 x 0.94 x 3 mm; TR/TE 3200/56 ms; 12 directions ($b = 500$ s/mm²) with 2 T2-weighted images; nex 16; total imaging time: 12 min. Full FOV (18 cm) ssEPI DTI also was acquired; voxel size: 1.8 x 1.8 x 3 mm; TR/TE 3200/66 ms. Diffusion tensor imaging metrics evaluated included mean diffusivity (MD), fractional anisotropy (FA), and fiber tractography (created using smartTRACK software (2)).

RESULTS

Reduced FOV DWI images demonstrated higher resolution and less susceptibility artifact in all cases. Fractional anisotropy was between 0.6 and 0.8 in an ROI located at C6 in the normal subjects, within the range reported by earlier researchers (3). Fractional anisotropy maps demonstrated the expected reduced FA in the central portion of the cord, which is largely gray matter. Both SCI patients showed reduced FA at the site of their lesion (mean 0.3). Selected images from patient #1 is shown in the Figure.

CONCLUSION

Using an rFOV diffusion approach, we demonstrate the feasibility of high-resolution spinal cord DTI in normal subjects and SCI patients at high field. The method was superior to standard full-FOV ssEPI, with higher resolution and reduced susceptibility artifacts. Reduced FA and disruption of mapped fibers using tractography were observed in both SCI patients. Based on these preliminary findings, rFOV DTI may be useful for evaluating white matter integrity following SCI.

REFERENCES


KEY WORDS: MR imaging, diffusion, spinal cord injury

Paper 350 Starting at 4:11 PM, Ending at 4:19 PM

Peripheral Lumbar Disk Margin Shape and Internal Disk Derangement: Imaging Correlation in Significantly Painful Disks Identified at Provocation Lumbar Diskography

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PURPOSE

The shape of the annular margin is a critical observation consistently used to characterize abnormality of the lumbar disk on CT and MR imaging studies. Abnormal disks also have internal features of annular derangement including radial annular defects (RD: radial annular tears, annular gaps) and annular degeneration (lamellar tears, annular fragmentation, peripheral annular tears). The purpose of this study was to evaluate the correlation between disk margin shape and the features of internal disk derangement identified on postdiskogram lumbar CT in significantly painful disks encountered at provocation lumbar diskography.

MATERIALS & METHODS

Significantly painful disks were encountered at 207 levels in 140 patients (75 male, 65 female) studied by provocation lumbar diskography where intradiskal lidocaine was administered to reduce the patient’s pain immediately after provocation. In 71 disks substantial/total relief of provoked pain occurred and in 56 disks no improvement developed after lidocaine administration (others: partial pain response, volume restriction, prior discectomy). The postdiskogram CT and diskogram imaging of these 127 unoperated upon disks were evaluated by two experienced interventional spine neuroradiologists and agreement reached by consensus. Postdiskogram CT was assessed for characteristics of the disk margin and features of disk internal derangement. Disk margin shapes were assessed and graded in standard fashion on postdiskogram CT including: 1) the presence of isolated generalized bulging of the disk margin (symmetric or asymmetric) or 2) the presence of focal protrusion of the disk margin (central, paracentral, foraminal, far lateral) without or with accompanying disk bulge. Features of disk internal derangement including: 1) Degenerative changes with...
Purpose

Peripheral annular fissures [annular high intensity zones (HIZ)] identified on T2-weighted MR imaging are known to correlate with diskogenic low back pain as demonstrated at provocation lumbar diskography (1). Studies also have demonstrated that enhancement may be common in peripheral annular fissures and T2 conspicuity may decrease with time (2). The purpose of this study was to correlate the provocation diskogram response and diskogram imaging appearance of lumbar disks with peripheral annular fissures as demonstrated on preprocedure combined unenhanced and enhanced MR imaging.

Materials & Methods

Over the course of 5 years, 43 patients were identified who had combined unenhanced and enhanced lumbar MR imaging available as their preprocedure study prior to provocation lumbar diskography. Peripheral posterior annular fissure was identified as focal enhancement of the annulus on postcontrast imaging at 28 unoperated disk levels in 19 of these patients (10 female, 9 male; age range 19-62 years, average 41 years) and form the focus of this study. Signal abnormality of the posterior annulus was graded on the sagittal T2-weighted MR sequence utilizing a 4-point scale by consensus of three experienced neuroradiologists: grade 1: negative/barely visible; grade 2: slight posterior annular signal; grade 3: obvious bright posterior annular signal; grade 4: posterior annular signal comparable to CSF. Grade 1-2 was considered no annular fissure, grade 3-4 was considered likely or definite annular fissure. Features identified at diskography were tabulated for each disk with annular fissure including: pain response (discordant, discordant, negative), anesthetic response, diskogram and postdiskogram imaging appearance (radial defect/tear, degenerative change, diskographic contrast leakage).

Results

Pain was provoked at diskography in 24 of 28 (85.7%) disk levels with an annular fissure identified on postcontrast MR imaging [discordant: 19 (64.3%), discordant: 6 (21.4%) with 4 disk levels normal]. Traditional HIZ (annular fissure) was judged to be present on sagittal T2-weighted sequence in only 16 of 28 disks (grade 3-4) and was judged not to be present in 12 of 28 disks (grade 1-2). Diskographic contrast leakage was identified in 13 disks, with 16 disks being contained. Provoked pain response to intradiskal lidocaine injection included: total/substantial pain relief: 6 disks (leak: 6); partial improvement: 6 disks (leak: 2, contained: 4); no improvement 10 disks (leak: 2; contained: 8) with no lidocaine injected at 6 levels (normal: 4; volume restriction: 2).

Conclusion

Annular fissure as identified on postcontrast MR imaging shows high correlation with diskogenic low back pain identified at provocation lumbar diskography. Annular fissures may be missed on sagittal T2-weighted imaging due to lack of sufficient signal intensity. Routine application of postcontrast MR imaging in lumbar spine evaluation may markedly improve prediction of diskogenic low back pain. Discordant pain might represent disks that have undergone partial healing.

References


Key Words: Disk annular tear, diskogenic low back pain, enhanced and unenhanced MR imaging
Correlation between Lumbar Spine MR Imaging Pathology and Pain Ratings in Patients with Chronic Low Back Pain Prior to Lumbar Epidural Steroid Injections

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PURPOSE
The association between lumbar spine MR findings and pain ratings in patients with chronic low back pain (CLBP) is controversial. Few studies have examined pathology in the neuroforamina and lateral recess. The purpose of this study was to use a comprehensive set of imaging criteria to determine whether neuroforaminal narrowing or other MR findings correlate with numeric pain ratings in patients with CLBP referred for lumbar epidural steroid injection (LESI).

MATERIALS & METHODS
The charts and images of patients with CLBP referred for LESI to the Pain Medicine Clinic at the University of Chicago Medical Center were reviewed retrospectively in this IRB-approved study. A total of 48 patients with recent MR imaging and pre-LESI pain ratings as determined by the visual analog scale (VAS) were included. Multiple imaging parameters were assessed in a blinded fashion by independent reviewers at the level of the intended LESI, including disk height, disk signal, annular tear, extrusion, central spinal stenosis, multilevel degenerative changes, neuroforaminal stenosis (as measured by effacement of the perineural fat), dorsal root impingement (as measured by obliteration of the dorsal root fat), lateral recess narrowing, and synovitis (as measured by T2 signal in the posterior facets out of proportion to other levels). Correlations between pain ratings and imaging findings were calculated using point biserial correlation with a two-tailed t-test and significance at the 0.05 level.

RESULTS
Sixty levels in 48 patients were evaluated. L45 (45%) and L51 (40%) were the most common levels of intended LESI. There were significant correlations between the severity of neuroforaminal stenosis and pain ($p < 0.03$), and between the presence of dorsal root impingement and pain ($p < 0.03$). Correlations between other variables were not significant at the $p = 0.05$ level.

CONCLUSION
While most MR findings do not appear to be correlated with pain ratings in CLBP patients, neuroforaminal stenosis and dorsal root impingement may be associated with back pain in this pre-LESI population. These results are thought to reflect the pathophysiology of back pain and may suggest a role for MR imaging in the evaluation of CLBP patients.

KEY WORDS: Pain ratings, MRI spine, lumbar epidural steroid injections
Wednesday Afternoon

3:15 PM – 4:45 PM
Room 312

(40d) Adult Brain: New Techniques (Scientific Papers 354 - 364)

See also Parallel Sessions
(40a) Adult Brain: Neoplasms II
(40b) Interventional: Aneurysms I
(40c) Spine: New Techniques And Degenerative
(40e) Quality/Socioeconomic

Moderators: Andrei I. Holodny, MD
Gul Moonis, MD, BS

Paper 354 Starting at 3:15 PM, Ending at 3:23 PM
Characterization of Multiple Sclerosis Lesions with MR Imaging at 7 T

Sammet, S. · Schmalbrock, P. · Shah, J. · Boster, A. · Bluestein, K. · Zachariah, C. R. · Aguila, F. · Kapur, V. · Chakeres, D. · Yuh, W. T. C. · Racke, M. · Knopp, M. V.
The Ohio State University
Columbus, OH

PURPOSE
To evaluate 7 T MR imaging (MRI) for visualizing and characterizing MS lesion substructure with the long-term goal to bring 7 T MRI into clinical practice thus expanding capabilities for early diagnosis and treatment assessment.

MATERIALS & METHODS
Ten MS patients (33-53 years old) were studied at 7 T (Achieva, Philips, Cleveland, OH, USA) using the following sequences: 2D-susceptibility-weighted imaging (SWI: TR/TE/flip = 1600/12/50°); 2D-white matter attenuated inversion recovery TSE (WHAT: TR/TI/TE = 8000/500/14) and T2-weighted gradient spin-echo (GraSE: TR/TE = 4000/70). Phase images were reconstructed from the SWI data. All 7 T MR images were compared visually and the numbers of lesions seen with each sequence were counted.

RESULTS
Overall, lesions had highest contrast on WHAT. The high spatial resolution and excellent GM/WM contrast allowed depicting a number of juxtacortical lesions and a few GM lesions. White matter attenuated inversion recovery images also provided excellent depiction of perivascular spaces. Susceptibility-weighted imaging magnitude images depicted only 93% of the lesions seen on WHAT. This is due to the decreased contrast in the weakly PD weighted SWI magnitude images compared to WHAT. Susceptibility-weighted phase images showed several interesting features. Some lesions were seen on the magnitude images, but not on the phase images indicating that contrast in these lesions is due to free water increase. Other lesions were seen only on phase but not magnitude images. These lesions must have significant presence of paramagnetic material, e.g., iron. Furthermore, a dark outer ring was observed on some lesions on SWI phase images that was not visible in SWI magnitude or WHAT images, and most lesions visible on SWI magnitude and phase images were associated with venous vasculature.

CONCLUSION
This ongoing study indicates that 7 T MRI provides several novel contrast mechanisms not typically visible at 1.5 T for detailed characterization of MS lesions and depiction of their internal structure. Future studies are needed to correlate the variable 7 T MRI appearance of MS lesions with clinical findings. High-resolution MR imaging at 7 T MRI enables to differentiate substructures in MS lesions. Therefore, ultra-high field MRI of MS might help to better understand the course of the disease and monitor treatment.

KEY WORDS: Multiple sclerosis, MR imaging, 7 T

Paper 355 Starting at 3:23 PM, Ending at 3:31 PM
Optimal Monochromatic Energy Level for CT Angiography Using Dual-Energy CT Scanners

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PURPOSE
Dual energy CT (DECT) scanners can generate simulated monochromatic images at various energy levels. The signal-to-noise ratio (SNR) and contrast-to-noise ratio (CNR) for different tissue types varies across the energy spectrum. We determined the energy levels (KeV) that optimize the SNR and the CNR for contrast-enhanced vessels as visualized against the surrounding brain parenchyma.
MATERIALS & METHODS
Head CT angiograms on 10 patients (mean age: 60 years, range: 45-80 years) were obtained using GE Discovery HDI 750 DECT (GE Healthcare, Waukesha, WI). The tube voltage was alternately changed between 140 kVp and 80 kVp, with tube current of 630 mA, rotation speed 0.8 s, pitch of 0.969:1, slice thickness 1.25 mm, reconstruction interval of 0.625 mm, CTDIvol = 59.82 mGy. The projection data were postprocessed to generate monochromatic images simulating energy levels from 40 KeV to 100 KeV, in increments of 5 KeV. These 140 data sets were analyzed to find the KeV level that maximized the SNR, or alternatively, the CNR. Signal-to-noise ratio - defined as mean HU of a tissue divided by its standard deviation - was measured for the arteries and the brain parenchyma. Contrast-to-noise ratio for arterial enhancement was calculated as the difference in attenuation of the artery and the adjacent brain divided by the RMS value of the standard deviations. Signal-to-noise ratio and CNR were plotted against monochromatic energy levels to find the optimal values. One-way variance analysis (Tukey's posthoc test) was used to determine statistical significance.

RESULTS
The highest SNR for both brain and arterial enhancement was obtained at 65 KeV. At this energy level, it was statistically significantly better than all other KeV levels (p < 0.05) except for the two adjacent energy levels (i.e., 60 KeV and 70 KeV). The optimal CNR value also was obtained at 65 KeV. The CNR at 65 KeV was significantly better than that at energy levels 70 KeV and higher; for levels 60 KeV and below, the difference was not statistically significant.

CONCLUSION
By using optimal monochromatic energy level, the SNR for the brain parenchyma and arterial enhancement can be boosted up approximately by factors of 2 and 2.5, respectively (see Figure 1). The CNR for relative enhancement of the arteries can be increase by a factor of approximately 3. These results have bearing on the images sets that should be archived and reviewed, and the minimum amount of iodinated contrast needed in the setting of renal function compromise.

KEY WORDS: Monochromatic energy level, dual-energy CT, CT angiography

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Paper 356 Starting at 3:31 PM, Ending at 3:39 PM
Application of Dual-Energy CT in the Evaluation of Unknown Origin Intracranial Hemorrhage: Differentiation between Tumor Bleeding and Pure Hemorrhage
Kim, S.1 · Kim, S.1 · Lim, H.1 · Choi, C.1 · Lee, D.1 · Suh, D.1 · Kim, J.2
1Asan Medical Center, Seoul, KOREA, REPUBLIC OF, 2Chungang University Hospital, Seoul, KOREA, REPUBLIC OF

PURPOSE
We investigated clinical utility of dual-energy CT (DECT) in the differentiation of tumor bleeding from pure intracerebral hemorrhage (ICH).

MATERIALS & METHODS
This study was approved by the institutional review board, and informed consent was obtained. Precontrast single-energy and postcontrast dual-energy CT scans were obtained in 25 patients with spontaneous ICH in a dual-source CT scanner. Image sets including precontrast, enhanced average which is similar to conventional enhanced CT, virtual non-contrast (VNC), color-coded iodine overlay, and fusion image of iodine overlay and VNC were produced from source data. Diagnostic performance for detecting underlying tumors was compared among fusion images, enhanced average images, and enhanced average plus precontrast images. Image noise and overall image quality were compared between fusion images and enhanced average images. Statistical analysis was performed using receiver operator characteristics (ROC) curve analysis and McNemar test.

RESULTS
Our series included eight primary or metastatic tumors and 17 nontumorous ICH. Nine cases were pathologically proved and 16 cases were diagnosed by clinical background and imaging follow up. Diagnostic performance for detecting brain tumors was higher in fusion images compared to enhanced average image alone and combined enhanced average and precontrast images (sensitivity 87.5, 37.5 and 75.0%, specificity 94.1, 94.1 and 94.1%, and accuracy 92, 76 and 88%, respectively). Area under curve (AUC) on ROC curve was 0.923, 0.871 and 0.890, respectively. Image noise was lower with VNC compared to that of precontrast images, but overall image quality was not different between the two groups. Lesion conspicuity was compared between fusion images and enhanced average images. Statistical analysis was performed using receiver operator characteristics (ROC) curve analysis and McNemar test.

CONCLUSION
Dual-energy CT with fusion images showed higher sensitivity for detecting underlying tumor in patient with spontaneous ICH compared to enhanced average images, and lesions were more conspicuous on fusion images compared to average images.

KEY WORDS: Dual-energy CT, brain hemorrhage, brain neoplasm
Intraoperative MR imaging (MRI) in neurosurgery has been introduced as an early resection control while further resection within the same anesthesia is still possible. Furthermore neuronavigation can be updated. However, surgical manipulation can cause a temporary disruption of the blood-brain barrier and thus contrast enhancement can simulate residual tumor burden. DSC-MRI has been used preoperatively to assist differentiation of various brain lesions by maps and ratios of CBV and CBF and also during follow up to differentiate recurrent disease from radiation necrosis. The purpose of this study was to assess the feasibility of DSC-MRI intraoperatively, prove its reliability in comparison to preoperative acquired data and to assess its clinical applicability.

Materials & Methods
Thirty patients with glioblastoma multiforme were enrolled in this study after signed informed written consent was obtained. Our institution is equipped with an intraoperative 1.5 T MRI (Philips, Best, The Netherlands) and a dedicated OR suite including a rotating table allowing patient transport from the surgical (outside the 5 Gauss line) to the imaging site. Prior to scanning of patients, phantom studies were performed to assess the image distortion at a water-air level as well as in a flow phantom. For iDSC-MRI a dynamic susceptibility contrast-enhanced T2*-weighted EPI PRESTO sequence (TR/TE = 17 / 8 ms; FOV 240 mm; matrix 128 x 128; EPI factor = 17, number of slices 30 with slice thickness of 3.5 mm) was used. Contrast agent was applied intravenously after an initial rest period as a bolus with 5 cc/sec followed by a saline flush. Maps from MTT, rCBV and rCBF were created using the NordicIce software (NordicNeuroLab, Bergen, Norway).

Results
Image distortion in the phantom studies was negligible encouraging us to perform clinical studies. In the majority of cases complete removal already was achieved by the time of iDSC-MRI. The resection cavity was clearly depicted and no increased perfusion values were obtained in the adjacent brain parenchyma again proved in the postoperative MRI. In eight cases residual tumor was found. Ratios of rCBV and rCBF obtained pre or intraoperatively did not differ significantly (two-tailed t-test). However, we found a high correlation between these values (Pearson correlation; r(2)rCBV = 0.86, p < 0.01; r(2)rCBF = 0.86, p < 0.01). Intraoperative DSC-MRI assisted in the decision process intraoperatively of a complete removal in the other cases.

Conclusion
Intraoperative DSC-MRI is feasible and as reliable as preoperatively acquired data. The resection cavity can be detected clearly; distortion is negligible. Residual tumor can be depicted easily and thus assist complete removal of GBM. Pathophysiologic information thus is available intraoperatively at any time. Intraoperative DSC-MRI is furthermore independent of any amount of brain shift and from surgical-induced blood-brain barrier disruption.

Key Words: Intraoperative MR imaging, DSC MRI, glioblastoma

Comparative Analysis of Ferumoxytol and Gadolinium in Neuroimaging Using Standard MR Sequences: Preliminary Data

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Purpose
Given recent concerns about nephrogenic system fibrosis (NSF) in relation to gadolinium (Gd) administration, interest in alternative MR imaging contrast agents seems warranted. We review our initial experience with Ferumoxytol (Fe), an ultrasmall superparamagnetic iron oxide nanoparticle (USPIO), as an alternative contrast agent for MR imaging with favorable characteristics for neuroimaging.

Materials & Methods
Two neuroradiologists retrospectively reviewed all MR examinations in patients imaged on 3 IRB-approved neuroimaging protocols with known CNS pathology at our institution over the 2006-2008 time period. Patients receiving both Gd and Fe during the same imaging session (performed over a 2-3 day time period) were included, except for two patients who had only outside Gd-enhanced MR imaging within 40 days of the research exam (unable to receive Gd on protocol due to history of renal transplant). Fe was administered as an IV bolus, with postcontrast imaging assessed 24 hours postinjection. Comparative imaging sequences were identical and performed on the same scanner except for the two patients noted. All pre and postcontrast T1- and T2-weighted imaging was reviewed. Lesion size and enhancement characteristics were assessed, with consensus review by two neuroradiologists. Lesional bidimensional size was measured to the nearest tenth cm on postGd and 24 hour postFe images. Lesion enhancement intensity was scored on T1-weighted images from 0-10. Postcontrast T2-weighted images were reviewed for T2 hypoenhancement (postcontrast image darkening) and scored 1 if present, 0 if not. Mixed model repeated measures analysis of variance (ANOVA) was used to determine differences in lesion size and enhancement intensity between Gd and Fe, between lesion size and enhancement intensity relative to T1 sequence type for each contrast agent, and for each of the three protocols and group as a whole.

Results
Fifty-one MR imaging examinations were reviewed in 30 male and 21 female adults (aged 19-74 years, mean 51 years). Neoplasms included 17 GBM, 3 astroblastomas, 2 oligodendrogliomas, 2 astrocytomas, 2 metastatic melanomas, 2 posttransplant lymphoproliferative disorders, one each: anaplastic ependymoma, lymphoma, spinal glioma, unspecified glioma, schwannoma. Vascular lesions...
included 2 each of: stroke, cavernoma, capillary telangiectasia. Inflammatory disorders included 12 suspected treatment-related necrosis in known glioma patients, and one multiple sclerosis. All CNS neoplasms except schwannoma were confirmed histologically. Characteristic imaging and clinical history confirmed diagnosis in the remainder. Difference in size between Gd and 24-hour postFe was statistically significant (p = 0.0449). Much greater enhancement was observed with Fe than Gd in the two cases of PTLD. Differences in enhancement intensity for Gd and Fe was significant (p = 0.0006). T2 hypo-enhancement was observed only with Fe (51% of cases).

CONCLUSION
Central nervous system diseases may be effectively enhanced using Fe as an alternative MR imaging contrast agent, though lesion size and enhancement intensity vary. While most pathology showed slightly smaller size and less intense enhancement with T1 imaging, some pathology was larger and more intense with Fe. T2 hypo-enhancement was observed only with Fe (51% of cases).

KEY WORDS: Ferumoxytol, MR contrast agents

Paper 359 Starting at 3:55 PM, Ending at 4:03 PM

Voxel-Based Analysis of Brain Regional Vulnerability to Hypoperfusion in Stroke Patients

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PURPOSE
We defined a “vulnerability index” to evaluate voxel-based sensitivity of different brain areas to blood flow reduction using admission DWI and CTP scans of acute ischemic stroke patients. The “vulnerability index” maps are calculated so that brain areas with a large percentage of infarction despite relatively high blood flow receive the highest values, reflecting ischemic vulnerability to hypoperfusion.

MATERIALS & METHODS
We evaluated CTP and DWI scans of 92 consecutive patients who were admitted to our center with acute ischemic stroke and underwent both shuttle-mode CTP (8 cm coverage) and DW-MRI within 9 hours of symptom onset. Infarcted brain tissues were outlined manually on DWI sequences. All outlined infarcted lesions and CTP maps were coregistered to standardized brain space. For each brain voxel, the probability of infarction was calculated following coregistration. The “vulnerability index” of each voxel was determined as the product of the absolute cerebral blood flow (CBF) value and the probability of infarction in that voxel; thus voxels with a high probability of infarction along with relatively high blood perfusion (CBF) receive the highest VI values. We overlaid all “vulnerability index” maps on standardized brain space and calculated the average value for each voxel across all patients.

RESULTS
We analyzed the admission CTP and DWI scans of 92 patients (mean age of 66 years). As depicted in the figure, all cortical gray matter tissue appears to have high level of ischemic vulnerability to blood flow reduction. Other cerebral areas with relatively higher vulnerability include: anterior pole of the temporal lobe (superior temporal gyrus), insula, putamen, caudate nucleus, left middle frontal and superior precentral gyrus.

CONCLUSION
To our knowledge, this is the first study to determine brain regional ischemic vulnerability to hypoperfusion using DWI and perfusion scans in acute stroke patients. Determining brain regional sensitivity to hypoperfusion can improve the CTP-based differentiation of infarction core/penumbra. The
PURPOSE
To our knowledge the appearance of cerebral fat emboli on susceptibility-weighted imaging (SWI) has not been described previously in the radiologic literature. We observed the presence of innumerable tiny low signal foci throughout the brain substance on SWI in two different trauma patients with long bone fractures that demonstrated the classical clinical presentation of systemic fat emboli. These patients also demonstrated the previously reported “Starry Night” pattern of T2-weighted and diffusion-weighted imaging (DWI) signal abnormalities in the brain that were much less numerous. MR spectroscopic imaging (MRSI) was performed in one patient in order to substantiate our belief that the numerous low-signal foci noted on SWI were actually fat emboli within the brain vasculature. Follow-up exams also were obtained in both patients.

MATERIALS & METHODS
Two patients underwent complete MRI brain exams including T1W, T2W, FLAIR, DWI, and SWI sequences as well as a follow-up exam that included a gradient-echo sequence in the first patient and a MR spectroscopic examination in the second patient. MR spectroscopic imaging was performed using both single and 2D multivoxel technique at low and high TE and PRESS algorithm.

RESULTS
Both patients demonstrated innumerable tiny low signal foci throughout the brain substance on SWI, much greater than T2 and FLAIR signal abnormalities or foci of restricted diffusion. These occurred predominately in the white matter and at the gray-white matter junctions following a path of endarteries throughout the brain substance. MR susceptibility imaging in the second patient demonstrated a reproducible strong lipid peak on numerous spectra within the brain substance at 9.1-1.5 ppm which is confirmation of the presence of fat emboli corresponding to the low signal foci on SWI.

CONCLUSION
Cerebral fat emboli have a characteristic appearance on SWI that consists of innumerable low signal foci throughout the brain substance that greatly outnumbers the T2 and DWI signal abnormalities present and therefore the awareness of this finding can greatly aid in this difficult diagnosis. Also, the presence of massive fat emboli to the brain can be substantiated with the use of MRSI by detecting the presence of lipid within brain spectra.

KEY WORDS: Susceptibility-weighted imaging, fat emboli, cerebral

Paper 361 Starting at 4:11 PM, Ending at 4:19 PM
Brain Alterations in Chronic Alcoholism: A Voxel-Based Morphometry and Tissue Coherence Study
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PURPOSE
Brain imaging studies of alcohol addiction have revealed both general reduction of brain tissue and regional damage. Changes in different brain regions, particularly involving frontal lobes were subject of neuropathologic research. Unlike conventional volumetry measurements based on a priori selected brain regions, voxel-based morphometry (VBM) emerged as a method to investigate alterations in entire brain. It uses massive univariate approach to determine differences in gray/white matter density or microstructure tissue properties such as apparent diffusion coefficient or fractional anisotropy in diffusion tensor imaging. Together with VBM we used tissue coherence metrics to investigate pattern of brain damage induced by chronic alcohol consumption. Subjects: 23 male patients (mean age 45.3 years) with history of alcohol consumption over 10 years and more than 20 standard drinks per day, without comorbidities were examined together with 22 age-matched controls.

MATERIALS & METHODS
All subjects were scanned on the 1.5 T Siemens Sonata MR scanner using MPRAGE sequence (TR = 2860 ms, TE = 3.93 ms, FA = 15°, acquisition matrix: 256 × 256, 176 slices, slice thickness = 1 mm) and 8 channel array coil. Data processing: All MPRAGE images were checked for artifacts and manually aligned so that the origin of the coordinate system was located at the anterior commissure. To improve the quality of image segmentation we applied non-local-means denoising filter before SPM8 segmentation procedure. Segmented images (gray and white matter) were warped into a new reference space representing an average of all subjects using DARTEL (Ashburner, 2007) and resampled to 1.5 mm isotropic voxels. Gray matter probability values were scaled by the Jacobian determinants to account for the volume change. After that, GM volumes were smoothed using 6 mm FWHM Gaussian kernel. Two group t-test was used for evaluation of GM changes due to alcohol abuse. Additionally for each point with GM “amount” more than 10% and for each group (controls and alcohol patients) we determined the volume of the neighborhood with general correlation coefficient >0.8 - coherence volume for given point. This resulted in two templates: normal and alcoholic. For each point we made permutation test of the mean correlation coefficient inside the “coherence volume” of the control group to find regions with significant tissue coherence differences.

RESULTS
Voxel-based morphometry revealed pattern of gray matter loss in chronic alcoholic patients most prominent in frontobasal area, thalami, Inferior frontal gyrus, insular region and cerebellum (with p < 0.05, family-wise-error). Additionally, coherence analysis have shown more areas with tissue integrity loss.
CONCLUSION
One important improvement for voxel-based morphometry is done in preprocessing by using non-local-means filtering, useful in all MR measurements that suffer from low signal/noise ratio. Additionally, coherence tissue analysis reveals larger regions of impaired tissue than standard voxel-based morphometry. We were able to demonstrate number of regions of cytotoxic damage caused by chronic alcoholism that correlate well with neurologic and behavioral changes.

KEY WORDS: Morphometry, alcoholism

Paper 362 Starting at 4:19 PM, Ending at 4:27 PM
Withdrawn

Paper 363 Starting at 4:27 PM, Ending at 4:35 PM
Large Scale Spatial Pattern Analysis of Neuroimaging Data Using Machine Learning Techniques: A Feasibility Study

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PURPOSE
Machine learning methods are becoming increasingly popular as they are multivariate in nature and use spatial information to overcome some of the characteristic limitations of univariate methods. Whole-brain multimodality analyses are challenging for these new methods due to the high dimensionality from the huge number of voxels. Here we study very high dimensional classification analyses of neuroimaging data using logistic regression with elastic net penalty (LOGNET).

MATERIALS & METHODS
The LOGNET model is fitted by solving the optimization problem in Figure 1. We simulated brain volumes, for two balanced groups of subjects, each containing approximately 1.6 million voxels and we added signal of spherical shape to the subjects in one of the two groups at a common position randomly chosen inside the brain volume. We carried out three simulations to evaluate LOGNET performance: 1) varying signal to noise ratios (SNR); 2) increasing number of subjects per group (Ns); and 3) increasing number of relevant voxels (V). In the first simulation for varying SNRs we added constant values (A = 3, 2, 1 and 0) of Gaussian noise N (0,1) at predefined locations with fixed V and Ns of 1000 and 30 respectively. In the second simulation we varied V (1000, 2000, 4000) with A and Ns fixed to 1 and 30 respectively. For the last simulation we used three values of Ns (30, 50 and 75) with V = 2000 and A = 1. LOGNET performance is characterized in terms of power and false positive rates using 30 realizations of the data for each analysis.

![Lognet optimization problem](image)

Figure 1. Lognet optimization problem. $N$ is the number of samples, $y$ is a vector containing the class labels, $x_i \in \mathbb{R}^P$ is the $i$th sample, $p$ number of predictors, $\beta_0, \beta$ are the parameters of the model and $\lambda, \alpha$ are the regularization parameters. One implementation is based on the glmnet toolbox.

RESULTS
We observed good performance of the LOGNET method in terms of power and false positive rate (FPR) in all simulations. As expected power decreased with the SNR: 100%, 99% and 61% for the three signal levels we studied while the FPR slightly increased: 0, 10-4, 10-3 and 10-3. Increasing the number of relevant voxels resulted in an increase in power: 59%, 67% and 70% and similar levels of FPR: 10-3, 3x10-3 and 2x10-3. Increasing the number of subjects from 30 to 75 in each group resulted in an increase of power: 59%, 87% and 90% and decrease in FPR: 10-3, 6 x 10-4 and 10-5.

CONCLUSION
Our simulation study suggests that classification analysis based on LOGNET is feasible at the scale of 1.6 million voxels explored in this work. This framework can be extended to multimodal voxel-wise analyses at high dimensionality typically used for neuroimaging studies.

KEY WORDS: Machine learning

Paper 364 Starting at 4:35 PM, Ending at 4:43 PM
Optimized Double Inversion Recovery MR Brain Imaging at Very Low SAR for Patients with Neurostimulators

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PURPOSE
Double inversion recovery (DIR) has shown significant promise in neuro-MR imaging (1) but it is SAR intensive, requires high field and is time-consuming without multicoil parallel imaging, most of which are not suitable for patients with active medical devices. We have optimized an investigational version of 3D DIR Cube sequence at 1.5 T (2) using transmit-receive head coil to produce high quality images for patients with neurostimulators at SAR levels 10-20 fold lower than most clinical 2D MR imaging methods that pose substantial RF heating risk.

MATERIALS & METHODS
A 3D DIR Cube sequence (2) was optimized on phantoms and normal volunteers with low-flip angle refocusing pulse trains and were applied in transmit-receive head coil within low SAR restrictions. Apart from optimizing for low-SAR, the TI2 values were kept at 150-200 ms to obtain higher SNR and to avoid full suppression of white or gray matter. Five patients with neurostimulators (DBS and VNS; turned off during MR imaging) were scanned to assess postsurgical follow up or related complications and 10 patients without implants also were scanned in body-transmit, head-receive coil with active medical devices. We have optimized an investigational version of 3D DIR Cube sequence at 1.5 T (2) using transmit-receive head coil to produce high quality images for patients with neurostimulators at SAR levels 10-20 fold lower than most clinical 2D MR imaging methods that pose substantial RF heating risk.

RESULTS
In the figure at left is shown a 2.6 mm section from 3D coronal DIR images for a seizure patient with no implant present,
imaged at 0.8 W/kg SAR and at right a 2.0 mm section from a seizure patient with a vagal nerve stimulator using transmit-receive head coil at 0.1 W/kg SAR. The images were interpreted by three neuroradiologists and a neurosurgeon. Qualitatively, the SNR and G/W contrast appear to be comparable at low and normal SAR. No complication or implant malfunction was reported after the MR imaging. The contrast in DIR was found superior to that of FLAIR in both implant and nonimplant patients.

CONCLUSION
Using low-flip-angle refocusing RF pulses with modulation to sustain magnetization, high quality 3D DIR imaging with substantially lower SAR is achievable for patients with active medical devices and may present a viable DIR option to patients with pacemakers. This drastically reduces the MR imaging risk potential for these patients while maintaining the image quality expected from DIR sequences.

REFERENCES

KEY WORDS: DIR, Neurostimulators, low SAR

Wednesday Afternoon
3:15 PM – 4:45 PM
Room 210

(40e) Quality/Socioeconomic
(Scientific Papers 365 - 377)

See also Parallel Sessions
(40a) Adult Brain: Neoplasms II
(40b) Interventional: Aneurysms I
(40c) Spine: New Techniques and Degenerative
(40d) Adult Brain: New Techniques

Moderators: Patrick A. Turski, MD, FACR
Suresh K. Mukherji, MD, FACR

Paper 365 Starting at 3:15 PM, Ending at 3:23 PM
Maintenance of Certification: Update on Attitudes of Members of the American Society of Neuroradiology

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Baltimore, MD

PURPOSE
Neuroradiology is in the 5th year of subspecialty recertification. New requirements for the maintenance of certification (MOC) process include a practice quality improvement (PQI) initiative. The purpose of this report was to survey compliance of ASNR members with the MOC process.

MATERIALS & METHODS
A 12-question internet-based survey was sent to the 2864 members of the ASNR through email addresses. The survey asked questions regarding compliance with cognitive testing, self-assessment modules (SAMs), continuing medical education (CME) credits and PQI. Multiple reminders were sent and open comments graded for attitudes towards the MOC process.

RESULTS
While most respondents were engaged in the MOC process [878/1074 (81.8%)] and were aware of CME and SAM [736/1067 (69%)] and cognitive testing requirements of the recertification, the PQI initiative had limited participation and many questions about the component. Of the 1057 respondents 687 (490 not started, 87 registered but not started, 110 unaware of PQI) or 65% had not started a PQI project at the time of the survey. The ASNR was asked to help with the cognitive examination by 25 (4.4%), CME offerings by 53 (9.4%), SAM modules by 88 (14.0%), and PQI projects by 205 (36.2%) respondents. Open comments were generally unfavorable towards the MOC-PQI process by a 3:1 ratio.

CONCLUSION
Compliance with the MOC process has improved since a prior survey 3 years ago; however, confusion over the PQI process remains the primary concern of ASNR members.

KEY WORDS: Maintenance of certification, competency, self-assessment
The vast majority of interpreted head CT cases read by board certified general radiologists for patients presenting with stroke or stroke symptoms do not result in discordant interpretations as verified by subspecialty experts. Discordant interpretations did not result in changes in clinical management in most cases. Double reading of head CTs for these patients by subspecialty experts appears to be an inefficient method of substantially improving imaging health quality outcomes in acute stroke management.

**Key Words:** Quality improvement, health outcomes, CT and stroke imaging

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**Paper 367 Starting at 3:31 PM, Ending at 3:39 PM**

**Doses to Pediatric and Adult Patients in Head CT Imaging**

Thampy, R. · Huda, W. · Magill, D. · Thompson, B. · Rumboldt, Z.

Medical University of South Carolina

**Purpose**
To estimate adult and pediatric effective doses (E) for head CT examinations using ICRP 103 tissue weighting factors.

**Materials & Methods**
Effective doses per unit Dose Length Product (DLP) for adult head CT examinations were generated using ICRP 103 tissue weighting factors. Relative patient effective doses per unit DLP for head CT examinations were obtained as a function of patient age from the scientific literature (1). The absolute intensity (CTD\textsubscript{vol}) for adult head CT examinations was obtained using data from the ACR CR Accreditation program. Relative intensities for pediatric head CT examinations were taken from recommendations made on the Image Gently web site. Scan lengths for normal head CT examinations in four age groups (i.e., newborn, 1 year old, 5 year old, and adult) were obtained from current clinical practice at our institution. Effective doses were generated as the product of CTD\textsubscript{vol}, CT scan length, and patient age dependent E/DLP conversion factors.

**Results**
Replacing ICRP 60 with ICRP 103 tissue weighting factors increases E/DLP conversion factors in head CT by approximately 10%. The x-ray beam intensity (CTD\textsubscript{vol}) in head CT is reduced from 55 mGy for adult patients to 41 mGy for newborns, and the corresponding scan length is reduced from 15 cm to 12 cm. Adult effective doses for a single head CT examination are 2.0 mSv, and increase to 6.1 mSv in newborns.

**Conclusion**
Routine adult head CT examinations have effective doses of about 2 mSv, but are up to three times higher in pediatric patients.

**References**

**Key Words:** Dose, CT, pediatric
Reducing Radiation Exposure in Aneurysmal Subarachnoid Hemorrhage by Implementing Utilization Guidelines: A Practice Quality Improvement Project

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**PURPOSE**
The purpose of this study was to reduce the cumulative radiation exposure from head CT for patients with aneurysmal subarachnoid hemorrhage (A-SAH).

**MATERIALS & METHODS**
Retrospectively, data were collected on all CT exams of the head performed throughout the hospital course of 60 A-SAH patients; 30 before and 30 after the implementation of a departmental PQI imaging protocol designed to limit CT angiography (CTA) and CT perfusion (CTP) exams and reduce cumulative radiation exposure. Radiation exposure estimates were obtained by recording dose-length product (DLP) values for each individual exam. Comparison of mean, median and standard deviation estimates were performed for cumulative radiation exposure and absolute numbers of each exam.

**RESULTS**
Sixty patients were included in the study; 30 patients for baseline and 30 patients following implementation of the quality improvement plan. Four hundred one CT exams were performed; 241 exams at baseline and 160 exams following the new protocol. Following the new algorithm, the mean number of CT exams per patient was 5.8 compared to 7.8 exams at baseline, representing a decrease of 25.6%. CT perfusion exams per patient decreased by 32%. Overall, there was a 12.1% decrease in cumulative radiation exposure (p > 0.05).

**CONCLUSION**
Our structured imaging algorithm decreased the cumulative radiation exposure and number of head CT exams performed in A-SAH patients by defining appropriate imaging time points and clearly defined termination points. Application of these methods to other high CT utilization patient populations may reduce cumulative radiation exposure while maintaining the clinical benefits of CT imaging.

**KEY WORDS:** Radiation reduction, quality improvement, subarachnoid hemorrhage

Development of a Comprehensive, Multidisciplinary, Simulator-Based Training Course in Cerebral Angiography

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**PURPOSE**
To describe the development of a simulator-based training course in cervicocerebral angiography for neuroradiology fellows, radiology residents, neurosurgery residents and stroke neurology fellows.

**MATERIALS & METHODS**
Training materials were developed in the areas of cognitive knowledge necessary to perform cervicocerebral angiography and in angiographic techniques and interpretation. These were based on current literature, standard textbooks and the expertise of seven faculty members, five neuroradiologists and two neurosurgeons. These are given to trainees in the form of didactic lectures at the beginning of the course. A lecture and in-service in the use of the virtual reality simulator was given to the faculty prior to their use of the simulator and also is given to trainees prior to their simulator use. Two procedures were selected on the simulator representing commonly encountered pathology, internal carotid artery stenosis and posterior communicating artery aneurysm. The seven faculty completed six repetitions of each case. Diagnostic performance standards were determined from this using built-in metrics on the simulator that capture specific performance attributes. Mean performance measures for each attribute were computed and these means were used to define the standard of performance to be reached by trainees during the course. A reviewer rating scale was developed also for assessment of trainees in the clinical context pre and postsimulator training.

**RESULTS**
A virtual reality-based course in cervicocerebral angiography has been developed and currently is being implemented to instruct trainees in multiple disciplines.

**CONCLUSION**
This program will help trainees develop skills in cervicocerebral angiography that can otherwise be learned only in live subjects. This should lead to improved outcomes in performing cerebral angiography.

**KEY WORDS:** Neuroangiography, guidelines, standards
Turnaround Time for Neurologic MR in the Emergency Department: It Is Longer than CT, Is this a Problem?

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PURPOSE
Despite its typically higher accuracy in diagnosing neurologic disease, MR imaging is less used in the emergency department (ED) than is CT. In part this is due to the substantially longer time required for MR studies. We investigated whether delays inherent in MR imaging contribute to delays in diagnosis and treatment in the ED setting.

MATERIALS & METHODS
We analyzed all neurologic MR studies (brain, neck, and spine) performed on ED patients over 6 months, at the beginning (“summer” - July 1st to September 30th 2009) and end (“spring” - February 1st to April 30th 2009) of consecutive academic years. We analyzed the following time points: patient arrival in emergency department, study order time, time technologist acknowledged the order, time of completion, and time of interpretation. We performed similar analyses of neurologic CT examinations.

RESULTS
In the summer period we performed 127 MR and 2608 CT examinations. For MR and CT, respectively, median times were [minutes (standard deviation)] 144 (110) vs 50 (84) from patient arrival to study order, 156 (92) vs 50 (51) from study order to completion, and 81 (107) vs 25 (39) from study completion to interpretation. In the spring we performed 121 MR examinations, within 1.5% of summer volume adjusted for number of days. Thus there was no “new trainee” effect on study volume.

CONCLUSION
All time intervals were significantly longer and more variable for MR imaging than for CT. Intervals did not vary by body part, shift, or day of week. Resident experience level, greater in the spring period, did not affect ordered study volume or interpretation time. The longer time from ED presentation to MR order may be appropriate if more work up preceded the MR orders. The longer time to bring the patient to our department may reflect a greater need for patient stability, and the fact that we have CT, but not MR imaging, in the ED. The requirement for a patient safety checklist and limited capacity of MR may contribute to this delay. The longer scan time is inherent to MR vs CT technology. Longer interpretation time may result from the greater number of images. More likely this reflects a resident evaluation system that prioritizes interpreting as many studies (as opposed to images) within 30 minutes of completion. Thus residents have an incentive to focus first on a large number of relatively simple studies. In spite of the far longer times for MR, our routine tracking of concerns about diagnostic delays in the ED identified no such complaints from the ED staff during these periods. This study focused on MR examinations ordered on patients in the ED and for whom the results are expected to affect disposition. Note that many patients are admitted to an inpatient service before an emergency MR examination is ordered. These patients were not captured in this study. Overall, MR imaging from the ED is far slower than CT, but this does not appear to impact negatively on clinical decision making for these patients.

KEY WORDS: MR imaging, emergency department, delay

Door to CTA Time: Experience in a Primary Stroke Center

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PURPOSE
We share our experience of the time taken from door to the completion of CT of the head and CTA in acute stroke patients and how it compares with the guideline set out by the American Stroke Association.

MATERIALS & METHODS
Three-month data of all patients that received iv tPA at our institution were obtained. Specific time periods were recorded from arrival to initial clinical exam, stroke activation, and CT/CTA. In our institution, when a potential stroke patient arrives, the ER initiates a stroke protocol and pages are automatically sent to the neurology service, CT technologists, and ER radiology resident. One Phillips 64-slice CT scanner, located in the emergency department, is manned 24/7 by two CT technologists. A back-up Phillips 64-slice CT scanner also is available in case required. Standard stroke protocol includes a noncontrast head CT followed by a CTA of the head and neck. A power injector is utilized with disposable syringes. A tracker is utilized for contrast bolus timing. Sixty to 100 ml of intravenous contrast is given based on body size. Maximum intensity projection images of the head and neck and limited 3D volume-rendered images of the brain are created. Real time evaluation by the ER radiology resident or neuroradiologist is provided with neurology on-site.

RESULTS
A total of 36 patients received iv tPA therapy during the 3-month interval for early management of ischemic stroke. The time from presentation to the ER to the stroke team activation averaged 1-5 minutes. Neurology arrived on average 2-5 minutes after the stroke activation. In 34 patients, the average time from the ER to transfer to CT scanner room was 15-19 minutes. The time from arrival at the ER to the completion of the CT/CTA averaged 20-25 minutes. Delay in imaging occurred in two patients due to hypotensive events.

CONCLUSION
With good coordination between the ER, neurology, and neuroradiology, it is possible to meet the guideline set by the American Stroke Association to image acute stroke patients in under 25 minutes from presentation.

KEY WORDS: Stroke, acute, time
PURPOSE
Multiple factors determine both longitudinal and transverse relaxation rates (R1 & R2) associated with the presence of exogenous contrast media. As the choice of available MR contrast agents and the range of possible MR imaging field strength increases, knowledge of the interaction of MR contrast agents with imaging variables becomes critical. The aim of this in vitro study was to determine the influence of non- and weak-protein binding contrast media on R1 and R2 at 1.5 and 3 T.

MATERIALS & METHODS
A constant concentration (0.5 mmol/L) of 2 contrast agents were studied, each of which are known to have different protein interactions: nonprotein gadopentate dimeglumine (Gd-DTPA, Magnevist, Berlex Labs, Wayne, NJ) and weak-protein binding gadobenate dimeglumine (Gd-BOPTA, MultiHance, Bracco Diagnostics Inc., Princeton, NJ). All measurements were performed on in vitro samples prepared in 10 cc plastic tubes (diameter = 10 mm). For each of the two contrast media, three sets of tubes were prepared: (1) contrast + buffer (physiologic pH = 7.35); (2) contrast + buffer + human serum albumin (HSA, 4.5 g/dL, Sigma-Aldrich Chemie, Germany) at a concentration of 4.5 mg/dL and (3) contrast + standard donated human plasma (~ 7.0 g/dL of protein content, Octaplas, Octapharma Ltd, UK). Imaging was performed at 1.5 T and 3.0 T (Intera, Philips Medical Systems, The Netherlands). A constant temperature of 37°C was maintained by a purpose-built, in-scanner, water-bath system. T1- and T2-maps were calculated online by the scanner manufacturer’s proprietary software, following data acquisition using a MIX dual-echo, turbo-spin-echo technique (TE = 10,100 ms; TR = 1000 ms; TI = 2260 ms).

RESULTS
For Gd-DTPA and Gd-BOPTA the R1 decreased by 10% and 20% respectively at 3 T compared to 1.5 T. An increase in protein concentration caused increase in R1, most notably for the weak-binding agent Gd-BOPTA. Although observed at both field strengths, the effect was less at 3 T. Overall R2 increased with field strength for both agents tested. The variation of the sequence parameters had a direct impact on the achieved enhancement properties.

CONCLUSION
The differential effects of the available contrast media on R2 dominate at 3 T while those on R1 dominate at 1.5 T. These data suggest that the effects of protein-binding are greater at the lower field strength studied (1.5 T). At 3 T, the choice of contrast agent may be influenced by which of the two contrast mechanisms are being utilized. These issues are particularly pertinent as MR vascular perfusion assessments become more widely used in the clinical setting.

KEY WORDS: MR contrast agents, MR imaging, contrast optimization
What Factors Account for Variability in Procedure Withdrawal Rates among Radiologists Participating in a Utilization Management Program?

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Jefferson Medical College/Thomas Jefferson University Hospital, Philadelphia, PA, University of Washington Medical Center, Seattle, WA

PURPOSE
To analyze factors contributing to the variability in procedure withdrawal rates among radiologists participating in a utilization management (UM) program.

MATERIALS & METHODS
The performance of six academic neuroradiologists (2 years of participation) and 14 subspecialty radiology fellows (< 1 year of participation) in a UM program directed by a radiology benefit management program (RBM) company (HealthHelp, LLC) was assessed. All participating radiologists received identical training, and used the same evidence-based rule sets, to evaluate the appropriateness of outpatient CT, MRI, PET, and/or nuclear medicine studies ordered for patients in a variety of national and local health plans. Participating radiologists could approve studies based upon available electronic data, or contact the ordering physician for further information. We compared the aggregate rate of withdrawals (study not performed, or study changed, by consensus with the ordering physician) among the participating radiologists. Studies were not denied by the radiologists.

RESULTS
Withdrawal rates for academic neuroradiologists (757/4561; 17%) were similar to subspecialty radiology fellows (542/3298; 16%). For academic neuroradiologists, overall withdrawal rates were higher in the first 6 months of participation (19%) than the last 6 months (15%) of the 2-year study period. Among academic neuroradiologists, withdrawal rates varied by approximately a factor of two (12-22%); among fellows, withdrawal rates varied by approximately a factor of four (7-27%). However, the median withdrawal rates were similar for both groups (15%). Among academic neuroradiologists, two participants had the highest withdrawal rates for each 6-month interval of the study period.

CONCLUSION
The single greatest determinant of a radiologist’s withdrawal rate in this UM program was not level of training/status in the department; rather, each radiologist must bring individual biases to the interpretation of evidence-based rule sets in the context of a UM program that are not likely to substantially change. Duration of participation (fatigue factor) may play a secondary role; alternatively, ordering physicians may have learned to better navigate the UM process over time. These results may have important implications for RBM programs.

KEY WORDS: Utilization management, withdrawal rates

Comparison of Full Head CT with Three-Slice CT Protocol for Shunt Failure Detection and Effective Dose Implications

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Barrow Neurological Institute
Phoenix, AZ

PURPOSE
To determine if a limited three-slice CT protocol would be an effective screening tool for the diagnosis of shunt failure in emergency department patients. Effective dose for standard and limited scan protocols was assessed.

MATERIALS & METHODS
Noncontrast CT scans of the head in 107 consecutive emergency department patients with ventricular catheters presenting with neurologic symptoms were reviewed retrospectively (49 men and 58 women; mean age, 31.1 years). Data recorded included the size of each ventricle, any change in ventricular size, catheter position, and any additional acute or incidental findings. For each case, three slices were selected from the scout image at the level of the orbital rim, tip of the mastoid air cells, and midway between the vertex and skull base to form the three-slice CT examination. These three slices then were independently evaluated and compared to the findings of the contiguous scan. The effective dose for pediatric and adult patients was estimated using a 16 cm CTDI phantom. The effective dose was compared for contiguous CT and the limited three-slice CT protocol.

RESULTS
One hundred seven CT studies were included. Eleven (10.3%) studies demonstrated findings consistent with shunt failure; all would have been diagnosed with the limited three-slice protocol. The sensitivity of the three-slice CT for identifying all four ventricles and the ventricular catheter was 91.6 and 93.5%, respectively. Forty-three patients had abnormal findings unrelated to the ventricular system; of these, 39 (90.7%) would be detected with the limited protocol. Focal regions of encephalomalacia seen only on the complete CT protocol accounted for three of the four undetected abnormalities and a lacunar infarct not seen on the limited scan accounted for the fourth. No change in acute management would have resulted from discrepancies between the contiguous and limited protocols. The average effective dose of a contiguous CT in pediatric and adult patients was 1.9 mSv and 3.4 mSv, respectively, compared to 0.2 mSv and 0.3 mSv with the three-slice protocol. The effective radiation dose with a three-slice CT would be reduced (relative to a contiguous CT) by 91% and 92% in pediatric and adult patients, respectively.

CONCLUSION
Limited 3-slice CT protocol has equivalent accuracy in the diagnosis of shunt failure compared to standard protocols and offers a potential screening alternative in emergency department patients with a significant reduction in radiation exposure.

KEY WORDS: Hydrocephalus, shunt failure, radiation dose
How to Handle Incidental Findings in Neuroimaging Research?

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PURPOSE
According to the current literature, incidental findings (IF) in the brain are estimated to occur in 2-8% in healthy subjects. All of these studies were either analyzed in retrospect (including screening examinations, patient data and elderly subjects) or were reviewed only by a (neuro-) radiologist after the PI detected a suspicious lesion (obviously not being trained to read MR scans). There is an ongoing debate about how to handle incidental findings detected in healthy individuals who participate in neuroimaging studies (MR imaging for the most part). Currently, there are no established international guidelines regarding their management or the question whether these IF should be detected at all.

MATERIALS & METHODS
We prospectively assessed the frequency of IF in a population of 206 young healthy volunteers (mean age: 26 years) who additionally underwent structural MR imaging of the whole brain as part of a scientific MR protocol. For this purpose we included a FLAIR (TR / TE = 11000 / 120 ms; slice thickness 5 mm, axial orientation) and a MPRage sequence (TR / TE = 8.5 / 3.9 ms; voxel size 1 mm in sagittal orientation). All studies were performed within 1 year on a 3 T Philips scanner. Prior to the study all subjects gave their informed written consent including information about this management and the fact that IF might be found that will influence their further lifes. IRB approval was obtained.

RESULTS
Assessment of the structural MR imaging by two board-certified neuroradiologists revealed IF in 19% of the subjects (n = 39). In approximately half of these subjects (n = 21) these findings were of potential clinical relevance and required further diagnostic investigations: among these were large cysts of the pineal gland (n = 5), pituitary abnormalities (n = 12), cavernomas (n = 2), arteriovenous malformations (n = 2) and two cases suggestive for subclinical multiple sclerosis. Fortunately, none of these potentially relevant IF prompted immediate active medical treatment.

CONCLUSION
Incidental findings are much more frequent than previously published (especially with regard of studying young healthy volunteers). Since many of the IF require further diagnostic work up, standardized procedures for MR imaging and the handling of these images obtained from brain research studies are mandatory to ensure competent and responsible clinical management including further neuroradiologic assessment and clinical management by neurologists or neurosurgeons. As previously reported volunteers expect us to find these IF. Incidental findings may distort the anatomy, thus functional areas could be displayed and second level analysis might be corrupt. Incidental findings thus can not be ignored neither from a research-based point of view nor in terms of responsibility for our volunteers.

KEY WORDS: Incidental findings, responsibility, management

Incidental Neuroimaging Findings Found in “Healthy” Volunteers during Research: Current UK Practice

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PURPOSE
Incidental findings (IF) are common and have important implications for the process of informed consent, the need for clinical review of images, design and implementation of mechanisms for notification of the subject, and for the subject themselves. Incidental findings may have serious implications for health, employment, medical and life insurance, and the volunteer’s state of mind. Furthermore, suspected abnormalities incorrectly identified by nonradiologically trained researchers may cause unnecessary distress. A review of the UK, European and International ethical and legal aspects of incidental neuroimaging findings found in “healthy” volunteers during research describes: 1. current guidance on informed consent, 2. clinical image analysis, and 3. disclosure. We aim to compare this “guidance”, with current UK “practice”. The null hypothesis was that there is not wide variation in UK practice and opinion when dealing with incidental findings. Subsidiary a priori null hypotheses were: 1. that there are no differences in current practice between medical and nonmedical researchers, between radiologists and nonradiologists, between those imaging children and those not imaging children, and 2. practice is not affected by the duration that the researcher has been a principal investigator (PI).

MATERIALS & METHODS
Inclusion criteria: PI imaging “healthy” volunteers within the last 3 years. Using research institution websites and correspondence, PIs were identified. Survey Design: Market research best evidence was used to maximize response. An automated internet questionnaire plus postal mail shots were used. Statistical analysis used descriptive techniques.

RESULTS
One hundred sixty potential PIs were identified. Of those eligible, 63 (43%) completed the questionnaire: 75.8% imaged brain; 56.5% were medical researchers; 22.6% were psychologists; 12.9% neuroradiologists; 8.1% neurologists; 4.8% psychiatrists; 98.4% imaged adults and 15.9% children; 74.6% used structural MRI; 52.5% fMRI; 42.4% whole volume MRI; 35.6% DTI; 30.5% MRS; 11.5% had no site specific guidelines concerning ethics or governance. Information regarding consent: includes 69.8% not being informed of potential harms during consent (e.g., medical insurance); 12.5% do not have IF contingency plans. Methods of PI disclosure is variable: 46% disclose an IF if after the PI detected a suspicious lesion (obviously not being trained to read MR scans).
are disclosed to the volunteer by family doctors in 43% or
the research team physician in 32%. Reporting method is
variable: For example, radiologists never report scans in
12.3% and in 17.5%, additional clinical scans are obtained
and reported by neuroradiologists.

CONCLUSION
Most research imaging of “healthy” volunteers involves the
brain and is performed by a wide variety of disciplines.
There is variety in consent, clinical image analysis, and dis-
closure methods. There is discordance in best practice and
current UK practice. Current practice is influenced by
whether a PI is medical or nonmedical, a radiologist or a
nonradiologist, and by the duration that they have been a PI.
Improved standards to guide management of research
images and incidental findings are urgently required.

KEY WORDS: Incidental, findings, neuroimaging

Wednesday Afternoon
1:15 PM – 2:45 PM
Room 208

(41) Synaptic Junction Programming -
Lecture: Leadership Skills and
Challenges

(378) Leadership in Difficult Economic Times
— Carolyn Cidis Meltzer, MD, FACR

(379) Group Identification, Framing Effects, and
Organizational Leadership
— Andrew F. Simon, PhD, PsyD

(380) Differentiating Key Leadership Concepts:
Authority/Power and
Cooperation/Collaboration
— Andrew F. Simon, PhD, PsyD

Leadership in Difficult Economic Times
Carolyn Cidis Meltzer, MD, FACR

Group Identification, Framing Effects, and
Organizational Leadership
Andrew F. Simon, PhD, PsyD

Dr. Andrew Simon specializes in organizational psychology.
He is an Associate Professor at Seton Hall University, New
Jersey, and works as a staff member at the Leadership
Development Workshop in the Executive Education program
at the Wharton School of Business. In addition to his teach-
ing and research, Andy has worked with businesses, school
systems, federal and state government, and NGOs.

LEARNING OBJECTIVES
Upon completion of this presentation, participants will be
able to:
1) Identify multiple group identifications.
2) Define framing effects.
3) Cite key elements of leadership.

PRESENTATION SUMMARY
This presentation will be the first of two offering a social-
psychologic perspective on organizational leadership. The
intent of both will be to provide leaders with conceptual
guidelines that can be applied to real-world settings (the pre-
sentations are independent of one another). I will begin with
the proposition that conventional approaches to improving
leadership, emphasizing strategies and techniques (e.g., how
to run a meeting, when to delegate), are not enough to facil-
itate success. Rather, effective leadership primarily is based
on managing relationships. To further the ability of leaders to
succeed in this domain, I will address several underlying
variables that affect collegial interaction, including (a) mul-
tiple group identifications, (b) the assumptions or “frames”
from which we interpret and process information, and (c)
how these factors interact to shape organizational behavior.
Understanding these components will enhance the ability of
leaders to interpret the actions and reactions of colleagues at
all levels in the workplace.

Differentiating Key Leadership Concepts:
Authority/Power and Cooperation/Collaboration
Andrew F. Simon, PhD, PsyD

LEARNING OBJECTIVES
Upon completion of this presentation, participants will be
able to:
1) Demonstrate differences in key leadership concepts.
2) Identify means by which leaders may succeed.
3) Cite alternative perspectives for organizational dynamics.

PRESENTATION SUMMARY
This presentation will be the second of two offering a social-
psychologic perspective on organizational leadership. As
with the previous discussion, the intent here will be to pro-
vide leaders with conceptual guidelines that can be applied
to real-world settings (the presentations are independent of
one another). The focus of this presentation will be on dis-
tinguishing authority from power, and cooperation from col-
laboration. Inherent to any leadership position is the issue of
power. Struggles over how power is handled and who gen-
uinely maintains organizational influence are familiar dilem-
as to leaders. Similarly, leaders wrestle with how and when
to work with others. Organizational effectiveness can be maximized by collaborative efforts but in making our working relationships more complex, leaders become responsible for the problems that arise when success is dependent upon the performance of a group. Despite an awareness of these issues, leaders often find themselves in the midst of power struggles and collaborative efforts that take a toll on those involved. This presentation has been designed to break down these elements. Leaders will be offered a framework for avoiding potential problems and successfully managing those that arise.

CT Screening of Spinal Trauma
Diego B. Nunez, Jr., MD, MPH

LEARNING OBJECTIVES
Upon completion of this presentation, participants will be able to:
1) Review the indications for MDCT in acute cervical spine trauma.
2) Identify common injury patterns and imaging algorithms based on risk stratification.

PRESENTATION SUMMARY
This presentation will review the current role of multidetector CT in the evaluation of trauma patients with suspected cervical spine injury, with emphasis on screening. Specific injury patterns as well as the use of clinical predictors and risk factors for appropriate selection of imaging algorithms also will be discussed.

MR Imaging Evaluation
Robert M. Quencer, MD

LEARNING OBJECTIVES
Upon completion of this presentation, participants will be able to:
1) Identify the MR appearance of signal changes due to non-penetrating spinal cord injury.
2) Analyze the factors which contribute to and account for the spinal cord alterations in low velocity versus high velocity injuries.
3) Interpret subacute and chronic changes in the spinal cord as a result of severe injuries.

PRESENTATION SUMMARY
Changes which occur within the spine and spinal cord from acute through subacute through the chronic stages of spine injury will be demonstrated with emphasis on how the imaging work up may affect the subsequent surgical care of these patients. The indications for the use of MR imaging in the setting of spine injuries will be emphasized along with corresponding pathology. Of particular interest will be the long-term consequences of SCI and how MR imaging can guide subsequent care and possible reversal of progressive neurologic deterioration.

Pathogenesis and Treatment of Spinal Cord Injury
W. Dalton Dietrich, PhD

LEARNING OBJECTIVES
Upon completion of this presentation, participants will be able to:
1) Describe current experimental studies in the area of spinal cord injury and repair.
2) Discuss high content screening approaches to identify new neuroprotective and reparative compounds.
3) Discuss current clinical studies utilizing therapeutic hypothermia and Schwann cell transplantation to repair the nervous system.
PRESENTATION SUMMARY
This presentation will discuss recent advances directed toward identifying and testing new therapies to target patients with acute and chronic spinal cord injury. The use of several technologies in the laboratory setting will be described that are identifying new targets for drug development and treatment. Ongoing work in the area of therapeutic hypothermia targeting spinal cord injury now has been translated successfully from the bench to the bedside, and those studies also will be described. Cell therapy including human Schwann cell and stem cell transplantation procedures also will be summarized and the clinical studies discussed. Finally, the importance of rehabilitation strategies including robotic locomotive training will be emphasized as an important combination treatment to enhance recovery of function even in the more chronic injured subject.

REFERENCES

Wednesday Evening
4:45 PM – 6:15 PM
Room 302-304-306

(43) Socioeconomics Programming:
Informatics of Healthcare Reform

(384) Multienterprise Imaging
— Gary J. Wendt, MD, MBA

(385) Order Entry Decision Supports the MGH Experience
— Daniel I. Rosenthal, MD, FACR

(386) Structured Reporting and Emerging Technologies for Improving Communication in the Healthcare Environment
— C. Douglas Phillips, MD, FACR
Moderator: C. Douglas Phillips, MD, FACR

Multienterprise Imaging

Gary J. Wendt, MD, MBA

Order Entry Decision Supports the MGH Experience

Daniel I. Rosenthal, MD, FACR

LEARNING OBJECTIVES
Upon completion of this presentation, participants will be able to:
1) Demonstrate how decision support can improve appropriateness of ordering.
2) Indicate ways in which decision support can improve patient safety.

PRESENTATION SUMMARY
Electronic order entry should be a two-way communication in which information about safety and appropriateness is reported to the ordering physician at the same time that information needed to perform, interpret and bill the examination is collected. If done with attention to detail it can modify physician behavior by decreasing inappropriate utilization, while not increasing the time required for each order transaction.
Structured Reporting and Emerging Technologies for Improving Communication in the Healthcare Environment

C. Douglas Phillips, MD, FACR

Learning Objectives
Upon completion of this presentation, participants will be able to:
1) Identify potential weaknesses in the delivery system as it exists for reports.
2) Describe the ongoing attempts to create standardized reporting formats for radiology.
3) Review other innovative methods to improve communications with referring clinicians and patients.

Presentation Summary
Radiologists are responsible for the preparation and delivery of the report which details the findings of their diagnostic exam, or the procedure which they conducted. There are a number of ways in which this preparation and delivery could be streamlined or improved. I will cover a few of the recent innovations in this system.

Wednesday Evening

4:45 PM – 6:15 PM
Room 311

(44) SNIS Programming: Trial Updates: Progress Report from Trials that Will Change your Practice

(387) Trial Tribulations
— Jean Raymond, MD

(388) CREST
— Thomas G. Brott, MD

(389) Update on Progress of SAMMPRIS Trial
— Colin P. Derdeyn, MD

(390) IMS III
— Thomas A. Tomsick, MD

Discussion
Moderator: Joshua A. Hirsch, MD

Trial Tribulations
Jean Raymond, MD

Learning Objectives
Upon completion of this presentation, participants will be able to:
1) List key principles in the interpretation of trial results.
2) Compare the ethical and scientific differences between case series, observational studies and clinical trials.

Presentation Summary
The problem: Evidence-based medicine is slowly reaching the neuroradiological/neurosurgical community, but methodological aspects remain mysterious to many clinicians. Clinical research unfortunately has been divorced from clinical care for too long. Research should address important clinical dilemmas that affect current patients being offered an expanding array of technological advances without the reliable knowledge necessary to make informed decisions. In addition, many diagnostic and therapeutic interventions that are considered “routine” have never been proved beneficial, useless or even harmful. There is an urgent need to take action. Trials should be designed to meet this need. The importance of predefining the primary hypothesis, the size of population, and the error rates will be emphasized, as well as the need for endpoints that are simple, clinical, meaningful, valuable and resistant to bias. This is where the contribution of clinicians is not only invaluable but essential to yield trials that will have an impact on patient care. This is particularly true when outcomes are adjudicated using composite or surrogate endpoints, such as imaging findings, which may help reach statistical “significance”, but which may not mean anything in real practice. Delegating the duty of research to the industry or to regulatory agencies cannot assure that trial results will mean something valuable to patients and those taking care of them. There are major problems related to research in diagnostic studies, such as spectrum bias, absence of definite “gold standards”, lack of blinding, but perhaps the most important one is the difficulty involved in attempting to assess the impact of imaging studies on clinical outcomes. In vascular neuro-intervention, a rational means of dealing with constantly changing technologies and the pressure of fashion, marketing, and other extraneous interests is direly needed. Clinical research provides an ethical and scientific means to guide the realization of a “good medical practice” within the pervasive context of uncertainty. Recent examples from publications and abstracts of relevant journals and meetings will be used to emphasize the need for a greater day-to-day involvement of clinicians in research. The world is too small, resources in terms of time, money, and energy too scant, and the task ahead of us too immense to be able to continue to foster the artificial separation between care (teaching and practicing medicine) and research.

CREST
Thomas G. Brott, MD

Dr. Brott graduated from Harvard College and the University of Chicago Pritzker School of Medicine. He completed medical and neurologic training at the Harvard
Update on Progress of SAMMPRIS Trial

Colin P. Derdeyn, MD

LEARNING OBJECTIVES
Upon completion of this presentation, participants will be able to:
1) Summarize the rationale for the SAMMPRIS study.
2) Describe the role of intensive risk factor management for symptomatic intracranial disease.

PRESENTATION SUMMARY
Background: Atherosclerotic stenosis of the major intracranial arteries is an important cause of stroke worldwide. The Warfarin Aspirin Symptomatic Intracranial Disease (WASID) trial showed that patients with severe stenosis (70-99%) and TIA or stroke within 30 days prior to enrollment had a 22.9% rate of ischemic stroke in the territory of the symptomatic artery at 1 year (5% CI 15.4% - 30.4%). In addition, patients with poorly controlled blood pressure and elevated low density lipoprotein (LDL) during follow up had a significantly higher rate of stroke, myocardial infarction (MI), or vascular death, compared with patients with good control of these risk factors. Stenting has emerged as a promising treatment for intracranial stenosis that is being used increasingly in clinical practice but the efficacy of this procedure remains to be proved. SAMMPRIS is an ongoing randomized trial in the USA that is comparing stenting and aggressive medical therapy vs aggressive medical therapy alone in patients with symptomatic intracranial arterial stenosis. Design, Objective, and Primary Endpoints: SAMMPRIS is an investigator-initiated, NIH/NINDS funded, randomized clinical trial that will determine whether intracranial stenting (using the Wingspan self-expanding nitinol stent) and aggressive medical therapy is superior to aggressive medical therapy alone for preventing the primary endpoint (any stroke or death within 30 days after enrollment, any stroke or death within 30 days after any revascularization procedure done during follow up, or stroke in the territory of the symptomatic intracranial artery beyond 30 days after enrollment) during a mean follow up of 2 years in patients with symptomatic stenosis of a major intracranial artery (MCA, carotid, vertebral, basilar). The anticipated sample size is 764 subjects. The primary inclusion criteria include TIA or stroke within 30 days prior to enrollment attributed to a 70% to 99% atherosclerotic stenosis of a major intracranial artery. Aggressive medical therapy in both arms of the study consists of aspirin 325 mg per day for entire follow up, clopidogrel 75 mg per day for 90 days after enrollment, and intensive risk factor management primarily targeting systolic blood pressure < 140 mm Hg (< 130 if diabetic) and LDL < 70 mg/dl. Trial Status: Sixty sites have been selected. Enrollment began at six sites in November 2008. Two hundred eighteen patients have been enrolled and randomized at 41 active sites as of January 15, 2010. An update on the progress of the trial will be presented at the meeting.

IMS III

Thomas A. Tomsick, MD

LEARNING OBJECTIVES
Upon completion of this presentation, participants will be able to:
1) Evaluate the ongoing IMS III Trial.
2) Identify potential benefits, risks of combined IV/IA therapy for acute ischemic stroke.

PRESENTATION SUMMARY
An update on the status of the Interventional Management of Stroke III Trial will be presented.

Wednesday Evening

4:45 PM – 6:15 PM
Room 312

(45) Advanced Imaging Seminar: New Developments in Brain Perfusion Imaging

(391) Perfusion Imaging Methodology
— Greg G. Zaharchuk, MD, PhD

(392) MR and CT Perfusion in Cerebrovascular Disease
— Pamela W. Schaefer, MD

(393) Advances in Permeability Imaging
— Daniel P. Barboriak, MD

Moderator: Elias R. Melhem, MD
Perfusion Imaging Methodology

**Greg G. Zaharchuk, MD, PhD**

**LEARNING OBJECTIVES**

Upon completion of this presentation, participants will be able to:
1. Illustrate the wide range of perfusion methods currently in use for neuroradiologic studies.
2. Contrast the differences between commonly used perfusion approaches.
3. Identify artifacts associated with each technique.
4. Select the most appropriate perfusion study for a given patient.

**PRESENTATION SUMMARY**

Perfusion imaging is valuable in a wide range of diseases of the central nervous system. Many modalities can be used to acquire perfusion information, including CT, MR imaging, ultrasound, and nuclear medicine techniques. This talk will focus on the methodology of perfusion techniques primarily for the most widely-used modalities, CT and MR imaging. Perfusion methods can be broken down into those using diffusible vs nondiffusible tracers, based on whether the perfusion-sensitizing tag is able to freely cross the blood-brain barrier or whether it is confined to the intravascular space, respectively. Diffusible methods, which typically are considered more quantitative, include stable xenon-enhanced CT and arterial spin labeling (ASL); these methods excel at quantifying cerebral blood flow (CBF). Bolus contrast perfusion-weighted imaging (PWI) can be performed with either CT or MRI and the underlying assumptions and models are quite similar. Bolus-based methods offer the potential to measure not only CBF, but also other hemodynamic parameters, including cerebral blood volume (CBV), mean transit time (MTT), and the normalized bolus arrival delay time (Tmax), though these parameters are influenced heavily by the choice of model and the accuracy of the arterial input function measurement. Also, if there is significant leakage of contrast through an altered blood-brain barrier, bolus-based hemodynamic measurements may contain significant errors; methods to identify and correct such problems will be discussed. The goal of this talk is to explain how the most common perfusion imaging techniques work, to describe their underlying assumptions, to enable the identification of artifacts and potential sources of error, and to help radiologists determine the most appropriate perfusion method for a given patient.

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MR and CT Perfusion in Cerebrovascular Disease

**Pamela W. Schaefer, MD**

**LEARNING OBJECTIVES**

Upon completion of this presentation, participants will be able to:
1. Illustrate how CT and MR perfusion can be used to identify infarct core and ischemic penumbra in acute stroke patients.
2. Recognize technical factors that affect the determination of infarct core and ischemic penumbra in acute ischemic stroke patients.
3. Compare CT and MR perfusion for assessing acute ischemic stroke patients.
4. Illustrate how CT and MR perfusion lesion volumes can be used in clinical decision making.

**PRESENTATION SUMMARY**

This talk will address predominantly the use of MR and CT perfusion imaging for the evaluation of acute stroke patients. Specifically, it will address the utility of cerebral blood volume, cerebral blood flow and tissue transit time measures for identifying infarct core and ischemic penumbra. The use of perfusion maps to predict hemorrhagic transformation also will be presented. MR and CT perfusion imaging will be compared and contrasted. The advantages and disadvantages of both techniques will be presented. How technical factors such as selection of arterial input function and delay correction affect image interpretation will be covered. The lack of standardization of postprocessing software perfusion packages and how this affects our ability to identify infarct core and penumbra also will be discussed. How chronic carotid occlusions and stenoses and underlying chronic cerebrovascular disease affect acute stroke image interpretation will be covered. Semiquantitative and quantitative methods of measuring infarct core and penumbra volumes will be presented. The use of these volumes in combination with clinical stroke scales to determine treatment also will be included.

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Advances in Permeability Imaging

**Daniel P. Barboriak, MD**

**LEARNING OBJECTIVES**

Upon completion of this presentation, participants will be able to:
1. Recognize the importance of brain capillary endothelial permeability in the pathophysiology of brain tumors and stroke.
2. Describe the theory of how DCE-MRI and CT perfusion can be used to assess brain capillary endothelial permeability.
3. Review how advances in CT and MR acquisition techniques and the application of advanced pharmacokinetic models may help improve the assessment of capillary endothelial permeability.

**PRESENTATION SUMMARY**

The measurement of capillary endothelial permeability using dynamic contrast-enhanced magnetic resonance imaging (DCE MRI) or CT perfusion. These techniques use repeated measurements to track the passage of contrast agents through the cerebral vasculature. Despite the promise of these techniques, these applications remain incompletely validated for specific clinical purposes. The purpose of this lecture is (1) to discuss the role of increased capillary permeability/breakdown of the blood-brain barrier in the pathophysiology of brain tumors and stroke; (2) to review the principles used to quantify capillary endothelial permeability using DCE MRI or CT perfusion; and (3) to discuss current and future developments in permeability imaging. In this lecture, the steps used to measure permeability-related parameters using DCE
MRI and CT perfusion will be reviewed. The most commonly derived of these parameters are $K^{\text{trans}}$ (the volumetric leakage rate of contrast agent from the plasma space to the extravascular extracellular space) and PS (the permeability surface area product). Advances in CT and MR acquisition techniques and the application of more realistic pharmacokinetic models hold the promise of more accurate assessment of capillary permeability in the future. These advances may improve the ability of CT and MR imaging to measure changes in rates of contrast agent leakage, and may help in future validation of these techniques for clinical decision-making in patients with brain tumors or stroke.

REFERENCES
Notes
NOTE ABOUT SCANNED IMAGES: Scanned images are included in the proceedings book. Some submitted images were reduced during the printing process, thereby decreasing clarity. The images as originally submitted can be viewed within the abstract on the ASNR website at www.asnr.org/2010.

Thursday Morning

7:45 AM – 8:45 AM
Ballroom ABC

(46) Maintenance of Certification (MOC) – Review Session Spine
Audience Response Plus (AR+)*

(394) Spine
— Alyssa T. Watanabe, MD

(395) Spine
— M. Judith Donovan Post, MD, FACR

Moderators: Alyssa T. Watanabe, MD
M. Judith Donovan Post, MD, FACR

*An educational grant was received by Bayer Healthcare Pharmaceuticals, Inc. in support of the Audience Response Plus+ (AR+) technology in the Maintenance of Certification (MOC) Review Sessions.

Spine

M. Judith Donovan Post, MD, FACR

LEARNING OBJECTIVES
Upon completion of this presentation, participants will be able to:
1) Review the imaging appearance of commonly encountered spinal lesions.
2) Review the imaging clues helpful in providing a differential diagnosis.
3) Cite the cases in a MOC fashion.
4) Question the audience in determining the correct diagnoses.

PRESENTATION SUMMARY
Numerous cases will be shown in a MOC format to illustrate the typical imaging findings in patients presenting with a myelopathy and/or radiculopathy due to infectious, inflammatory, demyelinating, neoplastic, vascular, traumatic and iatrogenic etiologies. The audience will have the opportunity to review the images in each case and determine the correct diagnosis and answer questions about each disease process. A summary of the imaging findings in each entity being illustrated then will be provided as well as the salient findings in the spinal lesions which were included in the differential diagnosis. Emphasis will be placed on MR imaging clues in the spine as well as in the brain. The importance of clinical and pathologic correlation also will be stressed. Surgical findings with pathologic specimens will augment some of the case illustrations.

Spine

Alyssa T. Watanabe, MD

LEARNING OBJECTIVES
Upon completion of this presentation, participants will be able to:
1) Review spinal nontraumatic cases.
2) Cite sample cases for CAQ preparation.
3) Describe findings seen in unusual spinal cases.
4) Review differential diagnosis of common spine imaging findings.

PRESENTATION SUMMARY
This presentation will include a review of interesting spine cases in preparation for CAQ exam in Neuroradiology. The cases also will provide refresher material for radiologists interested in spinal imaging in general.
Thursday Morning

8:45 AM – 10:15 AM
Ballroom ABC

(47) General Session: Tackling the Many Faces of the AJNR

(396) An Overview of the AJNR...It's More Than Just a Journal
  — Mauricio Castillo, MD, FACR

(397) Searching the Journal for Evidence-Based Radiology
  — Pina C. Sanelli, MD, MPH

(398) Potholes and Speed Bumps along the Road to Publishing a Manuscript
  — James M. Provenzale, MD, MPH

Panel Discussion
Moderators:  Mauricio Castillo, MD, FACR  
             Pina C. Sanelli, MD, MPH

Thursday Morning

10:45 AM – 12:30 PM
Ballroom ABC

(48a) Interventional: Thrombolysis/Stroke
(Scientific Papers 399 - 411)

See also Parallel Sessions
(48b) Interventional: Aneurysms II
(48c) Adult Brain: Vascular Intracranial
(48d) Adult Brain: Inflammatory/Infectious Diseases
(48e) Spine: Intervention: Vertebroplasty, Biopsy, Pain Management

Moderators:  Colin P. Derdeyn, MD  
             Steven W. Hetts, MD

Paper 399 Starting at 10:45 AM, Ending at 10:53 AM

Long-Term Effect of Carotid Artery Stenting on Cognitive Function in Patients with Carotid Artery Stenosis

Turk, A. S. 1 · Chaudry, I. 1 · Haughton, V. 2 · Rowley, H. 3 · Aagaard-Kienitz, B. 3 · Niemann, D. 3 · Pulfer, K. 3 · Strother, C. 3 · Turski, P. 3

1 Medical University of South Carolina, Charleston, SC
2 University of Wisconsin, Madison, WI

PURPOSE
Carotid artery stenosis may be a cause of reduced cognitive performance. We previously have demonstrated that stent revascularization resulted in short-term improvement in cognitive testing. The goal of this study was to demonstrate the long-term durability of improved cognitive performance 1 year after carotid stenting.
MATERIALS & METHODS
Patients referred for stenting of a unilateral carotid artery stenosis were enrolled in the study. Neuropsychologic testing was performed with a mini-mental status examination, an extended mental status examination, a subjective cognitive status measure, and a psychomotor performance speed test. The severity of stenosis was measured on angiography performed prior to stenting. One year after stenting, CT angiography was performed to ensure no restenosis had occurred and neuropsychologic testing was repeated. Differences in neuropsychologic test scores pre and post-stenting were calculated and tested for significance with a student t test.

RESULTS
Thirteen patients with a single unilateral greater than 50% carotid stenosis completed the study. The stenosis of the carotid artery averaged 84% prior to treatment and 9% after treatment. Poststenting, the extended mental status examination was improved significantly. There was also significant improvement in delayed memory at 1 year that was not present at 3-month follow up. The subjective cognitive status measure also improved. No significant change was noted in the mini-mental status examination or in the speed of psychomotor performance.

CONCLUSION
Carotid artery stenting in patients with a unilateral carotid artery stenosis resulted in significant long-term improvements in cognitive test scores, most notably delayed memory.

KEY WORDS: Cognition, carotid stenosis, stent

Paper 400 Starting at 10:53 AM, Ending at 11:01 AM
Mechanical Thrombectomy by the Penumbra System Improves Functional Outcome in a Middle Cerebral Artery Stroke Cohort with Large Vessel Occlusions
Frei, D. · Bellon, R. · Huddle, D. · for the POST Study Investigators
Swedish Medical Center
Englewood, CO

PURPOSE
The Penumbra System™ is a new generation of mechanical devices designed to reduce clot burden in acute stroke due to large vessel occlusion. This device has been cleared for commercial use since late 2007. The purpose of this study was to assess the safety and effectiveness of this device on functional outcome since approval using data from the PROACT II (1) study as the historical control.

MATERIALS & METHODS
This study was a retrospective case review of 89 consecutive patients with large vessel occlusion within the middle cerebral artery (MCA) who were treated with the Penumbra System at seven international centers. All patients reviewed presented to the hospital within 8 hours of symptom onset with an occlusion (TIMI 0 or 1) of a treatable MCA. The primary endpoint was good functional outcome as defined by a modified Rankin Scale (mRS) score of 2 or less at 90 days postprocedure. Results from placebo patients in the PROACT II trial were used as the historical control.

RESULTS
The results indicate that the patients treated with the Penumbra System have a significantly higher rate of revascularization than those treated by placebo in the PROACT II trial. This was accompanied by a greater proportion of patients achieving good functional outcome (mRS score of 2 or less) at 90 day follow up (51.4% vs 25%). Although the symptomatic ICH rate was higher in the Penumbra group (5.6% vs 2%), it was not statistically significant. Moreover, the 5.6% symptomatic ICH rate was similar to those observed in other IA thrombolytic treatments.

<table>
<thead>
<tr>
<th></th>
<th>PROACT II PLACEBO (N=59)</th>
<th>PENUMBRA MCA GROUP (N=89)</th>
<th>p-values+</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (mean) (years)</td>
<td>64</td>
<td>66</td>
<td>0.4097</td>
</tr>
<tr>
<td>Female</td>
<td>39%</td>
<td>50.6%</td>
<td>0.1814</td>
</tr>
<tr>
<td>Baseline NIHSS (median) (range)</td>
<td>17(4-28)</td>
<td>15(5-25)</td>
<td>NA</td>
</tr>
<tr>
<td>TIMI 2-3</td>
<td>18%</td>
<td>87.6%</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Symptomatic ICH</td>
<td>2%</td>
<td>5.6%</td>
<td>0.4026</td>
</tr>
<tr>
<td>mRS ≤ 2 at 90 days</td>
<td>25%</td>
<td>51.4%</td>
<td>0.0037</td>
</tr>
<tr>
<td>Death at 90 days</td>
<td>27%</td>
<td>14.6%</td>
<td>0.0895</td>
</tr>
</tbody>
</table>

CONCLUSION
These results suggest that when compared with the appropriate population, the Penumbra System is effective in the revascularization of large vessel occlusion in the MCA leading to good functional outcome.

REFERENCES

KEY WORDS: Stroke, MCA, large vessel occlusion

Paper 401 Starting at 11:01 AM, Ending at 11:09 AM
Nonionic Iso-Osmolar Contrast Reduces Infarct Volume in a Middle Cerebral Artery Occlusion/Reperfusion Model
Morales, H. · Tomsick, T. · Lu, A. · Kurosawa, Y. · Clark, J. · Leach, J. · Weiss, K.
University of Cincinnati
Cincinnati, OH

PURPOSE
Cerebral infarct volumes after reperfusion with nonionic iso-osmolar or low-osmolar iodinated radiographic contrast materials (IRCM) has not been compared previously using rodent models of infarct. Infarct volume, cerebral blood flow (CBF) and mortality rate were compared in a MCA occlusion/reperfusion model in rats using intraarterial infusion (IA) of iodixanol - 320 mgI/mL (290 mOsmol), iopamidol - 300 mgI/mL (616 mOsmol) or normal saline (300 mOsmol).

MATERIALS & METHODS
Infarct was induced in 30 rats by a previously validated
method of MCA occlusion with an intraluminal suture. After 5 hours of occlusion the suture was removed and reperfusion was performed as follows: group 1: Saline + iodixanol (n = 9), group 2: Saline + iopamidol (n = 12), and group 3: Saline (n = 9). Each rat was infused with saline (1ml/kg) for 10 minutes. Next, either Iodixanol, Iopamidol or saline was infused (1ml/kg) for additional 10 minutes. Cerebral blood flow was measured by transcranial Doppler (TCD) before ischemia, immediately after ischemia and immediately after reperfusion. MR imaging was performed at 6 hours and 24 hours after ischemia. The infarct volume was determined with T2 and diffusion-weighted images by semiautomatic segmentation with BrainLAB Software. The rats were sacrificed 24 hours after ischemia. ANOVA and posthoc analysis were used to evaluate differences between groups.

**RESULTS**

One (11%) rat of the iodixanol group, 2 (17%) rats of the iopamidol group and 5 (55%) rats of the saline group died before 24 hours (x2, p < 0.06, ns). There was no statistical difference between groups in CBF measured as perfusion after ischemia/ before ischemia (39 ± 26, 39 ± 17 and 46 ± 22% in groups 1, 2 and 3 respectively) and perfusion after medication/before ischemia (88 ± 14, 90 ± 18, and 78 ± 16% in groups 1, 2 and 3 respectively). The mean volumes of infarct as measured on T2-weighted imaging at 6 hours were 242 ± 89, 324 ± 70 and 345 ± 92 mm³ in groups 1, 2 and 3 respectively. The differences in infarct volume between iodixanol and iopamidol groups were significant at 6 hours (p < 0.03) and 24 hours (p < 0.02). Post hoc analysis for infarct volume showed reduced infarct volume in comparison with saline or iopamidol in this MCA occlusion/reperfusion model. It is reasonable to believe that iso-osmolar contrast cross the blood-brain barrier to a lesser degree contributing to a decreased infarct volume in these studies. This and other physiopathologic mechanisms of IRCM interaction in acute ischemia need to be investigated.

**CONCLUSION**

Iodixanol showed reduced infarct volume in comparison with saline or iopamidol in this MCA occlusion/reperfusion model. It is reasonable to believe that iso-osmolar contrast cross the blood-brain barrier to a lesser degree contributing to a decreased infarct volume in these studies. This and other physiopathologic mechanisms of IRCM interaction in acute ischemia need to be investigated.

**KEY WORDS:** Iodinated contrast material, stroke, infarct volume

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**Paper 402 Starting at 11:09 AM, Ending at 11:17 AM**

**Factors Affecting Long-Term Restenosis after Carotid Stenting for Carotid Atherosclerotic Disease**

Shankar, J. J. S. · dos Santos, M. · Zhang, J. · Lesiuk, H. · Bussiere, M. · Lum, C.

The Ottawa Hospital

Ottawa, ON, CANADA

**PURPOSE**

Restenosis following carotid artery stenting (CAS) for carotid atherosclerotic disease is a concerning delayed complication. The incidence of carotid restenosis ranges from 1 to 37% with only 0-8% of patients having restenosis-related symptoms. Various factors such as characteristics of patient, the atherosclerotic plaque, technique and tools for the CAS could be responsible for the restenosis. The most significant factors leading to restenosis are yet to be described in the literature. Similarly, it is unclear which patients would benefit from a closer postprocedural follow up to detect restenosis. The purpose of our study was to identify the incidence of restenosis in our patients with CAS for carotid atherosclerotic disease and to identify risk factors that are significantly responsible or related to the restenosis.

**MATERIALS & METHODS**

In retrospective analysis of patients who underwent CAS for atherosclerotic disease between 2002 and 2006, we studied various demographic, clinical and medical factors, plaque characteristics and the technical aspect of CAS. The study was approved by the institutional ethics committee. All patients were followed up with carotid Doppler at baseline after 2 to 4 weeks of CAS and then with Doppler and clinically for various intervals of time. The restenosis was classified based on carotid Doppler results into: Mild- any change from baseline Doppler velocity less than moderate; Moderate- peak systolic velocity (PSV) > 200 cm/s; Severe- PSV > 200 cm/s and end diastolic velocity (EDV) > 125 cm/s. All patients were followed up clinically and treated accordingly. Clinically restenosis was classified as symptomatic or asymptomatic. Statistics: Pearson correlation coefficients were used to assess the statistical correlation of the different factors with the incidence of restenosis and general linear model was used to assess the statistical significance of their explanatory power with dependent variable being the presence of long-term restenosis following CAS. P = 0.05 was taken as significant.

**RESULTS**

We had total of 105 patients (Male 76; Female 29; Age 44-91 years; mean 70.8 years; median 69 years). The initial presentation was asymptomatic in 21 patients; stroke or transient ischemic attacks in 83 and no clinical records available in one patient. We had a total of 204.6 patient year follow up (mean-1.95 years; range 0-7.3 years). The overall incidence of restenosis was 26.7% (n = 28), Mild - 7.6% (n = 8), Moderate - 10.5% (asymptomatic - 11; symptomatic - 0) and Severe - 8.6% (asymptomatic - 5; symptomatic - 4). Overall 14.3% (n = 4) patients with restenosis were symptomatic and only 7.1% (n = 2) underwent retreatment. Out of the various risk factors assessed, the immediate poststenting residual stenosis was related significantly to the long-term restenosis(p = 0.02). Poststenting residual stenosis greater than 30% (p = 0.016) and greater than 50% (p = 0.05) were significant.
for long-term restenosis. Length of the atherosclerotic plaque (p = 0.084) and stent type (p = 0.084) were showing a trend towards significance. Plaques longer than 20 mm were (p< 0.001) related significantly to restenosis. Use of Wallstent (p < 0.001) and Precise stents (p = 0.018) was related also to restenosis.

CONCLUSION
The incidence of restenosis in our series is comparable to those reported in the literature. The most important factor to explain restenosis was the immediate post CAS residual stenosis. The length of the plaque and the type of stents used for CAS also appears to be significant factors in the occurrence of restenosis.

KEY WORDS: Carotid artery stenting, restenosis, carotid artery stenosis

Paper 403 Starting at 11:17 AM, Ending at 11:25 AM
Penumbra Stroke System for Recanalization of Large Vessel Occlusions in Acute Ischemic Stroke: Initial Experience from the Calgary Stroke Program
Menon, B. K. · Eesa, M. · Modi, J. · Wong, J. · Hudon, M. · Morrish, W. · Hill, M. D. · Demchuk, A. M. · Goyal, M. 
University of Calgary
Calgary, AB, CANADA

PURPOSE
IV tPA has proved efficacy in acute ischemic stroke up to 4.5 hours from onset. However, this limits thrombolysis to a minority of patients. IV tPA is limited also by low rates of recanalization in proximal intracranial occlusions. Intraarterial techniques often are used up to 8 hours from stroke onset with excellent recanalization rates even in proximal occlusions. The Penumbra system (Penumbra Inc., Englewood, CO) is a newly approved mechanical device for the treatment of acute stroke designed for better and faster recanalization. The initial pivotal study demonstrated 82% recanalization but only 25% good outcomes. We describe our initial experience with the use of this device at our dedicated stroke center.

MATERIALS & METHODS
We retrospectively studied 28 consecutive patients with acute ischemic stroke from January 2009 to October 2009 at our stroke center, in whom the Penumbra system was used. Patients had a CT brain and/or CTA head and neck at admission as per institutional protocol. The primary outcome variable was reperfusion (TIMI grade 2/3) at completion of the angiogram. Secondary outcome variables included procedural complications such as vessel rupture, dissections and groin complications, presence of symptomatic intracranial hemorrhage, distal emboli into the occluded vascular bed, mRS (3 months and when not available, at discharge) and mortality.

RESULTS
Twenty-eight patients (14 male, mean age 61.57 ± 14.95 years) were treated during the period from January to October 2009. Median NIHSS on admission was 17.5, median ASPECTS on NCCT at admission was eight (range 5 - 10) and median onset to door time was 78 minutes. Twenty-two of 28 (78.5%) patients had anterior circulation strokes and 17/28 (60.7%) had iv tPA initiated prior to angiography. Among the vessels treated, 10 were isolated MCA M1 occlusions, four were M2 occlusions, seven were a “L” or “T” type ICA occlusions, six were basilar artery occlusions and one was a M2 occlusion with bilateral A2 occlusions. Twenty-three of 28 (82.1%) patients achieved TIMI 2/3 grade reperfusion at completion of the procedure. Excluding five patients who needed a second device for recanalization and one patient with spontaneous recanalization (noted after Penumbra was deployed) from the analysis, the Penumbra device achieved TIMI 2/3 reperfusion in 18/27 (66.6%) of patients. Thirteen of 28 (46.4%) patients had mRS of 0-2 on follow up (3 months or at discharge). Sixteen of 17 (94.1%) patients in the IV/IA group achieved TIMI 2/3 reperfusion when compared to 7/11 (63.6%) patients in the IA alone group (RR 1.47 95% CI 0.93 - 2.34 p value 0.06). One per-procedural complication, a superior division M2 dissection/vasospasm was noted which was asymptomatic. Distal emboli was noted in 13/28 (46.4%) patients. Two of 28 (7.1%) patients had symptomatic intracerebral hemorrhage classified as PH2 and 5/28 (17.8%) patients died in this series.

CONCLUSION
High recanalization rates and good clinical outcomes are achievable with the Penumbra system. We find the device to be relatively safe and easy to use. The complication rate is comparable to that in previously published literature.

KEY WORDS: Intraarterial, thrombolysis, penumbra

Paper 404 Starting at 11:25 AM, Ending at 11:33 AM
Multimodal CT Scan Protocol Does Not Delay TPA Administration in the Emergency Room
Fanale, C. · Salottolo, K. · Leonard, K. · Bar-Or, D. 
Swedish Medical Center
Englewood, CO

PURPOSE
Patients with an acute ischemic stroke require immediate medical treatment, with administration of iv tPA the paramount consideration. A CT scan to rule out hemorrhage or infarct is required before thrombolytic therapy. However, the addition of an intra and extracranial vascular study as well as a brain perfusion study may be of benefit to help determine candidacy for intraarterial therapies. We adapted our acute stroke protocol to include a multimodal CT scan (Triple CT): CT without contrast agent, CT with contrast, and CT perfusion. The purpose of this study is to determine whether performing triple CT delays initiation of tPA beyond a goal of 60 minutes from hospital arrival.

MATERIALS & METHODS
All patients admitted through the ED as a stroke alert with time from symptom onset to hospital arrival < 2.5 hours over a 3-year period were included. Patients treated with intraarterial therapy and patients with a contraindication to tPA were excluded. Wilcoxon rank-sum tests and logistic regression analyses were used to determine whether triple CT delays tPA administration, and which variables independently predict whether tPA was initiated within the goal of 60 minutes from arrival.
RESULTS
There were 124 patients included in the analysis. No demo- 
graphic or clinical differences were detected for patients receiving triple CT (n = 109) vs those who did not (n = 15).
One patient in the triple CT group did not receive tPA due to 
equivocal hemorrhage on CT scan. Median time from hospit- 
al arrival to tPA administration was 56 minutes; median 
time was significantly shorter for patients who received a 
triple CT vs those who did not (55 minutes vs 78 minutes, p = 0.02). After adjustment, variables that increased the odds of 
timely tPA administration (within the 60-minute goal) 
were as follows: stroke alert by EMS/transfer (vs ED alert, 
OR = 3.23; p = 0.046); prompt time to CT (OR = 0.95; p 
=0.02) and delayed time from symptom onset to arrival (OR 
= 1.02, p = 0.02). Receiving a triple CT increased the odds 
of timely tPA initiation by 3.6-fold; however this was not 
significant (OR = 3.6; p = 0.09).

CONCLUSION
In our single center experience, the use of multimodal CT 
scan in acute stroke patients did not delay administration of 
v tPA beyond a goal of 60 minutes from patient arrival. 
Further study is needed to assess feasibility and safety of the 
routine use of triple CT in the acute stroke setting.

KEY WORDS: Computed tomography, stroke, thrombolysis

Paper 406 Starting at 11:41 AM, Ending at 11:49 AM
Prognostic Implications of Digital Subtraction 
Angiography Findings in Acute Ischemic Stroke

Rodriguez Covili, P. · Ng, P.
University of Utah
Salt Lake City, UT

PURPOSE
To correlate the DSA findings of patients undergoing 
endovascular treatment for AIS with their clinical outcome 
and CT findings of intracranial hemorrhage (ICH) and final 
infarct volume.

MATERIALS & METHODS
A retrospective review of prospectively collected clinical 
data and imaging studies of consecutive patients undergoing 
endovascular treatment for single territory AIS from January 
2004 to Nov 2009 was conducted. Imaging (CT and DSA) 
studies were reviewed by a single interventional neuroradi- 
ologist who was blinded to the clinical outcome. Statistical 
analysis was undertaken to determine significant correla- 
tions between angiographic findings and clinical outcome 
using the modified Rankin score (mRS) at follow up (mean 
3 months).

RESULTS
Eighty-two patients (39 female, 43 male) with a mean age of 
62 years (range 4-93 years) had single territory AIS during 
the study period. The median time from stroke onset to the 
DSA acquisition was 4:31 hours. The sites of arterial occlusion 
were: MCA (68%), BA (15%), ICA (11%), ACA (5%) and 
PCA (1%). A Merci® retriever (Concentric Medical 
Inc.) was used in 52% of patients and the Penumbra® Stroke 
system (Penumbra Inc.) used in 23%. Both thrombectomy 
devices were utilized in 11%. Forty-four patients (54%) 
received either IA tPA or abciximab. A combination of these 
drugs was used in 35 patients (43%). The initial TIMI score 
was 0 in 68%, 1 in 27% and 2 in 5%. After endovascular 
treatment, the TIMI score was 0 in 5%, 1 in 26%, TIMI 2 in 
51%, and 3 in 18%. No patient had worsening of their TIMI 
score with treatment. In 14 patients (17%), the TIMI score 
did not improve with endovascular treatment. In 68 patients 
(83%), the TIMI score was increased at least 1 point after 
treatment. Additional DSA findings included the presence of 
collateral circulation to the involved vascular territory before 
IA treatment (61%), early venous drainage from the at-risk 
territory (59%) and luxury perfusion after treatment (21%). 
ICH was seen on follow-up CT in 37% of patients. Clinical 
outcome after a mean period of 3 months was mRS 0 (15%), 
1(15%), 2(13%), 3(6%), 4(15%), 5(18%) and 6(13%). 
Superior outcomes (mRS 0-2) correlated with age < 50 years 
old, baseline NIHSS ≤15, basilar artery occlusion and time to 
endovascular treatment <3hours. Poor outcomes (mRS ≥ 3) 
correlated with age > 80 years old, early venous drainage, 
luxury perfusion, ICA terminus occlusion, TIMI 0-1 after 
treatment, and ICH.

CONCLUSION
In patients undergoing endovascular treatment for AIS, DSA 
findings of early venous drainage, luxury perfusion and 
failed recanalization are bad prognostic indicators.

KEY WORDS: Stroke, brain attack, intraarterial thrombolysis

Paper 407 Starting at 11:49 AM, Ending at 11:57 AM
Usefulness of Diffusion-Weighted Imaging Findings to 
Predict Long-Term Clinical Outcome after Emergency 
Reperfusion Therapy for Acute Stroke Patients

Nakazaki, M. · Mori, T. · Tajiri, H. · Iwata, T. · Uesugi, T. · 
Soga, N.
Shonan Kamakura
Kamakura, JAPAN

PURPOSE
It is unclear whether or not MR findings have relation to 
clinical outcome following reperfusion therapy, although 
MR findings are included as one of criteria for reperfusion 
therapy. The purpose of our retrospective study was to inves- 
tigate the relationship between MR findings using DWI- 
ASPECT score on admission and long-term clinical outcome 
following emergency reperfusion therapy.

MATERIALS & METHODS
Inclusion criteria for retrospective analysis were patients 1) 
who were admitted to our institution during the period from 
October 2006 to August 2009, 2) who presented serious neu- 
rologic symptoms of GCS of 12 or less and of NIHSS score of 
10 or more, 3) who had total occlusion of intracranial 
major arteries displayed by MRA on admission, and 4) who 
derived emergency intravenous rt-PA or endovascular 
treatment within 6 hours from stroke onset. We assessed 
patient’s age, sex, DWI-ASPECT score, MRA findings, stroke 
subtype, onset-to-treatment time (OTTT), mRS before admission, mRS on admission (AD-mRS), mRS on the 
th 10th day, mRS at 3 months (3M-mRS), NIHSS score on 
admission (AD-NIHSS), NIHSS score on the 7th day (7D-
NIHSS), cerebral hemorrhage within 7days from onset, and
Angiographic occlusion sites were cavernous ICA in 2, ICA mg/kg) was done before the procedure in six patients.

Score was 10 in median. Intravenous t-PA therapy (0.6 Corp.) from December 2007 to May 2009. The initial NIHSS ischemic stroke patients (13 men, average age of 63.1 years) were treated with Neuroform® stent (Boston Scientific Seoul, KOREA, REPUBLIC OF

Primary or Secondary Use of a Self-Expanding Stent

Treatment of Acute Ischemic Stroke: The Feasibility of Primary or Secondary Use of a Self-Expanding Stent

Park, S. · Lee, D. H. · Kim, S. M. · Choi, C. G. · Kim, S. J. · Suh, D. C.

Asan Medical Center
Seoul, KOREA, REPUBLIC OF

Purpose

A self-expanding stent can be used as a recanalization tool during endovascular management of acute cerebral ischemia. It could be used as a primary or secondary recanalization method. The purpose of this study is to evaluate the feasibility of using a self-expanding stent (Neuroform®) in the treatment of acute cerebral ischemia and to compare the treatment results of primary and secondary stenting groups.

Materials & Methods

We retrospectively analyzed the treatment results of 14 acute ischemic stroke patients (13 men, average age of 63.1 years) who were treated with Neuroform® stent (Boston Scientific Corp.) from December 2007 to May 2009. The initial NIHSS score was 10 in median. Intravenous t-PA therapy (0.6 mg/kg) was done before the procedure in six patients. Angiographic occlusion sites were cavernous ICA in 2, ICA terminal portion in 2, MCA trunk in 5, distal VA in 1, basilar trunk in 2 and basilar top in 2. Underlying atherosclerotic stenosis with thrombotic occlusion was suspected in three patients and MCA dissection with occlusion was suspected in two. The stent was used as the primary recanalization method in seven patients (primary group). Various kinds of endovascular recanalization measures were tried before the stenting in the other seven patients (secondary group). We analyzed the overall procedure duration, recanalization rate immediately after stent placement (TICI ≥ 2b), need of additional measure after stenting, final recanalization rate (TICI ≥ 2b), occurrence of hemorrhage or hemorrhagic transformation, early reocclusion rate after 24 hours and three-month functional recovery rate (mRS ≥ 2). Those results of both primary and secondary groups were compared.

Results

Fifty-two patients were included for our analysis. Age (median) was 76 years, 23 patients (44.2%) were female, NIHSS score on admission (median) was 19.5, DWI-ASPECT score (median) was 7.5, and OTTT (median) was 3.16 hours. Among them, 36 patients underwent intravenous rt-PA and other 16 patients endovascular treatment. Three-month investigation showed that there were nine (17.4%) in mRS of 0 and 1, 15 (28.8%) in mRS of 2 and 3, 13 (25.0%) in mRS of 4 and 5, and 15 (28.8%) in mRS of 6. Intracerebral hemorrhage occurred in five patients (9.6%) within 7 days of onset. Among 52 patients, 26 belonged to S group and others to L group. In group S and L, 7D-NIHSS (median) was 7 and 17 (p < 0.01), 3M-mRS (median) was 3 and 5 (p < 0.05), the number of patients with good clinical outcome was 20 and 5 (p < 0.01), respectively. Logistic regression analysis demonstrated that younger age (OR 0.84 95%; CI; 0.74-0.96 P < 0.01), lower point of AD-NIHSS (OR 0.87; 95%; CI; 0.77-0.98, p < 0.05), and 8 or more of DWI-ASPECT score (OR 0.135 95%; CI; 0.02-0.90, p < 0.05) were the independent predictors of good clinical outcome.

Conclusion

DWI-ASPECT score of eight or more was the independent predictor of favorable clinical outcome in acute stroke patients who had major intracranial artery occlusion and underwent emergency perfusion therapy within 6 hours.

Key Words: Reperfusion therapy, MRI/DWI, ischemic stroke

Paper 408 Starting at 11:57 AM, Ending at 12:05 PM

Contrast Staining Lesions on CT after Intraarterial Thrombolysis Is not Associated with Intracerebral Hemorrhage Revealed by T2*-Weighted Gradient-Echo Imaging

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Purpose

The purpose of this study was to investigate the hemorrhage rate of contrast staining lesions on posttherapeutic CT scan by using T2*-weighted gradient-echo imaging.
MATERIALS & METHODS
We performed a retrospective analysis of 42 consecutive patients who received intraarterial (IA) thrombolysis for acute ischemic stroke between May 2005 and August 2008. All patients underwent both unenhanced CT scan immediately after IA thrombolysis and MR imaging study including T2*-weighted gradient-echo, DWI, and MRA within the next 24 hours. We classified contrast staining lesions on CT scans into two categories: contrast enhancement and contrast extravasation. Contrast enhancement was defined as a hyperdense lesion with maximum Hounsfield (HU) unit less than 80. Contrast extravasation was defined as a hyperdense lesion with maximum HU unit > 90. The relationship between contrast staining lesions and intracerebral hemorrhage revealed by T2*-weighted gradient-echo imaging on day 1 was investigated.

RESULTS
Twenty-nine patients (69%) had contrast staining lesions on CT scan. Contrast enhancement was found in 16 of 42 patients (38.1%). Contrast extravasation was seen in 13 (30.9%). Overall, 22 patients (52.4%) had intracerebral hemorrhage on T2*-gradient echo imaging. Symptomatic hemorrhage occurred in three of 42 patients (7.1%). There were no significant differences in both of the rates of hemorrhage (55.2% vs 46.2%) and symptomatic hemorrhage (6.9% vs 7.7%) between patients with contrast staining lesions (n = 29) and those without contrast staining lesions (n = 13). There was a nonsignificant trend toward higher incidence of symptomatic hemorrhage in the contrast extravasation group than contrast enhancement group (15.4% vs 0%, p = 0.104).

CONCLUSION
Contrast staining lesions on posttherapeutic CT scan is a frequent finding. This study indicates that contrast staining lesions on CT is not associated with subsequent intracerebral hemorrhage revealed by T2*-weighted gradient-echo imaging.

KEY WORDS: Thrombolysis

Paper 410 Starting at 12:13 PM, Ending at 12:21 PM
Solitaire™ Stent Used as a Revascularization Device in Acute Ischemic Stroke: Acute Results
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PURPOSE
Prompt recanalization of occluded brain arteries in patient victims of acute ischemic stroke (AIS) is associated with a better clinical outcome. Several trials have assessed the efficacy and safety of intrartrial (IA) mechanical thrombectomy combined with intravenous (iv) administration of thrombolytic drugs in the therapy of AIS. The aim of this work is to evaluate the efficacy and the safety in using an intracranial microstent, Solitaire FR (SFR) (ev3 Inc., Irvine, CA, USA), as a revascularization device in treatment of AIS in combination with iv administration of thrombolytic drugs.

MATERIALS & METHODS
Data concerning 21 patients treated within 7 hours of AIS symptom onset with SFR in the setting of iv-IA combined therapy were analyzed.

RESULTS
Solitaire FR was successful to achieve complete recanalization in 19 patients (90.4%) with a final score of three according to the Thrombolysis in Myocardial Infarction classification (TIMI). Partial recanalization (TIMI 2) was obtained in one patient (4.7%). Treatment failure was observed (TIMI 0) in one patient (4.7%). Four adverse events were recorded (21%): two intraprocedurals thrombo-embolic events (10.5%) and two symptomatic intracranial hemorrhagic infarctions (10.5%). One patient died during the hospitalization due to massive brainstem infarction. Marked improvement of National Institutes of Health Stroke Scale (NIHSS) from baseline to 24 hours after recanalization was obtained in 12 patients (57.1%).

CONCLUSION
Solitaire FR was effective in achieving high rate of complete artery recanalization with a low rate of complications. Solitaire FR may be considered as a promising tool for endovascular cerebral thrombectomy.

KEY WORDS: Thrombectomy, stroke, intracranial stent

Paper 411 Starting at 0:21 AM, Ending at 12:29 PM
Effects of Iodinated Contrast at High Magnetic Field: Implications for Acute Stroke Imaging
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PURPOSE
No comprehensive reports of MR image effects of iodinated radiographic contrast material (IRCM) have been published. In the setting of acute stroke evaluation and therapy, IRCM is known to be deposited in the brain in some instances, and may be difficult to distinguish from hemorrhage on CT and MR imaging. The potential for demonstration of enhancement-extravasation of IRCM on MR images after diagnostic/therapeutic CT/digital angiography studies may be increasing with wider use of these modalities in acute stroke evaluation. We analyzed both the in vitro signal changes (using multiple MR pulse sequences at 1.5 and 3 T), as well as the CNRs, of Iopamidol and Iodixanol with the purpose of identifying the potential for detection of IRCM in the infarcted brain.

MATERIALS & METHODS
Aliquots of Iopamidol (300 mgI/mL) and Iodixanol (320 mgI/mL) mixed with normal saline (NS) were scanned at 1.5 and 3 T. Signal intensity (SI) was measured using similar SE-T1, SE-T2, GRE and FLAIR sequences at both magnets. CNR (SI contrast-SI saline/SD noise) were calculated in order to determine the sequence with greatest lesion conspicuity and highest potential detection rate. Graphic analysis of CNR versus IRCM concentration for four different sequences at both field strengths was performed.
RESULTS
Both IRCMs demonstrated increased SI on T1 and decreased SI on T2 sequences (SE-T2, GRE and FLAIR) at 1.5 and 3 T, compared with NS solution. CNR of Iopamidol 300, at 1.5 and 3 T respectively, were: SE-T1: 6.4,20.4; SE-T2: 47.8,92.4; GRE: 13.2,34.6; and FLAIR: 14.3,40.9. CNR of Iodixanol 320, at 1.5 and 3 T respectively, were: SE-T1: 25.2,23.5; SE-T2:24.2,76.8; GRE: 7.4,36.1; and FLAIR: 3.7,32.2. CNR values decreased with NS dilution. Iodixanol had higher CNR than Iopamidol on T1 and Iopamidol had higher CNR than iodixanol on T2, at both 1.5 and 3 T.

CONCLUSION
The highest CNRs were found on SE-T2 at 1.5 and 3 T, with a significant increase in CNR at 3 T. Detection of enhancement-extravasation of IRCM after IV-IA injection in the setting of acute stroke might be possible, particularly on T2-weighted images as areas of hypointensity at 3 T. Less conspicuous T2 shortening on GRE images may allow distinction from hemorrhage. Different IRCM may have different conspicuity on MR imaging. Presence of IRCM may be confused with hemorrhage, and may predispose to hemorrhage. Understanding the imaging characteristics of IRCM on MR imaging is important in acute stroke diagnosis/intervention.

KEY WORDS: Iodinated contrast, MR imaging, stroke
Results
Successful deployment of the stent was achieved in 95.7% of procedures. After the stent-assisted procedure, complete occlusion of the aneurysm was observed in 62.7% of cases, a residual neck in 25.7% and a residual sac in 13.6% of cases. Technical complications, with or without clinical consequences, were encountered in 9.8% of patients. At 1 month follow up, 93% of patients were unchanged in relation to their preoperative neurologic status, 6% improved and 1% worsened. According to mRS, 90.2% of patients had a score of 0 or 1; 4.4% a score of 2, 1% a score of 3; and 4.4% a score of 4. Midterm follow-up results are under analysis.

Conclusion
Analysis of the preliminary clinical results observed in the patients enrolled in this multicenter, prospective, consecutive and controlled study shows that the use of Neuroform3TM stent in the treatment of intracranial aneurysms is relatively safe. The use of Neuroform3TM stent does not seem to increase the percentage of complications and the incidence of morbidity and mortality in relation to coiling procedures performed without stenting.

Key Words: Aneurysm, stenting, multicentric study

Paper 413 Starting at 10:53 AM, Ending at 11:01 AM
Cerecyte Coil Trial: Clinical Outcome of Endovascular Coiling in Patients with Ruptured and Unruptured Intracranial Aneurysms Treated with Cerecyte Coils Compared with Bare Platinum Coils. Results of a Prospective Randomized Trial
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Purpose
To report the discharge and 6-month clinical outcomes in patients treated with Cerecyte or bare platinum coils in a prospective randomized trial.

Materials & Methods
Five hundred patients were enrolled in the Cerecyte prospective randomized trial, in 23 centers worldwide. Two hundred sixty-three patients were treated for a previously unruptured aneurysm and 234 with a recently ruptured aneurysm who were in Grade 1 or 2 after SAH. A secondary outcome of the trial was to collect the clinical outcomes and any differences between the allocated groups. This methodology allowed investigators to examine accurately, in a large multicenter trial, the clinical outcomes associated with treating patients with current expertise and coil technology, and to determine if there are any significant differences between the coil types in respect of clinical complications and outcomes. The clinical outcomes were determined at discharge and 6-month follow up by a validated self-reported modified Rankin Scale of dependency. The data were analyzed to examine procedural complications, discharge outcomes, lengths of stay and dependency at 6 months.

Results
Four hundred ninety-seven patients underwent coil treatment of their aneurysm: 234 patients with recently ruptured aneurysms (RA) and 263 with unruptured aneurysms (UIA). Of the 234 patients with RA discharge data were available for 227 (97%) at the time of abstract preparation. Procedural events: Aneurysm rupture was reported in 14/227 (6%), and thrombo-embolic complications were reported in 13/227 (6%). Nonprocedural complications reported included delayed cerebral ischemia in 30/232 (13%) and hydrocephalus requiring intervention in 7/232 (3%). Two hundred twenty of 227 (97%) patients were WFNS grade 1 or 2 at discharge, two were in poor grade (WFNS 3 and 4), in hospital death occurred in 2/231 (1%) patients. At 6-month follow up 210 of 218 patients were independent mRS 0-2 (96%), four were dead (2%) and four were dependent (mRS 3 or 4). In 263 patients with UIAs procedural aneurysm rupture occurred in six (2%), thrombo-embolic events occurred in 15 (3.8%). There was nonprocedural neurologic deterioration in 7/259 (3%). Hydrocephalus was reported in one patient who had sustained a procedural subarachnoid hemorrhage. There were no in-hospital deaths and the 255 of 259 (98%) patients were discharged home. At discharge 247/253 patients with data were mRS 0 or 1 and six were mRS 2. At 6-month follow up thrombo-embolic complications were reported in 4/231 (2%), headache in 17/231 (7%), neurologic deterioration in 4/231 (2%). There were no reports of hydrocephalus. Clinical outcome data were available for 229 patients at 6-month follow up. Two hundred twenty-four of 229 were mRS 0-2 (95%), mRS 0 or 1: 213, and mRS 2: 11. One patient had died, one was mRS 4, and three were mRS 3. No delayed hemorrhages were reported. The clinical outcomes by coil type will be reported.

Conclusion
The study will provide comparative safety data of the two coils types and the overall safety of coiling in patients treated for unruptured cerebral aneurysms, and those in good grade after SAH.

Key Words: Cerebral aneurysm, coiling, clinical outcomes

Paper 414 Starting at 11:01 AM, Ending at 11:09 AM
Critical Influence of Initial Framing Coil Orientation on Intraaneurysmal and Neck Region Hemodynamics Using Computational Fluid Dynamic Modeling
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Boston, MA

Purpose
Although coiling of intracranial aneurysms is believed to rely on obstruction of blood flow into the aneurysm and induction of intraaneurysmal thrombosis, little data exists on the effect of coil deployment on hemodynamics. We sought to evaluate the effects of simulated coiling of a model aneurysm on flow and wall shear stress (WSS) in the dome and neck regions using computational fluid dynamic (CFD) analysis.
MATERIALS & METHODS
A spherical sidewall aneurysm on a curved parent vessel underwent simulated embolization with one or more computer-designed helical coils with their axis having parallel, orthogonal, or transverse orientation with respect to blood flow. Pulsatile laminar flow CFD analysis was performed on high-resolution conformal meshes of the aneurysm-coil complex using realistic non-Newtonian blood viscosity.

RESULTS
Intraaneurysmal flow and energy flux into the dome were reduced significantly by coil insertion, with little effect on pressure distribution. Coiling increased viscosity in the distal dome with progressive spread towards the neck with greater coil packing. Coiling also decreased WSS and its gradient both in the inflow zone and in the downstream parent vessel. These alterations were dependent on coil orientation, with effectiveness rank order of parallel > transverse > orthogonal.

CONCLUSION
We have successfully modeled the hemodynamic effects of aneurysm coil embolization and uncovered a framing coil orientation dependence of dome and parent vessel hemodynamics. In addition to suggesting a pathophysiologic link between coil configuration, protection from rupture, and aneurysm regrowth, these results pave the way for the analysis of aneurysm-coil complex interactions on a patient lesion-specific basis.

KEY WORDS: Coil embolization, computer modeling, hemodynamics

Paper 415 Starting at 11:09 AM, Ending at 11:17 AM
Creation of Elastase-Induced Aneurysm in Left Common Carotid Artery in Rabbits
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PURPOSE
The right common carotid artery (RCCA) is widely used for creation of elastase-induced aneurysms in rabbits, with resultant side-wall aneurysm morphology. Conversion of the left CCA to an aneurysm with similar techniques would yield a distinct morphology from RCCA aneurysms. We report our experience in creation of LCCA, elastase-induced aneurysms.

MATERIALS & METHODS
Left common carotid artery (LCCA) exposure was followed by retrograde insertion of a 5Fr vascular sheath in New Zealand White rabbits (n = 13). A fogarty balloon was passed retrograde to the origin of the LCCA. Elastase was incubated in the LCCA lumen above the fogarty balloon through vascular sheath for 20 minutes. The balloon and sheath then were removed and the LCCA was ligated distally. Digital subtractive angiography (DSA) was performed at least 3 weeks following aneurysm creation surgery. Aneurysm morphology was catalogued. Aneurysm sizes (neck diameter, width and height) were measured and calculated.
RESULTS
Patent, saccular aneurysmal structures were present in all cases, with bifurcation-aneurysm type morphologies (see Figures 1 and 2). The mean aneurysm neck size was 3.7 ± 1.1 mm (range, 2.1 - 6.5 mm). The mean aneurysm width was 3.8 ± .9 mm (range, 2.6 - 5.9 mm). The mean aneurysm height was 8.7 ± 2.3 mm (range, 7 - 14 mm).

CONCLUSION
The LCCA can be used to create bifurcation-type, elastase-induced aneurysms. This modification will expand applicability of the rabbit model to study bifurcation aneurysm physiology and to test devices aimed at treating bifurcation type aneurysms.

KEY WORDS: Aneurysm, left carotid artery, model

Paper 416 Starting at 11:17 AM, Ending at 11:25 AM

Qualitative Comparison of Cerebral Hemodynamics Obtained Using Injection Dye, Phase-Contrast MR Angiography, and Computational Fluid Dynamics in an In Vitro Cerebral Aneurysm Model

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PURPOSE
Computational fluid dynamic (CFD) simulation is a valuable tool used to understand fundamental conditions of cerebrovascular flow. While there has been an increasing general acceptance of CFD validity, this method has not been compared rigorously with gold standard in vitro fluid dynamic studies. Additionally, conflicting results have been reported on the correlation between CFD calculations and directly measured flow (1). Our hypothesis is that CFD and direct in vitro measurements may differ in demonstrating flow within an identical cerebral aneurysm model. The purpose of this study is to qualitatively compare flow data derived from high-speed injection dye studies, phase-contrast MR angiography (MRA) and CFD.

MATERIALS & METHODS
A previously produced anatomical model of a midbasilar artery aneurysm was constructed using anthropomorphic vascular casts from human cadavers utilizing the lost wax technique. Three-dimensional angiography of the model was performed in a Philips angiography suite and a computational mesh was generated using Geomagic Studio and Gambit. Physiologic waveforms consisting of two cardiac cycles and a combined average flow rate of 185 cc/min, were applied to the inlets and the flow field was solved using the commercial code Fluent. Results then were visualized using Tecplot and particle paths were generated. MR angiography phase-contrast images were obtained through a coronal plan and flow paths were obtained using a 3 T Siemens scanner and programmable pump under similar flow conditions. Flow images from previously published in vitro dye injection (2), phase-contrast MRA, and the CFD results were compared (Figure).

RESULTS
Dye injection images, phase-contrast MRA, and CFD calculations demonstrate similar pathlines which enter the aneurysm at the distal neck and impact against the distal lateral aneurysm wall. In the CFD results the particles do not clear the aneurysm within two cardiac cycles; however the start of a vortex can be seen.

CONCLUSION
There is qualitatively consistent correlation between in vitro dye injection, phase-contrast MRA, and angiographically-derived CFD results using similar pulsatile flow conditions. Future work will include a rigorous statistical analysis of the point-by-point flow comparison between CFD results and phase-contrast MRA data.

REFERENCES

KEY WORDS: Aneurysm, computational fluid dynamics, model
Comparison of MR Angiography Techniques for the Evaluation of Intracranial Aneurysms Treated with Stent-Assisted Coil Embolization

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PURPOSE
To assess the difference between noncontrast time of flight (ncTOF), contrast-enhanced time of flight (cTOF) and dynamic-enhanced MR angiography (dMRA) in the evaluation of intracranial aneurysms treated with stent-assisted coil embolization.

MATERIALS & METHODS
In this retrospective study, 91 cases of stent-assisted coiling of intracranial aneurysms from February 2005 to October 2009 were assessed initially. Forty-nine cases were excluded for lack of contrast MR angiography. Among the 42 cases available for analysis, four cases had dMRA head and another four cases had dMRA head and neck with or without cTOF for comparison against ncTOF. In the remaining 34 cases, cTOF was compared against ncTOF. The images were assessed independently by three attending neuroradiologists. Poststenting digital subtraction cerebral angiography (DSA) was available in 32 cases. In 22 cases, DSA was performed within 3 months from MRA. A subgroup analysis was performed between 1.5 T vs 3 T MRA in 10 of the 42 cases.

RESULTS
There were 36 females and 6 males, ranging in age between 32 and 80 years. Forty-four intracranial stents (39 Neuroform and 5 Enterprise) were deployed in 42 patients (32 anterior and 10 posterior circulation). Noncontrast TOF showed flow void or severe stenosis at the site of stent and coils in 23 of 42 cases (55%). Contrast-enhanced TOF showed flow void or string-like stenosis in 23/38 cases (60%). Digital subtraction angiography excluded stent stenosis in all 32 cases. In spite of using twice the slice thickness of ncTOF, both dMRA head and dMRA head and neck were rated superior to ncTOF by all investigators. Dynamic-enhanced MRA showed superior in-stent flow signals with smoother margins and minimal or no artifactual stenosis in all except a case of basilar artery stenting. In one case, dMRA showed 10 x 11 mm residual cavernous carotid aneurysm, which was barely visible with either ncTOF or cTOF from coil-induced susceptibility. In the 38 cases where ncTOF and cTOF were compared, all three investigators noted ncTOF to be equivalent or superior to cTOF in the majority of cases (89%, 91% and 97%). Venous contamination from the cavernous and dural sinuses with cTOF made assessment with MIP challenging in the majority of cases. Residual neck/aneurysm was identified accurately in six cases and no difference was observed between ncTOF and cTOF. Further there was no difference noted between 1.5 T and 3 T MRA.

CONCLUSION
Noncontrast TOF is equal to or slightly superior to cTOF MRA in the assessment of intracranial aneurysms treated with stent-assisted coil embolization. 1.5 T MR angiography performs equally or slightly better than 3 T MR angiography to assess these cases. Dynamic-enhanced MRA is superior to TOF MRA. Dynamic-enhanced MRA has the potential to show maximum in-stent flow signals and residual neck or aneurysm. A prospective comparison of ncTOF versus dMRA in a larger patient population of aneurysms treated with stent-assisted coil embolization is likely to provide further guidance as to the most appropriate MR imaging modality for these patients.

KEY WORDS: MR angiography, intracranial stents, aneurysms

Psychologic Impact of Repeated Angiographies after Endovascular Coiling for Aneurysmal Subarachnoid Hemorrhage: A Follow-Up Study in Good Outcome Patients

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PURPOSE
The present treatment era is characterized by evidence that, if an intracranial aneurysm is suitable for both clipping and coiling, endovascular treatment is associated with a better outcome. Still, concern about the long-term benefit remains because of possible aneurysm recurrence. Therefore, angiography is customarily performed over and over again at variable intervals. While the yield and risks associated with such an invasive follow up have been addressed in several reports, less well studied are its psychosocial consequences. To elucidate the effects of repeated angiographies on mood, a subset of patients was extracted from our database encompassing 339 intracranial aneurysms coiled in 271 subjects from June 2002 to October 2009. Sampling was aimed to minimize the role of confounding variables and performed in accordance with the following criteria: size greater than one tenth of the entire population; series of consecutive patients treated for aneurysmal subarachnoid hemorrhage; good outcome with resumption of normal activities; negative result for aneurysm recurrence. Two-year follow-up data are reported here.

MATERIALS & METHODS
Thirty subjects (age: 24-73 years.; M: 12, F: 18) were recruited and administered the Hospital Anxiety and Depression Scale (HADS). In detail, the HADS is a brief and widely used instrument which requires participants to rate their experience of 14 subjective and behavioral symptoms over the preceding week. Seven are anxiety related and seven depression connected. For either mood state, the worst possible result is 21 and the scores of 11 or more fall within the clinical range while those between 8 and 10 are graded as borderline cases. The Student’s t test was used in a statistical analysis.

RESULTS
The mean scores were 6.8 95% CI 4.9-8.6 for anxiety and 5.5 95% CI 4.0-7.0 for depression, respectively. Neither of
outcome clipped patients by Powell and coworkers. In detail, seven (23%) patient showed anxiety in the clinical range while 3 (10%) were rated as borderline cases. With regard to depression, four (13%) subjects presented with scores falling in the clinical range and 5 (17%) with borderline symptoms.

**CONCLUSION**

In subjects with good neurologic recovery after surgery for aneurysmal subarachnoid hemorrhage, Powell and coworkers demonstrated mood disturbances which are similar to the pattern for posttraumatic symptomatology after other life-threatening events. Our data suggest that, in coiled patients, clinical levels of anxiety and depression are not raised by repeated follow-up angiographies. They also underline the need of focused interventions because of possible psychologic morbidity even in good-outcome subjects.

**REFERENCES**


**KEY WORDS:** Aneurysmal subarachnoid hemorrhage, endovascular coiling, clinical outcome of ruptured intracranial aneurysm

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**Paper 419 Starting at 11:41 AM, Ending at 11:49 AM**

**Identification of Aneurysm Inflow-Angle as a Discriminant for Rupture in Intradural Cerebral Sidewall Aneurysms: Morphometric and Computational Fluid Dynamic Analysis**

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**PURPOSE**

The ability to discriminate between ruptured and unruptured cerebral aneurysms on a morphologic basis may be useful in clinical risk stratification. The objective was to evaluate the performance of inflow-angle (IA), the angle separating parent vessel and aneurysm dome main axes, as a discriminant between ruptured and unruptured aneurysms and compare its performance to established morphometric parameters.

**MATERIALS & METHODS**

One hundred sixteen intradural sidewall-type (SW) aneurysms in 102 patients were analyzed using high-resolution 3D digital rotational catheter angiography volumetric datasets. Inflow-angle, maximal dimension (Dmax), height-width ratio (H/W), and dome-neck aspect ratio (AR) were measured in 3D space and evaluated with respect to rupture status. Computational fluid dynamic (CFD) analysis was performed in an idealized model with variational analysis of the effect of IA on intraneurysmal hemodynamics.

**RESULTS**

Univariate analysis identified IA as significantly more obtuse in the ruptured subset (124.9 degrees ± 26.5 vs 105.8 degrees ± 18.5, p = 0.0001); similarly Dmax, H/W and AR were significantly greater in the ruptured subset; multivariate logistic regression identified only IA (p = 0.0158) and H/W (p = 0.0017), but not Dmax or AR, as independent discriminants of rupture status. Computational fluid dynamic analysis showed increasing IA leading to deeper migration of the flow recirculation zone into the aneurysm, with higher peak flow velocities and a greater transmission of kinetic energy into the distal portion of the dome. Increasing IA resulted in higher inflow velocity, and greater wall shear stress magnitude and spatial gradients in both the inflow-zone and dome.
CONCLUSION
Inflow-angle is a significant discriminant of rupture status in SW aneurysms, and is associated with higher energy transmission to the dome. These results support its inclusion as a classifier in future prospective aneurysm rupture risk assessment trials.

KEY WORDS: Aneurysm, subarachnoid hemorrhage, morfophetry

Paper 420 Starting at 11:49 AM, Ending at 11:57 AM
Intracranial Stents and Coils: 3.0 T MR Angiography with and without Gadolinium vs CT Angiography and Rotational Digital Subtraction Angiography
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PURPOSE
Evaluation of sensitivity, specificity, advantages and disadvantages of both techniques for the follow up of endovascular-treated aneurysms.

MATERIALS & METHODS
We examined 100 intracranial aneurysms treated with endovascular procedures in a period of 15 months. MR imaging was acquired with 3.0 T unit (Philips Achieva) using 2D TOF pre and 3D TOF postgad sequence with a bolus of 3 cc/sec for a total of 10 cc, also TSE T1, T2, gradient-echo, Flair, diffusion and in some cases perfusion images were done. The examinations were performed from 2 hours to 6 months after the treatment. CT examinations were performed after a bolus of 70 cc of nonionic 320 mg/cc iodinated contrast at a rate of 5 cc/sec with a CT scanner Brilliance 64. CT and MR images were evaluated with MPR, volume rendering and MIP reconstructions in a remote workstation. Rotational DSA was performed with a flat panel bi-plane X-per-CT (Philips) using a total of 40 cc of nonionic contrast (320 mg/cc).

RESULTS
MR angiography was highly sensitive and accurate for the detection of remnants and revascularization of the aneurysms and absolutely safe in all the examinations performed. There were no artifacts caused by coils in any sequence except gradient echo. The lumen of the stents was evaluated better with 3D TOF postgad because the inhomogeneity of the magnetic field they generate decreases the signal inside them, mainly those with markers at the extremes. The comparison between 2D and 3D TOF sequences did not show any important difference but the remnants of treated aneurysm and lumen of the stents were better visualized with iv contrast. The comparison between rotational DSA and contrast 3D TOF did not show any diagnostic difference in all cases. Angiographic CT examinations were useless for evaluation of aneurysms treated with coils because the artifacts coming from the high radio density of such material made difficult the visualization of small remnants, especially in big ones.

CONCLUSION
3 T MR 3D TOF contrast images were safe and highly sensitive in the diagnosis of intracranial stent permeability and for the diagnosis of residual or reanalyzed endovascular-treated intracranial aneurysms being as sensitive and accurate as rotational DSA with the advantage of no radiation exposure, low contrast dose and no intraarterial catheter procedure.

KEY WORDS: 3.0 T, coils, stents

Paper 421 Starting at 11:57 AM, Ending at 12:05 PM
Effect of Flow Diverting Devices on Jailed Arteries and Perforators
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PURPOSE
To investigate the flow alteration in small arteries jailed by flow-diverting stents used to treat intracranial aneurysms.

MATERIALS & METHODS
Three patient-specific computational fluid dynamics models of cerebral aneurysms treated with flow diverting stents were created from 3D rotational angiographies. All aneurysms were located in the ophthalmic segment of the internal carotid artery. In two, the ophthalmic artery was jailed by the stent. In the third, a small side branch representing a perforator was added opposite to the aneurysm neck. Numerical simulations were performed under physiologic pulsatile flows. Resistive boundary conditions were imposed at the outlets. The relative resistances of the distal vascular beds were estimated assuming that the wall shear stress in the side branch was not substantially different from that in the parent artery. The same resistances were used in the aneurysm models before and after stenting. The thickness of the stent wires were varied in order to occlude different percentages of the inlet area of the jailed branches, and the corresponding flow rate reductions through these branches were quantified.

RESULTS
The estimated resistances of the distal vascular beds corresponding to the small arterial branches were significantly larger than the corresponding distal resistances of the large arteries. The flow rate in the artificial perforator was reduced by about 10% for a 90% occlusion of the area of its origin. Similarly, the flow rates in the jailed ophthalmic arteries were reduced by approximately 3% and 1% for a 90% occlusion of their inlet areas. The flow divisions are determined by the relative resistance of the distal vascular beds, and since the resistance of small side branches are quite high, the flow rate through these branches can be substantially reduced only if a large resistance (comparable to the distal resistance) is created at the inlet which requires occlusion of a large percentage of the inlet area (at least 90%).

CONCLUSION
Flow rates in side arteries jailed by flow diverting stents used to treat intracranial aneurysms are not substantially reduced even if a large percentage of their inlet area is occluded. This
is consistent with clinical observations that indicate that these arteries remain patent. These results ease the concern about usage of flow diverting devices intracranially; however it is still possible to completely occlude a small perforator, for instance if located in a region where the stent cells close due to the curvature of the parent vessel.

**KEY WORDS:** Flow diverting devices, perforators, blood flow

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**Paper 422 Starting at 12:05 PM, Ending at 12:13 PM**

**Analyses of Perfusion CT Parameters in the Evaluation of Malignant Brain Tumors**

Kajiwara, Y. · Yamasaki, F. · Kiura, Y. · Saito, T. · Sugiyama, K. · Kurisu, K.

Hiroshima University

**Hiroshima, JAPAN**

**PURPOSE**

Perfusion CT can provide additional information about tumor vascularity and angiogenesis for characterizing brain tumors. The aim of our study is to evaluate the usefulness of various perfusion CT (PCT) parameters in diagnosing the glioblastoma multiform (GBM), primary central nervous system lymphoma (PCNSL), and metastatic brain tumors (MBT).

**MATERIALS & METHODS**

Perfusion CT was performed in 39 patients (22 GBM, 6 PCNSL, and 11 MBT). Normalized ratios of the PCT parameters [normalized cerebral blood flow (nCBF), normalized cerebral blood volume (nCBV), normalized mean transit time (nMTT)] were used for final analysis. All parameters were obtained from tumor-enhanced region (nCBFt, nCBVt, and nMTTt) and peritumoral region (nCBFp, nCBVp, and nMTTp).

**RESULTS**

Mean nCBFt and nCBVt in GBM were 6.5 ± 7.59 and 4.85 ± 2.22, and significantly higher than PCNSL (1.97 ± 1.07, P < 0.002 and 2.07 ± 0.84, P < 0.001) and MBT (2.98 ± 2.71, P < 0.01 and 2.99 ± 2.31, P < 0.005). Mean nCBFp and nCBVp were statistically significant difference between GBM and MBT (nCBFp; GBM 0.79 ± 0.48 vs MBT 0.44 ± 0.14, P < 0.001, nCBVp; GBM 0.83 ± 0.31 vs MBT and 0.57 ± 0.17, P < 0.005). Mean nMTTp for MBT and PCNSL was 1.84 ± 0.68 and 1.22 ± 0.14, with a statistically significant difference between two groups (P < 0.005).

**CONCLUSION**

Perfusion CT provides useful information for preoperative diagnosis and valuable complementary information about tumor hemodynamics. Using statistical analyses both the tumor region data and peritumoral region resulted in significant use for diagnosis in malignant brain tumors.

**KEY WORDS:** Perfusion CT, glioblastoma, metastatic brain tumor

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**Paper 423 Starting at 12:13 PM, Ending at 12:21 PM**

**Image-Based Analysis of Hemodynamic Data for Cerebral Aneurysms: Towards the Integration of Computational Simulations into the Clinical Workflow**

Karmoknik, C. · Zhang, Y. J. · Klucznik, R. · Diaz, O. · Grossman, R. G.

The Methodist Hospital Neurological Institute

**Houston, TX**

**PURPOSE**

Computational fluid dynamics (CFD) simulations have shown potential for predicting rupture risk in cerebral aneurysms (1-3). Postprocessing of the simulation results are time and labor intensive, thereby preventing its integration into the clinical workflow. A new image-based approach for visualizing and quantifying CFD results based on the DICOM image standard is presented and its application is demonstrated with CFD data from seven cerebral aneurysms.

**MATERIALS & METHODS**

3D digital subtraction angiographic (DSA) image data (Siemens Medical Solutions) was obtained from seven patients [1 anterior cerebral artery (ACOM), 1 basilar tip and 6 internal carotid artery (ICA) aneurysms]. Computational fluid dynamics results (Fluent, Ansys, Inc.) available on mathematical grids used for the simulations was resampled and stored as DICOM images (Visualization Toolkit, Kitware Inc.) available for transfer to a clinical PACS system. Standard clinical image postprocessing algorithms were utilized to visualize hemodynamic parameters (blood velocity, vorticity, helicity and total pressure).

**RESULTS**

Computational fluid dynamics data were converted successfully into the DICOM format for all cases. Axial images of the velocity magnitude for the ACOM aneurysm revealed an oscillatory behavior for the inflow jet during the cardiac cycle not appreciated from previous, mesh-based data visualization (Figure 1, panel 1). In one ICA aneurysm, helical flow of opposite sign with high vorticity around the inflow jet was visible also previously not noted (Figure 1, panel 2). DICOM data created from the CFD simulation data was imported successfully into a standard clinical DICOM client (KPACS, Figure 1, panel 3).

**Figure 1:**

- Panel 1: On left, maximum intensity projection (MIP) of velocity magnitude in the ACOM aneurysm. On right: axial (top) and coronal (bottom) views of color coded helicity/vorticity. Panel 2: MIP projection of per ICA aneurysm. On right: velocity, vorticity and helicity at maximum inflow at the location noted by the dashed line on the left. Panel 3: DICOM window settings for the aneurysms shown in panel 2 imported into a standard DICOM client (KPACS).
CONCLUSION
Transformation of CFD simulation data for cerebral aneurysms into the DICOM format allows for easy integration of computational simulation data into the clinical workflow. Complex features of the blood flow (helicity, vorticity or temporal variations of the flow) can be assessed easily using standard image processing algorithms compared to the direct analysis of 3D volumetric data which require intensive user interaction. Further studies are warranted to assess the efficacy of the proposed visualization algorithm for clinical applications.

REFERENCES

KEY WORDS: Cerebral aneurysms, computational fluid dynamics, hemodynamics

Paper 424 Starting at 12:21 PM, Ending at 12:29 PM
Does Patency of the Posterior Communicating Artery during Coiling of an Aneurysm at Its Origin Increase the Thrombo-Embolic Events in the Posterior Circulation?
Jabehdar Maralani, P. · Shankar, J. J. S. · Grover, R. · Lum, C.
University of Ottawa
Ottawa, ON, CANADA

PURPOSE
Thirty to thirty-five percent of intracranial aneurysms arise at or near the internal carotid artery-posterior communicating artery (ICA-PCoA) junction. Some operators routinely occlude the PCoA when there is a patent ipsilateral P1 during the endovascular coiling of PCoA aneurysms to prevent thrombo-embolic events in the posterior circulation. In our center, we have not aimed to sacrifice the PCoA when coil- ing PCoA aneurysms. In this retrospective study, the load of the thrombo-embolic events was evaluated by diffusion-weighted images (DWI) comparing patients with coiling of PCoA aneurysms with a patent PCoA and patients with coiling of other nondmidline anterior circulation aneurysms.

MATERIALS & METHODS
Between Sep 2004 to Oct 2009, we selected 13 patients (male: 4, female: 9; age = 51.9 ± 2.3 years; right: 6 and left: 7) who underwent endovascular coiling of PCoA aneurysms and had patent prominent ipsilateral PCoA based on precoiling CT angiograms. A control group included patients (male: 1, female: 12; age = 50.6 ± 2.3 years; right: 6 and left: 7) with coiled aneurysms in nondmidline anterior circulation (cavernous, ophthalmic and supraclinoid segments of the internal carotid arteries). The controls were matched for age and side of the aneurysm. All patients had contrast-enhanced MR and DW imaging performed within a week of the endovascular coiling. The number of foci of acutely restricted diffusion was evaluated. Data were expressed as mean ± standard error of the mean. Two-tailed T-test and Fisher’s test were used for statistical analysis.

RESULTS
Ruptured vs unruptured aneurysms in cases and controls was 61% and 31% (P = 0.24), respectively. Balloon-assisted coiling was used in 69% and 53% (P = 0.69) in cases and controls, respectively. The number of DWI lesions in the ipsilateral posterior circulation of the study group and ipsilateral anterior circulation of the control group were comparable (1.8 ± 0.7 vs 2.3 ± 0.8, respectively; P = 0.6). The number of DWI lesions in the posterior circulation bilaterally in the PCoA group was higher compared to the patients in the control group (2.5 ± 0.8 vs 0.5 ± 0.4, respectively; P = 0.03). There were trends towards a greater (both anterior and posterior circulation) number of DWI lesions and total anterior circulation DWI lesions in PCoA group (10.0 ± 4.0 and 7.5 ± 3.4; respectively) compared to the control group (3.2 ± 1.3 and 2.7 ± 1.0, P = 0.11 and P = 0.19, respectively).

CONCLUSION
There is no difference between the number of DWI lesions in the ipsilateral posterior circulation in PCoA aneurysms coiled compared to controls. There was no evidence to suggest ischemic events were higher in cases where the PCoA is left patent. Currently, in our center, there is no compelling evidence to deliberately occlude the PCoA when coiling PCoA aneurysms. The relative higher incidence of DWI lesions in the PCoA group may be related to a higher percentage of balloon-assisted cases.

KEY WORDS: Posterior communicating artery, aneurysm, thrombo-embolic events
Thursday Morning
10:45 AM – 12:30 PM
Room 311

(48c) Adult Brain: Vascular, Intracranial
(Scientific Papers 425 - 437)

See also Parallel Sessions
(48a) Interventional: Thrombolysis/Stroke
(48b) Interventional: Aneurysms II
(48d) Adult Brain: Inflammatory/Infectious Diseases
(48e) Spine: Intervention: Vertebroplasty, Biopsy, Pain Management

Moderators: Meng Law, MD
Sameer Ansari, MD

Paper 425 Starting at 10:45 AM, Ending at 10:53 AM
Diagnostic Accuracy of CT Angiography and CT Perfusion for Cerebral Vasospasm: A Meta-Analysis

Greenberg, E. D.1,2 · Gold, R.3 · Reichman, M.1,2 · John, M.2,1 · Ivanidze, J.4 · Edwards, A. M.2 · Johnson, C. E.1,2 · Comunale, J. P.1,2 · Sanelli, P.1,2
1New York Presbyterian, New York, NY, 2Weill Cornell Medical College, New York, NY, 3New York College of Osteopathic Medicine, Old Westbury, NY, 4Ludwig Maximilians University of Munich, Munich, GERMANY

PURPOSE
To perform a meta-analysis of the diagnostic performance of CT angiography (CTA) and CT perfusion (CTP) for the diagnosis of vasospasm in patients with aneurysmal subarachnoid hemorrhage (A-SAH) based on the best evidence in the literature.

MATERIALS & METHODS
Pubmed, Embase, Cochrane Database of Systematic Reviews, Web of Science, and reference lists of included papers were searched for relevant articles published before February 2009. Inclusion criteria for relevant articles were: (1) published articles, (2) original research with prospective or retrospective data, (3) CTA or CTP as the index test, and (4) DSA as the reference standard. Exclusion criteria were: (1) abstracts only, (2) review articles (3) nonhuman models (animal or phantom), and (4) non-English publications. Qualitative and quantitative data were extracted from the articles. Two reviewers independently assessed the quality of the articles using the quality assessment of diagnostic accuracy studies (QUADAS) checklist. Pooled sensitivity, specificity, positive likelihood ratio (LR+), negative likelihood ratio (LR-), and diagnostic odds ratio (DOR) with the corresponding 95% confidence intervals were calculated for both the CTA and CTP data. Summary ROC (SROC) analysis also was performed.

RESULTS
CT angiography search yielded 10 eligible articles, six of which had sufficient data to be included in the meta-analysis. The area under the SROC curve (± standard error) and its Q* point (± standard error) was 0.98 ± 0.02 and 0.94 ± 0.04, respectively. The pooled estimates of CTA included sensitivity of 79.6% (95% CI: 74.9%, 83.8%), specificity of 93.1% (95% CI: 91.7%, 94.3%), positive LR of 18.1 (95% CI: 7.3, 45.0), and negative LR of 0.182 (95% CI: 0.092, 0.359). The overall diagnostic OR for CTA was 124.5 (95% CI: 28.4, 546.4). CT perfusion search yielded 10 eligible articles, three of which had sufficient data to be included in the meta-analysis. The area under the SROC curve (± standard error) and its Q* point (± standard error) is 0.97 ± 0.03 and 0.91 ± 0.05, respectively. CT perfusion data pooled estimates included sensitivity of 74.1% (95% CI: 58.7%, 86.2%), specificity of 93.0% (95% CI: 79.6%, 98.7%), positive LR of 9.3 (95% CI: 3.4, 25.9), and negative LR of 0.2 (95% CI: 0.04, 1.2). The overall diagnostic OR for CTP was 43.0 (95% CI: 6.5, 287.1). Qualitative analysis of the CTA and CTP articles demonstrated significant bias, including disease progression bias, review bias, lack of uniformity in result reporting, small sample sizes, and an overall lack of adherence to standards for the reporting of diagnostic accuracy studies (STARD) criteria.

CONCLUSION
CT angiography and CTP are important diagnostic tools for the detection of vasospasm in A-SAH patients with pooled sensitivity and specificity estimating 80% and 90%, respectively. Performing a meta-analysis also reveals the quality of the evidence available in the literature and the need for more research targeted towards improved uniformity in both methodology and reporting criteria.

KEY WORDS: Cerebral vasospasm, aneurysmal subarachnoid hemorrhage, CT angiography and CT perfusion

Paper 426 Starting at 10:53 AM, Ending at 11:01 AM
Practical Scoring System for the Identification of Patients with Intracerebral Hemorrhage at Highest Risk of Harboring an Underlying Vascular Lesion: The Secondary ICH Score

Delgado Almandoz, J. E.1,2 · Schaefer, P. W.1 · Goldstein, J. N.1 · Rosand, J.1 · Lev, M. H.1 · Gonzalez, R.1 · Romero, J. M.1
1Massachusetts General Hospital, Boston, MA, 2Mallinckrodt Institute of Radiology, Washington University, Saint Louis, MO

PURPOSE
To develop a practical scoring system to stratify patients with intracerebral hemorrhage (ICH) according to their risk of harboring an underlying vascular etiology.
Materials & Methods

Utilizing a database of 623 ICH patients who were evaluated by multidetector CT angiography (MDCTA) of the intracranial circulation over a 9-year period, we developed a practical scoring system to predict the risk of an underlying vascular abnormality as the cause of the ICH (Table 1). A positive CT angiogram was defined as one in which a vascular lesion as the ICH etiology was identified, such as arteriovenous malformations, aneurysms with intraparenchymal rupture and dural venous sinus thrombosis. A high-probability NCCT was defined as one in which there were either (1) enlarged vessels or calcifications along the margins of the ICH, or (2) hyperdensity within a dural venous sinus along the presumed venous drainage path of the ICH. A low-probability NCCT was defined as one in which neither (1) nor (2) were present and the ICH was located in the deep gray matter or brainstem. An indeterminate NCCT was defined as one that did not meet criteria for a high- or low-probability NCCT. We subsequently applied this scoring system to a prospective cohort of 225 ICH patients who presented to our emergency department over a 1-year period. Using receiver operating characteristic (ROC) analysis, we calculated the areas under the curve (AUC) for the scoring system in both the derivation and validation cohorts, as well as in the entire patient population. Patients with subarachnoid hemorrhage in the basal cisterns were excluded from the study.

Table 1. Calculation of the SICH Score

<table>
<thead>
<tr>
<th>Parameter:</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. NCCT categorization:</td>
<td></td>
</tr>
<tr>
<td>a. High-probability:</td>
<td>2</td>
</tr>
<tr>
<td>b. Indeterminate:</td>
<td>1</td>
</tr>
<tr>
<td>c. Low-probability:</td>
<td>0</td>
</tr>
<tr>
<td>2. Age group:</td>
<td></td>
</tr>
<tr>
<td>a. &lt;46 years:</td>
<td>2</td>
</tr>
<tr>
<td>b. 46-70 years:</td>
<td>1</td>
</tr>
<tr>
<td>c. &gt;70 years:</td>
<td>0</td>
</tr>
<tr>
<td>3. Female sex:</td>
<td>1</td>
</tr>
<tr>
<td>4. Neither known HTN nor IC at presentation:</td>
<td>1</td>
</tr>
</tbody>
</table>

The score is calculated by adding the total number of points for a given patient. NCCT: Noncontrast CT examination; HTN: hypertension; IC: impaired coagulation, defined as admission INR > 3, PTT > 80, platelet count < 50,000, or daily antplatelet therapy.

Results

Overall, an underlying vascular lesion was found in 121 of 848 ICH patients evaluated with MDCTA (14.3%). These included 55 arteriovenous malformations (45.5%), 27 aneurysms with intraparenchymal rupture (22.3%), 20 dural venous sinus thromboses (16.5%), 11 arteriovenous fistulae (9.1%), 4 cases of vasculitis (3.3%), and 4 cases of moyamoya disease (3.3%). The maximum operating point was reached at secondary ICH (SICH) scores > 2 (Table 2), with high yields of MDCTA in patients with SICH scores of 3 (18.5%), 4 (39%), 5 (84.2%) and 6 (100%). There was no significant difference in the AUC between both patient cohorts after ROC analysis.

Conclusion

The SICH score successfully predicted the risk of harboring a vascular etiology in patients with ICH. This practical scoring system could be used to select ICH patients for emergency neurovascular imaging.

Key Words: Intracerebral hemorrhage, vascular abnormality, CT angiography

Paper 427 Starting at 11:01 AM, Ending at 11:09 AM

CT Angiography as a Screening Tool for Dural Arteriovenous Fistula in Patients with Pulsatile Tinnitus: Feasibility and Test Characteristics

Narvid, J. · Do, H. · Gianella, D. · Fischbein, N.
Stanford University Medical Center
Stanford, CA

Purpose

The diagnosis of intracranial dural arteriovenous fistula (dAVF) with noninvasive cross-sectional imaging such as CT angiography (CTA) and MR angiography (MRA) is challenging due to poor temporal resolution. In light of recent technical advances, CTA may be an appropriate noninvasive screening tool for intracranial dural arteriovenous fistulas (dAVF) in patients with pulsatile tinnitus (PT). We sought to determine the sensitivity and specificity of CTA for dAVF in patients presenting with PT as compared to cerebral angiography.

Materials & Methods

All patients who underwent CTA for pulsatile tinnitus (PT) from 2004-2009 in our department were reviewed retrospectively and demographic, clinical, and imaging data collected following IRB approval. Seven patients with PT and angiographically proved dAVF and 7 age- and sex-matched control patients with PT but no dAVF comprise the study group. CTA angiography images were postprocessed using a standard protocol to generate multiplanar reformations and maximum intensity projection (MIP) images. These studies then were interpreted blindly by two experienced neuroradiologists who assessed the presence or absence of six variables, two of which have been reported previously to be associated with dAVF on CT or CTA: transcalvarial venous channels; asymmetrical density of jugular veins; numerous, asymmetric and/or dilated venous collaterals; numerous, asymmetric and/or dilated arteries; “shaggy” appearance of a dural venous sinus or the tentorium cerebelli; and enlargement of cortical veins.
RESULTS
Test characteristics of two previously reported indirect CTA signs of dAVF were evaluated: transcalvarial venous channels and asymmetrical density of the jugular veins. The presence of transcalvarial venous channels demonstrated poor sensitivity 29% (CI 5-70), but high specificity 86% (CI 42-99) and a positive predictive value of PPV 67% (CI 12-98). CT density of the jugular veins, measured in Hounsfield units 1 cm below the skull base, showed statistically significant asymmetry in the dAVF group vs the control group (p < .05). We also assessed several direct CTA signs of dAVF including the presence of arterial collaterals in the neck, venous collaterals in the neck, “shaggy” appearance of a dural venous sinus or tentorium due to dilated feeding or draining vessels, and cortical vein enlargement. The presence of arterial feeders showed good test characteristics for screening, with sensitivity 86% (42-99), specificity 100% (52-100), and PPV 100% (56-100). A shaggy sinus or tentorium was highly specific: sensitivity 42% (11-79), specificity 100% (56-100), and PPV 100% (31-100). Alternatively, evaluation of cervical venous collaterals or cortical veins performed less well, with sensitivity 42% (11-79), specificity 71% (30-95), PPV 60% (17-93) and sensitivity 29% (5-70), specificity 71% (30-95), PPV 50% (9-90) respectively (Table 1).

CONCLUSION
CT angiography demonstrates a number of direct and indirect signs that are suggestive of intracranial dural arteriovenous fistula. These signs can be used to screen for dAVF in patients with pulsatile tinnitus. In particular, the presence of abnormally enlarged arterial feeding vessels, a finding not emphasized in prior literature, has high sensitivity, specificity, and PPV for the diagnosis of dAVF.

KEY WORDS: Arteriovenous, DAVF, tinnitus

Paper 428 Starting at 11:09 AM, Ending at 11:17 AM
Role of Susceptibility-Weighted Imaging in the Detection of Persistent Arteriovenous Shunting in Previously Treated Vascular Malformations of the Brain

Jagadeesan, B. D. · Delgado Almandoz, J. E. · Benzinger, T. · Moran, C.
Mallinckrodt Institute of Radiology, Washington University St Louis, MO

PURPOSE
To evaluate the utility of susceptibility-weighted imaging (SWI) for the detection of persistent arteriovenous shunting (AVS) in patients with previously treated arteriovenous malformations (AVMs) of the brain.

MATERIALS & METHODS
We conducted a retrospective review of susceptibility-weighted images in all patients with a previously treated AVM who underwent follow-up imaging with MR imaging (MRI) and conventional catheter digital subtraction angiography (DSA) of the brain over a period of 3 years (with no treatments between the MRI and DSA examinations). Two experienced readers, blinded to the DSA results, independently reviewed the SWI sequences to assess for the presence of AVS, as determined by the presence of signal hyperintensity within a venous structure in the vicinity of the AVM being evaluated. Discrepancies in reader interpretation were resolved by consensus. Standard diagnostic accuracy parameters of SWI for the prediction of AVS in AVMs were calculated utilizing the results of DSA as the reference standard. Interobserver agreement for the presence of AVS in the SWI sequence was calculated with the kappa statistic.

RESULTS
A total of 16 previously treated AVMs were present in the 14 patients included in our study. Five AVMs had been treated with endovascular embolization, four with stereotactic radiosurgery, four with surgical resection, and three with a combination of radiosurgery and embolization. Eight patients were female (57.1%) and six were male (42.9%), with a mean age of 42.5 years (+/- 21.2 years (range 6 to 81 years). The median time between the DSA and MRI studies was 12 days. Susceptibility-weighted imaging demonstrated AVS in all 11 AVMs with persistent AVS on DSA (sensitivity 100%). Susceptibility-weighted imaging did not reveal shunting in any of the five AVMs without AVS on DSA (specificity 100%). The positive and negative predictive values were 100%. There was perfect interobserver agreement for the detection of AVS on the SWI sequence (kappa of 1).

Table showing the comparison between SWI and DSA in the detection of persistent AVS in treated AVMs

<table>
<thead>
<tr>
<th>Shunting on SWI</th>
<th>No shunting on SWI</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shunting on DSA</td>
<td>11</td>
<td>0</td>
</tr>
<tr>
<td>No shunting on DSA</td>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td>Total</td>
<td>11</td>
<td>5</td>
</tr>
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</table>

CONCLUSION
Susceptibility-weighted imaging has not been reported previously to diagnose AVS. In this study, SWI compared favorably with digital subtraction angiography in the follow up of patients with treated arteriovenous malformations and it may offer a reliable noninvasive way to follow patients with TBAVMs.

KEY WORDS: Arteriovenous malformations, MR imaging, susceptibility-weighted imaging
Noninvasive Evaluation of Intracranial Aneurysms: 3.0 T Contrast-Enhanced MR Angiography vs Multislice CT Angiography

Nael, K. · Pope, W. · Finn, P. J. · Villablanca, P. J.
David Geffen School of Medicine at University of California at Los Angeles
Los Angeles, CA

PURPOSE
To prospectively evaluate a high spatial resolution contrast-enhanced MR angiography protocol at 3.0 T for detection and characterization of intracranial aneurysms, and to compare the results with multislice CT angiography.

MATERIALS & METHODS
Fifty patients (27 F, aged 22-68 years) with suspected intracranial aneurysm underwent high spatial resolution contrast-enhanced MR angiography (CE-MRA) on a 3.0 T MR system and CT angiography (CTA) on a 16-slice CT scanner. By applying a fast GRE sequence (TR/TE/FA: 3/1.2/20°), integrated with generalized autocalibrating partially parallel acquisitions (GRAPPA) (1) algorithm with an acceleration factor of 6 (acceleration factor of 3 in phase encoding direction and an acceleration factor of 2 in slice encoding direction), high spatial-resolution (0.7 x 0.6 x 0.8 mm³) CE-MRA of the entire carotid and intracranial circulation was acquired in 20 seconds. CT angiography images were acquired with spatial resolution of 0.35 x 0.35 x 0.75 mm³ in 17 seconds. Image analysis was performed independently by two neuroradiologists for image quality, presence of aneurysm, and aneurysm characterization. The aneurysm dimensions were measured independently at both modalities. Statistical analysis was performed using a t-test, kappa and correlation coefficient.

RESULTS
All studies were determined to provide diagnostic image quality. A total of 25 aneurysms (19 patients) with maximal sac diameter: 1.4-18 mm, were identified by both CE-MRA and CTA. A comparative analysis of aneurysm detection and characterization showed excellent interobserver agreement for CE-MRA (k = 0.80) and CTA (k = 0.87). There was significant intermodality correlation for both qualitative assessment of aneurysm depiction (Rs = 0.90; 95% CI: 0.88, 0.96) and quantitative dimensional measurements of aneurysm size (r = 0.88, 95% CI = 0.85 to 0.96).

CONCLUSION
Described CE-MRA at 3.0T can reliably be used for the evaluation of intracranial aneurysms, with comparable results to multi-slice CTA. Using fast parallel acquisition techniques providing improved spatial resolution (0.33 mm³) and coverage, with high diagnostic image quality, approaching the spatial resolution of multi-slice CTA (0.1 mm³).

REFERENCES

KEY WORDS: MR angiography, CT angiography, intracranial aneurysm
CONCLUSION
PC-VIPR is a highly accelerated MRA technique that generates whole-brain angiograms with clinically useful velocity measurements, scan times less than 5 minutes, and levels of acceleration 20-100 times faster than Cartesian readouts. Prior investigators have found cardiac-gated MR underestimates velocity by ~30% compared to ultrasound because of lower temporal resolution (2). Our time-resolved PC-VIPR measurements were consistent with the literature with 25-30% underestimation compared to ultrasound and also consistent with 2D-PC. We currently are using PC-VIPR to generate wall shear stress measurements that closely approximate in vivo WSS and have prognostic value in determining pathologic flow conditions predisposed to aneurysms and atherosclerosis in patients, using this volunteer data as normal values for comparison with patients.

REFERENCES

KEY WORDS: PC-VIPR, ultrasound, velocity

RESULTS
A total of 41 VMs were present in the 26 patients included in our study (12 female and 14 male, mean age of 39 +/- 25.4 years, range 9 days to 81 years). The median time between the DSA and MRI studies was 9 days. Susceptibility-weighted imaging demonstrated AVS in 15 of the 16 VMs with AVS on DSA (sensitivity 93.8%). Four out of these 16 lesions on DSA were dural arteriovenous fistulas (DAVs) whereas the rest were parenchymal arteriovenous malformations. Susceptibility-weighted imaging detected AVS in all four DAVFs. Susceptibility-weighted imaging did not reveal shunting in any of the 25 VMs without AVS on DSA (specificity 100%). The positive predictive value was 100%, and the negative predictive value was 96.2%. There was perfect interobserver agreement for the detection of AVS on the SWI sequence (kappa of 1.0).

Performace of SWI in the detection of AVS in patients with no hemorrhagic untreated VMs

<table>
<thead>
<tr>
<th></th>
<th>Shunting on SWI</th>
<th>No Shunting on SWI</th>
</tr>
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<tbody>
<tr>
<td>Shunting on DSA</td>
<td>15</td>
<td>1</td>
</tr>
<tr>
<td>No Shunting on DSA</td>
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<td>25</td>
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<td>15</td>
<td>26</td>
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<td>16</td>
<td>41</td>
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CONCLUSION
Susceptibility-weighted imaging is highly accurate in the detection of arteriovenous shunting in previously untreated nonhemorrhagic brain vascular malformations. Potentially, it may be used also to identify DAVFs of the brain. Further validation of these novel findings with a larger study may be useful.

KEY WORDS: Arteriovenous malformations, susceptibility-weighted imaging, MR imaging

Role of Susceptibility-Weighted Imaging in the Detection of Arteriovenous Shunting in Patients with Nonhemorrhagic and Previously Untreated Vascular Malformations of the Brain

Jagadeesan, B. D. · Delgado Almandoz, J. E. · Benzinger, T. · Moran, C.
Mallinckrodt Institute of Radiology, Washington University St Louis, MO

PURPOSE
To evaluate the utility of susceptibility-weighted imaging (SWI) for the detection of arteriovenous shunting (AVS) in patients with nonhemorrhagic and previously untreated vascular malformations (VMs) of the brain.

MATERIALS & METHODS
We conducted a retrospective review of SWI images in all patients with previously untreated nonhemorrhagic vascular malformations of the brain who underwent imaging with magnetic resonance imaging (MRI) and conventional catheter digital subtraction angiography (DSA) over a period of 3 years (with no treatments between the MRI and DSA examinations). Two experienced readers, blinded to the results of DSA, independently reviewed the SWI sequences to assess for the presence of AVS, as determined by the presence of signal hyperintensity within a venous structure in the vicinity of the VM being evaluated. Discrepancies in interpretation were resolved by consensus. Accuracy parameters of SWI for the prediction of AVS in VMs were calculated utilizing the DSA results as the reference standard. Interobserver agreement for the presence of AVS in the SWI sequence was calculated with the kappa statistic.
Intraocular Hemorrhage Detected by CT in Patients Presenting with Nontraumatic Subarachnoid Hemorrhage: A Retrospective Analysis

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PURPOSE
Intraocular hemorrhages associated with nontraumatic subarachnoid hemorrhage have been reported to occur in up to 17% of patients as detected by direct fundoscopic examination. However, the ability of CT to detect these intraocular hemorrhages has not been well studied.

MATERIALS & METHODS
The CTA database was reviewed form January 1, 2009 to October 15, 2009. All studies ordered for nontraumatic subarachnoid hemorrhage were identified. The noncontrast head CTs of these patients were reviewed to identify the presence or absence of intraocular hemorrhage. The clinical records of these patients were reviewed to identify correlative information.

RESULTS
There were 1625 CTAs performed from January 1, 2009 to Oct 15, 2009. Twenty-six of these were performed for patients presenting with nontraumatic subarachnoid hemorrhage. There were nine males and 17 females. The average age was 54 years. The average Fisher Grade was 3. The average Hunt and Hess Score was 3. In four patients (15.4%) no cause for the subarachnoid hemorrhage was identified. In the remaining patients a ruptured aneurysm was identified. There were three patients (11.5%) with ocular hemorrhage identifiable on CT. All three patients had subarachnoid hemorrhage from ruptured intracerebral aneurysms. None of the intraocular hemorrhages were reported prospectively. The hemorrhages were most apparent on the initial presenting head CT. All identified ocular hemorrhages were subtle and seen on only one or two of the axial 4.8 mm slices of the noncontrast head CT. One of the three patients presented with bilateral ocular hemorrhages. One of the three patients was clinically symptomatic from the ocular hemorrhage and underwent surgical treatment for repair of the retinal detachment associated with the hemorrhage. All three patients had hydrocephalus on the initial head CT as compared to 39% of the patients without ocular hemorrhage. Two out of the three patients with ocular hemorrhages were comatose at time of presentation compared to 8.7% of the patients without ocular hemorrhage. Two out of the three patients with ocular hemorrhage had history of loss of consciousness at time of presentation compared to 26% of the patients without ocular hemorrhage. None of the patients without intraocular hemorrhage died. One of the three patients with intraocular hemorrhage died.

CONCLUSION
In patients presenting with nontraumatic subarachnoid hemorrhage, intraocular hemorrhage detectable by CT is not uncommon and is under-reported. The initial presenting noncontrast head CT is most sensitive for its detection. The presence of intraocular hemorrhage is more likely to be seen in patients with poorer clinical presentations.

KEY WORDS: Intraocular hemorrhage, subarachnoid hemorrhage, aneurysm

Outcomes of Intraarterial Thrombolytic Therapy in Acute Ischemic Stroke Patients with a Diffusion-Perfusion Matched Defect

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PURPOSE
Those acute ischemic stroke (AIS) patients who do not have a diffusion-perfusion mismatch defect (matched defect patients) are not considered appropriate reperfusion therapy candidates. However, reports of the existence of ischemic penumbra within regions of abnormal increased diffusion signal (1) and a 43% median reversal rate of the entire baseline diffusion lesion in DEFUSE study (2) suggest a beneficial role for reperfusion therapy in these patients. We therefore hypothesize that application of intensive reperfusion therapy regimen including intraarterial thrombolysis (IAT) in matched defect patients is expected to improve clinical symptoms without increased chance of symptomatic intracranial hemorrhage (SICH).

MATERIALS & METHODS
Records of AIS patients between Jan 1* 1998 and Oct 15* 2008 in whom the perfusion lesion was documented as matching with the diffusion lesion in MR imaging reports and who underwent IAT were analyzed. MR images were used to calculate the diffusion and perfusion lesion volumes. A perfusion deficit corresponding to the region of diffusion restriction and with the perfusion lesion < 120% of diffusion lesion by volume was defined as a matched defect. Intraarterial thrombolysis was performed using alteplase (7 patients, 7-30 mg) or urokinase (1 patient, 1million IU). A successful recanalization (SR) was defined as achievement of thrombolysis in cerebral infarction (TICI) score of >/ = 2 at the end of IAT. A favorable clinical response (FCR) was defined as NIHSS of 0-1 at discharge or >/ = 8 point decrease from baseline. An intracranial hemorrhage with >/ = 4 point increase in NIHSS was defined as a SICH.

RESULTS
The matched defect criterion was satisfied by eight patients (53-84 years). The mean NIHSS at presentation was 15.5 (range 6-22). The mean time from symptom onset to MR imaging and to initiation of IAT was 187.3 min (range 83-240) and 261.5 min (range 160-360), respectively. The mean diffusion and perfusion lesion volume is 121 (range 24-205) mL and 118 (range 18-207) mL, respectively. The perfusion lesion is 74% to 110% of the corresponding diffusion lesion by volume. Of six patients with SR, one achieved FCR, and four had SICH and died during hospitalization. Of two patients without SR, 0 achieved FCR or had SICH, and one died during hospitalization. Of five patients with diffusion lesion volume >/ = 100 mL, one had FCR and three died from SICH, while of the three with diffusion lesion volume < 100 mL, one had SICH (this patient had urokinase) and two died (one from SICH).

CONCLUSION
Low FCR (12.5%) and high SICH (50%) rates argue against the hypothesis and demonstrate that IAT in AIS patients with
matched defect have a low probability of improvement and high risk of SICH particularly in those with larger diffusion defect.

**REFERENCES**


**KEY WORDS:** Diffusion-perfusion mismatch, ischemic penumbra, stroke MR imaging

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**Paper 434 Starting at 11:57 AM, Ending at 12:05 PM**

**High Spatial Resolution 3D Cerebral Contrast-Enhanced MR Venography at 3.0 T: Initial Results Using Highly Accelerated Parallel Acquisition**

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**PURPOSE**

To evaluate a high spatial resolution 3D contrast-enhanced MR venography protocol for evaluation of intracranial venous system, using highly accelerated parallel imaging at 3.0 T.

**MATERIALS & METHODS**

Thirty patients (16 M, age: 38-81 years) with suspected cerebrovascular disease prospectively studied on a 32-channel 3.0 T MR system. A combination of 16 elements array coil [(head n = 12), neck (n = 4)] was used for signal reception. After a single intravenous contrast injection at 1.2 ml/s, high-spatial resolution 3D CE-MR angiography of the entire supra-aortic arteries was performed, followed immediately by 3D cerebral CE-MR venography. For CE-MR venography a fast 3D GRE sequence (TR/TE: 3.4/1.4, FA:20, BW: 620, matrix: 448 x 352) with elliptical centric k-space ordering (1) was applied in sagittal plane. Generalized autocalibrating partially parallel acquisitions (GRAPPA) algorithm (2) was integrated into the sequence with an acceleration factor of 3 in phase encoding direction and an acceleration factor of 2 in slice encoding direction. By selecting 176 partitions with a thickness of 0.8 mm, 3D cerebral CE-MR venography was acquired with voxel dimensions of 0.7 x 0.7 x 0.8mm³ in 24 seconds. Image evaluation was performed independently by two neuroradiologists for overall image quality, presence of noise, and artifacts. The image quality of 30 venous segments was evaluated in each subject, using a 1-4 scoring scale. In ten patients catheter angiography was available for correlation. Statistical analysis of data was performed by using Wilcoxon rank-sum test and kappa coefficient.

**RESULTS**

All studies were determined to be of diagnostic image quality by both observers. The majority (94%) of cerebral venous segments were evaluated to be of diagnostic image quality (median:3, range: 3-4) by both readers, and with excellent interobserver agreement (k= 0.86; 95% CI: 0.79, 0.93). Four patients with cerebral arteriovenous malformation were identified correctly by both observers and the details of nidus and draining veins were correlated and confirmed with subsequent conventional angiography. Two patients with meningioma invading the superior sagittal sinus, and two patients with superior sagittal sinus fistula were detected, and subsequently confirmed by conventional angiography.

**CONCLUSION**

The described protocol is promising in evaluation of cerebral venous system with high diagnostic accuracy in comparison to catheter angiography in a subset of our population. Higher SNR at 3.0 T combined with multichannel array coils effectively support highly accelerated parallel imaging, enabling subsequent acquisition of both high spatial resolution CE-MRA and CE-MRV following a single contrast injection, without impairing the image quality. Further clinical studies are warranted to determine the accuracy of this technique in a broader clinical setting.

**REFERENCES**


**KEY WORDS:** MR venography, parallel acquisition, 3 T

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**Paper 435 Starting at 12:05 PM, Ending at 12:13 PM**

**Idiopathic Intracranial Hypertension (IIH) : Should We Stent the Sinuses?**

Januel, A.

Hôpital Purpan Toulouse, FRANCE

**PURPOSE**

Idiopathic ICH are seen in young obese women presenting with headaches, visual obscuration and visual loss, papilloedema and CSF increased pressure at lumbar puncture. Tretament is based on weight loss, acetazolamide and ventricular shunting. We discuss indication of sinus pressure manometry and sinus stenting in severe forms of IIICH

**MATERIALS & METHODS**

We report a two-year experience in 10 patients (9 female), mean age of 34 years (21 to 57 years), patient weight was from 70 to 129 kg, CSF pressure measured by lumbar puncture was 25 to 90 cm H20. Repeated CSF lumbar subtractions were performed previously in four cases, ventricular shunting in three. Duration of symptoms before sinus manometry ranged from 1 month to 14 years. Eight patients were stented because of a pressure gradient > 10 (from 11 to 35) and two patients were not stented (gradient < 10). Poststen gradient significantly decreased in all cases. Five patients were rendered asymptomatic, two improved and one unchanged. In two patients symptoms recurred during follow up. One patient was retreated (on both sides). Two patients were not retreated despite recurrence of symptoms but because repeated manometry did not show a gradient > 10.
RESULTS

The importance of venous sinus stenosis in the etiology of IICH probably is underestimated. In patients with sinus stenosis and medical treatment failure, sinus stenting seems to be an interesting alternative to classic surgical approaches. However, papilledema, CSF pressure measurements, MR and MR venography, sinus pressure gradients have to be evaluated precisely before deciding on sinus stenting.

CONCLUSION

Larger studies are required to better determine sinus stenting results and indication.

KEY WORDS: Idiopathic intracranial hypertension, stent

Paper 436 Starting at 12:13 PM, Ending at 12:21 PM

Correlation of Pseudotumor Cerebri with Dural Venous Sinus Stenosis

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PURPOSE

Pseudotumor cerebri is an idiopathic condition manifesting in increased intracranial pressure with headaches and visual disturbances. It is diagnosed clinically utilizing the modified Dandy criteria with objective findings of elevated opening pressure and papilledema. Attempts to define imaging findings have been made in the past suggesting use of MR imaging and CT in evaluation of orbital structures, optic nerves, pituitary fossa, and dural venous sinuses. The purpose of our study is to correlate dural venous sinus stenosis noted on MR venography, in patients diagnosed with pseudotumor cerebri, with opening CSF pressure and other clinical features.

MATERIALS & METHODS

Retrospective review of 40 patients who underwent MR brain and 3D phase-contrast MR venography for clinical presentation of headaches over the past 5 years at our institution was conducted. Twenty-three patients who had a final diagnosis of pseudotumor cerebri were included in this study. Patient data were analyzed via review of our electronic medical records in regard to signs of increased intracranial pressure as headache, visual disturbances, nausea and/or vomiting, presence of papilledema, and measurements of opening CSF pressure in patients who underwent lumbar puncture. Corresponding MR imaging and MR venography were reviewed for presence or absence of dural venous sinus stenosis involving the distal transverse sinus regions. MR venography was considered positive if there was stenosis or complete gap sign noted in bilateral transverse sinuses, or of hypoplastic.

RESULTS

Study group was composed of 2 males (mean age 50.5 years, 49-52 years) and 21 females (mean age 34.3 years, 18-62 years). Sixteen (70%) of 23 patients had elevated opening CSF pressure (25-65 cm H2O, mean 43 cm H2O) noted on lumbar puncture. Sixteen patients (70%) had positive MRV findings of transverse sinus narrowing whereas seven patients (30%) had normal MRV. Twenty-one patients (91%) presented with headache, 16 patients (70%) had visual disturbances, 19 patients (83%) had papilledema, and 12 patients (52%) had nausea and/or vomiting. Sixteen patients who had positive MRV findings included 14 patients (88%) with headache, 12 patients (75%) with visual disturbances, 14 patients (88%) with papilledema, and nine patients (56%) with nausea and/or vomiting. Twelve out of these 16 patients (75%) had elevated ICP (26-65 cm H2O), mean 40 cm H2O). The group of seven patients with negative MRV findings included all seven patients (100%) with headache, four patients (57%) with visual disturbances, five patients (71%) with papilledema, and three patients (43%) with nausea and/or vomiting. Four patients (57%) had elevated ICP (25-52 cm H2O, mean 43 cm H2O).

CONCLUSION

The summary of our findings tentatively confirms the positive correlation between the transverse sinus stenosis noted on MRV in patients with pseudotumor cerebri. In particular, pseudotumor cerebri patients who had positive MRV also had higher incidence of papilledema, visual disturbances as well as elevated opening CSF pressure as compared to MRV negative group.

KEY WORDS: Pseudotumor, cerebri, sinus

Paper 437 Starting at 12:21 PM, Ending at 12:29 PM

Luminal Gains after Intracranial Angioplasty and Stenting: Wall Stretching or Plaque Redistribution?

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PURPOSE

To evaluate luminal gaining mechanisms of intracranial angioplasty and stenting using angiographic Eccentricity Index (EI).

MATERIALS & METHODS

Pre and postprocedural angiographies of 14 symptomatic intracranial arterial stenosis patients were reviewed retrospectively. The maximal and minimal distances from the center of the stenotic lesion to the outline of the vessel wall were measured, and the EI was calculated as |(Maximal distance - Minimal distance)/Maximal distance|. The stenotic lesions were categorized based on the EI: 0 ≤ EI < 0.3 (Concentric Lesion); 0.3 ≤ EI < 0.6 (Moderate Eccentric Lesion); EI ≥ 0.6 (Severe Eccentric Lesion). Pre and postprocedural percent lumen gain also were calculated. Periprocedural (24 hours) event rates were compared between eccentric and concentric stenosis group.

RESULTS

Angioplasty with stenting was performed in nine patients and angioplasty alone was performed in five patients. Preprocedure angiography showed: 2 Concentric, 4 Moderate Eccentric and 8 Severe Eccentric lesions. On postprocedure angiography, Concentric, Moderate Eccentric and Severe Eccentric lesions were 5, 7 and 2, respectively. All lesions showed both luminal gain (14.69% ~ 91.83%, mean = 52%) and decreased EI (4.49%~63.66%, mean = 33%)
after procedure. Nine lesions (9/14 = 64.3%) have changed their eccentricity category and their mean luminal gain was 59.8% and EI change was 41.2%. Five lesions which did not change their eccentricity category after procedure showed 29.2% of luminal gain and 9.85% of EI change. There was one periprocedural stroke/mortality in a patient who received angioplasty and stenting procedure. There was no statistical difference in periprocedural event rate between eccentric and concentric stenosis group.

CONCLUSION
Both stretching of arterial wall as well as plaque compression or redistribution might be mechanisms of intracranial angioplasty and stenting procedures. In eccentric lesions, plaque compression or redistribution appears to be the leading mechanism.

KEY WORDS: Eccentricity index, intracranial angioplasty, intracranial stenting

Thursday Morning
10:45 AM – 12:30 PM
Room 312
(48d) Adult Brain: Inflammatory/Infectious Diseases
(Scientific Papers 438 - 450)

See also Parallel Sessions
(48a) Interventional: Thrombolysis/Stroke
(48b) Interventional: Aneurysms II
(48c) Adult Brain: Vascular, Intracranial
(48e) Spine: Intervention: Vertebroplasty, Biopsy, Pain Management

Moderators: Vincent P. Mathews, MD
Steven G. Imbesi, MD

Paper 438 Starting at 10:45 AM, Ending at 10:53 AM
Unorthodox Manifestations of Central Nervous System Tuberculosis: Octopussy - Eight Chapters of Lessons Learned

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PURPOSE
To highlight the unusual imaging manifestations of tuberculosis in neuroradiologic practice.

MATERIALS & METHODS
Sixteen patients with proved neurotuberculosis were retrospectively reviewed and their neuroimaging manifestations categorized under following patterns: All patients have been scanned on 3 T Achieva MR imaging system (Philips Medical System) with volume T1 with contrast: T2, FLAIR, DWI, ADC, MR spectroscopy, MR perfusion. A 3D CT study was obtained in two cases. A CT PET was done in one case. All patients subsequently were followed after stereotactic biopsy with tissue pathology (n = 4), therapeutic trial (n = 4), surgery (n = 8).

RESULTS
Following the tissue pathology and response to antituberculous treatment, lesions have been grouped under following morphologic categories: 1. Petrous apex lesions (n = 2). 2. Skull base osteomyelitis pattern with meningeal carpet lesions (n = 1). 3. Tumefactive tuberculoma: mimicking a neoplasm: imaging/MRS (n = 3). 4. Pott’s Puffy tumor mimickers (n = 2) involving calvarium. 5. Abscess mimickers (n = 2). 6. Fleeting granulomas in white matter: mimicking demyelination and neoplasm on MRS (n = 2). 7. Cavernous sinus lesions: mimicking Tolosa Hunt syndrome (n = 2). 8. Glioma mimicker on MR perfusion (n = 2).
CONCLUSION
Tuberculosis, a chronic granulomatous infective disease of the CNS, has many intriguing and unorthodox neuroimaging manifestations. Awareness about these patterns should facilitate better tissue characterization, differential diagnosis of these lesions on conventional contrast-enhanced MR imaging, DWI, perfusion and MR spectroscopy.

KEY WORDS: Granuloma, infection, brain parenchyma

Paper 439 Starting at 10:53 AM, Ending at 11:01 AM
Neuroimaging of Immune Reconstitution Inflammatory Syndrome during HIV Infection
Cuvinciuc, V. · Martin-Blondel, G. · Dumas, H. · Cognard, C. · Marchou, B. · Bonneville, F.
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Toulouse, FRANCE
PURPOSE
To describe the imaging features of immune reconstitution inflammatory syndrome (IRIS) cerebral lesions in HIV-infected patients.

MATERIALS & METHODS
Retrospective analysis of 18 consecutive cerebral opportunistic infections in HIV patients under efficient highly active antiretroviral treatment (HAART). All patients were evaluated clinically, immunologically and microbiologically. Neuroimaging included CT (15 cases) and/or MR imaging (17 cases). The diagnosis was confirmed by cerebral biopsy in four cases.

RESULTS
Compatible with the definition of IRIS, the clinical aggravation appeared in all cases during rapid immune reconstitution, proved by increase in CD4 lymphocytes levels and decrease of HIV load. The suspected diagnoses were progressive multifocal leukoencephalopathy (PML) in 10 cases, cryptococcosis (5 cases) and toxoplasmosis (3 cases). In 11 cases, IRIS was paradoxical (clinical deterioration of known opportunistic infections). In seven cases, IRIS revealed a previously unsuspected cerebral infection. In the eight cases of paradoxical PML IRIS, there was a rapid increase of FLAIR hyperintensity of the white matter, with mass effect (4 cases), appariation of contrast enhancement (3 cases) and peripheral diffusion hyper intensity with restricted apparent diffusion coefficient (2 cases). In the revealing PML IRIS, MR imaging showed a FLAIR hyper intensity of the white matter compatible with PML, but with peripheral or speckled contrast enhancement. In cryptococcosis, MR imaging showed multiple leptomeningeal and parenchymal contrast enhancements, particularly perivascular and subependymal. In toxoplasmosis, there were multiple nodular lesions, with peripheral contrast enhancement, sometimes with ‘eccentric target sign’. The histologic exam showed signs of inflammation, mainly with CD8+ T cells infiltration.

CONCLUSION
MR imaging shows evidence of cerebral inflammation, supporting the clinical, immunologic and histologic diagnosis of cerebral IRIS.

KEY WORDS: IRIS, HIV, MR imaging

Paper 440 Starting at 11:01 AM, Ending at 11:09 AM
Evaluation of Cortical Thickness in HIV-Infected Patients by Advanced MR Imaging
Cabral, R. F. · Pereira, D. B. · Doring, T. M. · Kubo, T. T. A. · Garrido, R. Q. · Bahia, P. R. V. · Gasparetto, E. L. ·
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PURPOSE
AIDS patients have neurologic symptoms; however the mechanism of injury in specific brain regions is not well understood. This study aims to assess the brain regions most affected by HIV through the use of three-dimensional maps for assessing the cortical thickness from studies of MR imaging of the brain.

MATERIALS & METHODS
We evaluated 40 patients between 45 and 65 years of age, with 23 HIV-infected patients and 17 healthy individuals matched by sex and age. Images were obtained using a 1.5 T MPRAGE in the sagittal T1-weighted, with the study of cortical thickness (voxel 1.33 mm3, flip angle 7°, TR / TE / TI = 2.53 s/3.39 ms/1.1s). The assessment of cortical thickness was done semiautomatically through the program Freesurfer.

RESULTS
Several areas were observed with changes in cortical thickness in patients infected with HIV. The most significant changes were seen in the left lateral occipital region, and right superior temporal regions, precentral and posterior cingulate.

CONCLUSION
The presented results corroborate previous studies that show CNS involvement in HIV-infected patients, showing specific areas of change in cortical thickness in these cases. Future studies should correlate these findings with clinical and neuropsychologic attempts to demonstrate the clinical significance of these changes.

KEY WORDS: AIDS, brain, infection
Enlargement of Inferior Intercavernous Sinus: A New Sign of Intracranial Hypotension Syndrome

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Besançon, FRANCE

PURPOSE
To describe a new sign of intracranial hypotension syndrome, the enlargement of the inferior intercavernous sinus.

MATERIALS & METHODS
Over a 4-year period, we performed 15 MR studies in 12 patients (9 females, 3 males), aged from 21 to 70 years with clinically and radiologically proved intracranial hypotension syndrome. There were nine cases of spontaneous intracranial hypotension syndrome, two cases after diagnostic lumbar puncture and one case after CSF shunting. In three cases, MR follow up after treatment was performed. In addition to the standard protocol, i.e., diffusion imaging, sagittal T1, axial T2 FLAIR, axial and sagittal T1 after gadolinium injection, coronal T1 before and after gadolinium injection and T2 sequences focused on the sella turcica were obtained. We analyzed the morphology of the upper surface of the pituitary gland, the height of the sellar content and the visualization of the inferior intercavernous sinus.

RESULTS
The upper surface of the pituitary gland appeared convex upwards in 10 cases and flat in only two cases. The height of the sellar content varied from 7.5 mm to 11.6 mm: less than 8 mm in two cases, 8 to 10 mm in seven cases and more than 10 mm in three cases. The inferior intercavernous sinus was visualized in 11 out of 12 cases. It appeared thin in two cases, prominent in six cases and very thick in three cases, from 2 to 4 mm thickness. On the MR follow up after medical treatment or blood patch, shrinkage of the inferior intercavernous sinus (three cases) as well as decrease in size of the pituitary gland was demonstrated.

CONCLUSION
MR findings in intracranial hypotension syndrome are pachymeningeal enhancement and thickening, subdural collections, decrease in ventricular size, decrease in prepontine and suprasellar cisterns size, tonsillar herniation and enlargement of the pituitary gland. Our study suggests that enlargement of the inferior intercavernous sinus that we observed in nine out of 12 cases, can be an ancillary sign of intracranial hypotension syndrome. In the literature, it is hypothesized that enlargement of the pituitary gland in intracranial hypotension syndrome is related to hyperemia of the gland the same way as venous hyperemia and enhancement occur in the pachymeninges. We think that the presence of a prominent inferior intercavernous sinus can be partially responsible for the bulging of the pituitary gland. In the presence of an enlarged pituitary gland of unknown origin, demonstration of a prominent inferior intercavernous sinus leads to consider the diagnosis of spontaneous intracranial hypotension syndrome.

KEY WORDS: Intracranial hypotension, pituitary gland, MR

Detection of Chronic Hemorrhage with Iron Deposition in Neuro-Behçet Syndrome by Using Susceptibility-Weighted Imaging

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PURPOSE
The objective is to investigate chronic hemorrhage with iron deposition in brain parenchymal lesions with susceptibility-weighted imaging (SWI) in Neuro-Behçet syndrome.

MATERIALS & METHODS
Twenty patients with definitive diagnosis of Neuro-Behçet syndrome underwent brain MR imaging including following protocols: pre and postcontrast T1-weighted, T2-weighted, FLAIR, T2-weighted gradient-echo (GRE) and susceptibility-weighted imaging at 1.5 T MR unit. The parenchymal lesions of Neuro-Behçet syndrome were identified on each imaging sequence and each sequence was reviewed separately.

RESULTS
There were 12 male patients and eight were females. The mean age ± standard deviation was 37.3 ± 8.07 years. Conventional T2-weighted sequences detected 14 parenchymal lesions in 20 patients. T2-weighted GRE imaging depicted an additional lesion (15 lesions). The SWI demonstrated 21 parenchymal lesions in 20 patients. The SWI detected nine hemorrhagic lesions which were not detected by conventional T2-weighted sequences. Also eight of these lesions also were not seen in T2-weighted GRE imaging. Two lesions seen on conventional and GRE imaging were not seen clearly on SWI. Iron deposits due to hemorrhage were seen only in one (4 %) lesion in T2-weighted imaging and three (13 %) lesions in T2-weighted GRE images. However, iron deposits were detected in 20 lesions on SWI (87%). Additionally, prominent venous structures were seen adjacent to iron depositing lesions in four lesions.

CONCLUSION
Susceptibility-weighted imaging showed additional lesions that were not visible on conventional methods including T2-weighted GRE sequence. The venous system involvement which is believed to cause the etiology of Neuro-Behçet syndrome was substantiated in this study by demonstrating hemorrhagic iron deposits in the majority of the parenchymal lesions. Additionally, SWI is definitely better technique to delineate the extent of parenchymal involvement in Neuro-Behçet syndrome.

KEY WORDS: Neuro-Behçet, susceptibility-weighted imaging, iron deposition
**In Vivo Phosphorus (31P) MR Spectroscopy Reveals Alkaline pH in Intracranial Tuberculomas**

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**PURPOSE**
Several MR techniques, including spectroscopy (MRS) have been used to evaluate intracranial tuberculomas. Phosphorus (31P) MRS provides insight into energy status of intracranial lesions and evaluates pH of tissues. The aim of this study is to look for in vivo 31P MRS features intracranial tuberculomas and evaluate the pH.

**MATERIALS & METHODS**
Thirty-one patients with intracranial tuberculomas on MR imaging (24 confirmed histologically) were evaluated in the study. 31P MRS [single-voxel (1 - 2 mm3), intravoxel in vivo spectroscopy (ISIS)] was performed from the central core of the tuberculoma. pH was estimated by Petroff’s method, based on the chemical shift between phosphocreatine (PCr) and inorganic phosphate (Pi) resonances and correlation of metabolites was done by Pearson’s test (p < 0.05).

**RESULTS**
The pH of the center of tuberculomas (7.02 to 7.21) was slightly alkaline. There was significant positive correlation between high-energy phosphate metabolites (PCr and total ATP), which are markers of bio-energetic status and low energy phosphate metabolites such as membrane phospholipids [phosphomono- and di-esters (PME & PDE)] and Pi (p = 0.034).

**CONCLUSION**
Alkaline pH and observed 31P MR spectral profile have a potential role for in vivo characterization of intracranial tuberculomas and possibly implications in the treatment.

**KEY WORDS:** Phosphorus spectroscopy, 31P MRS, tuberculomas

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**Intracerebral Telangiectasia in Ataxia-Telangiectasia**

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**PURPOSE**
Ataxia-telangiectasia (AT) is an autosomal recessive disorder characterized by mucocutaneous telangiectasia, ocular apraxia, immunodeficiency, heightened radiation sensitivity and susceptibility of developing lymphoreticular malignancy. While the most common neuroimaging finding is profound cerebellar atrophy, supratentorial abnormalities in adults have been reported rarely. The purpose of this study is to analyze the MR imaging features of the supratentorial brain in young adult patients with AT.

**MATERIALS & METHODS**
Ten adult patients with AT (4 male, 6 female, mean age 23.2 years with range 19-32 years) underwent MR imaging (MRI) between 2005 and 2008. Eight of these patients consented to participate in a research study that required a pre-LP neuroimaging study, and two underwent MRI and MRSI as a part of clinical evaluation. Limited research brain MRI consisting of T1, T2, and susceptibility-weighted images (SWI) was performed at 3 T. For the two clinical studies, in addition to conventional sequences, 1H-MRSI (TR 1500/TE 280) was acquired at 1.5 T.

**RESULTS**
In six of 10 patients SWI showed multiple punctate signal voids scattered in the cerebral white matter suggesting hemosiderin deposits. These lesions were inconspicuous on the other pulse sequences (including T2-weighted FSE images) except in the two clinical patients, when additional findings of white matter T2 hyperintensity were present surrounding and highlighting some of these lesions. In one of the two clinical patients, there was also an ovoid T2 hyperintense fluid collection lined by hemosiderin deposits (Figure). A few lesions showed contrast enhancement suggesting telangiectatic vessels. MR spectroscopy showed a decrease of all metabolites in the fluid collection as well as the surrounding T2 hyperintensity (Figure).

**CONCLUSION**
Intracerebral telangiectasia is a frequent finding in adult patients with AT, with multiple punctate hemosiderin deposits best depicted using SWI. These lesions are not associated with clinical symptoms and, on MRI, simulate radiation-induced telangiectasia and cryptogenic vascular malformations (ref). The rarer findings of space-occupying collection and surrounding white matter T2 hyperintensity are consistent with transudative capillary leak and edema. The current MR findings coupled with a previous postmodem pathologic report (ref) of telangiectasia and coagulative necrosis in AT draw a remarkably similar parallel between radiation-induced changes and AT-related vascular abnormalities, believed to be due to underlying defective DNA repair mechanisms.

**KEY WORDS:** Ataxia-telangiectasia, SWI, MRS
Is There a Need for Sagittal and Coronal Reformatted Images of Noncontrast Head CT in Head Injury Patients?

Bag, A. K. · Roberson, G. H.
University of Alabama Birmingham
Birmingham, AL

PURPOSE
We hypothesized that supplemented sagittal and coronal reformatted images will increase the diagnostic yield of subtle intracranial hemorrhages and also increase the confidence level of the interpreter.

MATERIALS & METHODS
We retrospectively selected noncontrast head CT of 24 trauma patients positive for subtle intracranial hemorrhages. In each of the patients, the original 5 mm axial scans were reformatted in 1 mm sagittal and coronal planes at the original CT workstation and were pushed to PACS. The scans were stratified into two groups, A and B. Group A consisted of only the original 5 mm images. Group B consisted of original 5 mm axial images supplemented with the reformatted sagittal and coronal images. Both group A and group B was read by one experienced neuroradiologist in two different times. He was blinded to clinical information and the imaging findings of group A images when he was reading the group B images of the same patient and vice versa. The images in both group A and B were read in the same PACS.

RESULTS
In 18 patients, there were no different reads between groups A and B images. However, in six of these 24 patients, there was some additional information in the report of group B images, which were not reported in group A images. Findings of group A and B images in these six patients were compared in the table. The yield was 25% (6 of the 24 patients) higher in group B patients. In addition to the increased yield, the reader was more confident interpreting group B images compared to the group A images.

<table>
<thead>
<tr>
<th>Result Table</th>
<th>Group A</th>
<th>Group B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patient 1</td>
<td>No report of pericallosal hemorrhage</td>
<td>Pericallosal hemorrhage</td>
</tr>
<tr>
<td>Patient 2</td>
<td>Interpeduncular fossa hemorrhage</td>
<td>Interpeduncular fossa hemorrhage with the midbrain extension</td>
</tr>
<tr>
<td>Patient 3</td>
<td>No comment on right (rt) basal ganglia hemorrhage</td>
<td>Linear rt basal ganglia hemorrhage</td>
</tr>
<tr>
<td>Patient 4</td>
<td>No comment on rt frontal hemorrhage</td>
<td>Rt frontal hemorrhage</td>
</tr>
<tr>
<td>Patient 5</td>
<td>No comment on rt convexity hemorrhage</td>
<td>Rt convexity hemorrhage</td>
</tr>
<tr>
<td>Patient 6</td>
<td>No comment on subtentorial hemorrhage</td>
<td>Subtentorial hemorrhage</td>
</tr>
</tbody>
</table>

CONCLUSION
There are multiple limitations of the study. There was a small patient population. The study had selection bias. However, the benefit of added sagittal and coronal reformatted images in interpretation of subtle traumatic intracranial hemorrhages is quite obvious. Though there will be increased storage space utilization of PACS with these additional images, we recommend to consider supplemented sagittal and coronal reformatted images in interpretation of noncontrast head CT in the setting of head injury.

KEY WORDS: Sagittal, coronal, reformation, intracranial hemorrhage

Diffusion Tensor Imaging in Chronic Neurocognitive Dysfunction following Traumatic Closed Head Injury

Gibson, A. V. · Mohan, S. · Amberg, E. C. · Shah, G. V.

PURPOSE
Some patients with traumatic closed head trauma present with neurocognitive abnormalities and deficits. Conventional MR imaging and CT imaging may be normal; however, positive findings are elicited on neuropsychologic testing that is suggestive of damage to white matter tracts. This study investigates the role of diffusion tensor imaging (DTI) in assessing damage to the white matter tracts and whether these abnormalities can be correlated with abnormalities of neuropsychologic testing.

MATERIALS & METHODS
Fifteen patients ages 16-70 years (mean age 46 years) who are suffering from traumatic closed head injury and had documented neurocognitive deficits were imaged at University of Michigan Hospital with DTI on a 3.0 T magnet. The images were analyzed with fractional anisotropy (FA) values and tractography maps were generated. All the patients also underwent extensive neuropsychologic testing.

RESULTS
Diffusion tensor imaging measures revealed reduced FA values with reduced anisotropy and increased diffusivity in the region of the fornix and cingulum bundle. These findings significantly correlated with neuropsychologic testing that included cognitive tasks.

CONCLUSION
Diffusion tensor imaging is a useful technique to evaluate microstructural injury to the white matter fiber tracts in patients with closed head trauma. Diffusion tensor imaging findings correlate well with neurocognitive dysfunction on clinical testing. In the future, DTI can serve as a surrogate marker for closed head injury.

REFERENCES

**KEY WORDS:** DTI, trauma, MR imaging

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**Paper 447 Starting at 11:57 AM, Ending at 12:05 PM**

**Detection and Characterization of Acute Wallerian Degeneration Patterns with Diffusion-Weighted MR Imaging**

Zacharia, T. · Ittoop, A.
Penn State Hershey Medical Center
Hershey, PA.

**PURPOSE**

Diffusion-weighted MR imaging changes in descending corticospinal tracts remote from neuronal injury like arterial ischemia and diffuse axonal injury following trauma may represent acute wallerian degeneration. We hypothesized that diffusion-weighted MR imaging (DWI) could improve the detection and characterization of early wallerian degeneration.

**MATERIALS & METHODS**

Twenty consecutive patients (age range - 1 day to 78 years) with acute wallerian degeneration secondary to arterial ischemic infarct (n = 8), diffuse axonal injury (n = 5), profound hypoxic ischemic encephalopathy (n = 4) and partial lobectomy (n = 3) were evaluated retrospectively, scans were performed from January 2007 to October 2009. Twenty patients with arterial ischemic stroke without acute wallerian degeneration were designated as a control group. Scans were performed within 72 hours of onset of symptoms or after surgery. The study was approved by the Institutional Review Board (IRB). MR imaging included echo-planar diffusion-weighted imaging (DWI) (n = 10) (b = 1000s/mm²) and apparent diffusion coefficient (ADC) maps of all patients. Findings on DWI were compared with conventional MR imaging and the findings were correlated with clinical and imaging follow up. The Student t test was used to determine the statistical significance of these findings.

**RESULTS**

Areas of restricted diffusion were observed in foci of acute wallerian degeneration (AWD) manifested as bright areas on DWI and low signal on ADC maps. Lesions were more conspicuous on DWI compared to FLAIR and T2 sequences. Four acute wallerian degeneration patterns were observed. A. The most common pattern was an "arterial infarct pattern" (8/20, 40%) seen in patients with large vessel territory infarction. B. "Diffuse axonal injury pattern" (5/20, 25%) noted in patients who had severe head trauma. C. "Profound hypoxic encephalopathy pattern" (4/20, 20%) seen in patients who had severe anoxic episode. D. "Post partial lobectomy pattern" (3/20, 15%) seen in patients who had partial temporal lobectomy for mesial temporal sclerosis. The clinical outcome of stroke patients with AWD was compared to the control group without AWD. The subjects in the latter group were found to have less severe focal neurologic deficits at 6 month follow up (P = 0.001).

**CONCLUSION**

Acute wallerian degeneration demonstrate different patterns on diffusion imaging following neuronal injury. Diffusion-weighted imaging is sensitive to early changes of cytotoxic edema and depicts the acute axonal injury to descending white matter tracts that precedes wallerian degeneration. Acute wallerian degeneration is a predictor of poor clinical outcome.

**KEY WORDS:** Acute wallerian degeneration, diffusion-weighted imaging

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**Paper 448 Starting at 12:05 PM, Ending at 12:13 PM**

**Unilateral Calcification of the Caudate and Putamen: Association with Underlying Developmental Venous Anomaly**

Dehkharghani, S. · Dillon, W. P. · Bryant, S. O. · Fischbein, N. J.

1Stanford University Medical Center, Stanford, CA,
2University of California San Francisco, San Francisco, CA,
3Diversified Radiology, Denver, CO

**PURPOSE**

Developmental venous anomaly (DVA) is the most common cerebral vascular malformation. The DVA's association with other vascular abnormalities, most commonly cavernous malformations, is well recognized; a less well recognized association of DVAs is with parenchymal changes related to chronic venous hypertension and venous ischemia in its drainage territory. We identified a series of patients with calcification of the caudate and putamen in association with an adjacent DVA. To our knowledge, only a single such example has been described on cross-sectional imaging; consequently this entity may be overlooked among the differential considerations of unilateral basal ganglia calcifications.

**MATERIALS & METHODS**

Six cases identified during routine clinical readout at the authors' institutions over the past decade exhibited unilateral isolated mineralization of the caudate and putamen on CT. Gadolinium-enhanced MR scans and/or catheter angiography subsequently were performed in all cases, demonstrating the presence of a nearby DVA. These cases constitute the study population. Case review was performed in accordance with guidelines of the institutional review board.

**RESULTS**

All patients in the study population underwent initial evaluation with noncontrast head CT; five of six cases subsequently received contrast-enhanced MR imaging of the brain, and three cases were studied by catheter angiography. No patients in the study population suffered from disorders of calcium or phosphate metabolism. The findings in question were discovered incidentally during the evaluation of unrelated clinical abnormalities in all cases. Presenting symptoms included headaches in all patients; a single patient presented with seizures. Two patients presented in the setting of lobar hemorrhages remote from their DVA; one of these patients subsequently was shown to have a high-flow arteriovenous malformation. Findings were right-sided in five of six patients and left-sided in one patient. All cases demonstrated a deep DVA ipsilateral to dystrophic-appearing calci-
flications of the caudate and putamen. The anterior putamen was involved preferentially in all cases, and there was striking sparing of the anterior limb of the internal capsule in all cases. No mass effect or acute ischemia was noted in any case. Mild prominence of the ipsilateral frontal ventricular horns in four of six cases may have reflected mild parenchymal volume loss, likely due to regional chronic venous ischemia, perhaps secondary to outflow obstruction.

**CONCLUSION**

Developmental venous anomalies are the most common cerebral vascular malformation, with a generally benign clinical course. Venous stenosis and secondary venous hypertension likely explain the presence of chronic venous ischemia with dystrophic calcifications in our series. Given the frequent presence of DVAs near the frontal horns of the lateral ventricles, such parenchymal changes within the corpus striatum are not surprising. While numerous disorders may manifest with dystrophic calcifications of the basal ganglia, few of the more common entities are characteristically unilateral in nature. We believe chronic venous ischemia may rarely occur in the territory drained by DVA, causing parenchymal changes that may result in a potentially confusing pattern of unilateral basal ganglia calcification. Greater recognition of this entity as a primary diagnostic consideration may help to prevent unnecessary and often invasive evaluation in such patients.

**KEY WORDS:** Developmental venous anomaly, basal ganglia calcification, venous hypertension

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**Paper 449 Starting at 12:13 PM, Ending at 12:21 PM**

**Posttreatment Cessation Rebound in Multiple Sclerosis**

Titelbaum, D. S. · Schwartz, E. D.
Shields Health Care
Brockton, MA

**PURPOSE**

Multiple sclerosis disease activity rebound following cessation of treatment is controversial. We report five cases documenting posttreatment acute disease activity, four of whom had more enhancing lesions than pretreatment or intratreatment baseline. Possible neuroimmunologic explanation will be discussed.

**MATERIALS & METHODS**

Five patients with relapsing-remitting multiple sclerosis who stopped monotherapy treatment of natalizumab (n = 3), interferon beta-1a (n = 1), or glatiramer acetate (n = 1) were imaged 1-8 months following cessation of treatment. Patients who were treated with natalizumab had received between two and 13 infusions. In all cases, treatment was stopped voluntarily by the patient. Posttreatment clinical status and gadolinium-enhanced MR imaging were compared retrospectively with pretreatment “baseline” or intratreatment imaging and clinical status, with attention to number of enhancing lesions.

**RESULTS**

All patients presented with new neurologic symptoms beginning 1-8 months following cessation of treatment. For each patient, posttreatment imaging revealed gadolinium-enhancing lesions (mean = 3, range 1-6). Four of five patients showed increased number of enhancing lesions compared to pretreatment or intratreatment images (mean = 3, range 1-6).

**CONCLUSION**

Disease activity rebound can occur in some patients 1-8 months following cessation of neuroimmunomodulatory treatment. Larger sample size and controlled studies are needed to further investigate this phenomena.

**REFERENCES**


**KEY WORDS:** Multiple sclerosis, natalizumab

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**Paper 450 Starting at 12:21 PM, Ending at 12:29 PM**

**CT Angiography Spot Sign in Secondary Intracerebral Hemorrhage**

Delgado Almandoz, J. E.1,2 · Kelly, H. R.1 · Brouwers, H.1 · Yoo, A. J.1 · Stone, M. J.1 · Schaefer, P. W.1 · Goldstein, J. N.1 · Rosand, J.1 · Lev, M. H.1 · Gonzalez, R.1 · Romero, J. M.1
1. Massachusetts General Hospital, Boston, MA
2. Mallinckrodt Institute of Radiology, Washington University, Saint Louis, MO

**PURPOSE**

The presence of active contrast extravasation at multidetector CT angiography (MDCTA), the spot sign, is a potent predictor of hematoma expansion, mortality and poor outcome in patients with primary intracerebral hemorrhage (ICH). This study aims to determine the frequency and predictive value of this MDCTA finding in patients with secondary ICH (i.e., due to a vascular abnormality).

**MATERIALS & METHODS**

Two experienced readers, blinded to clinical data, retrospectively reviewed CT angiograms (CTA) performed on 173 consecutive patients presenting to our emergency department with secondary ICH over a 10-year period to assess for the presence of spot signs. Medical records were reviewed for baseline clinical characteristics and discharge disposition. Baseline and follow-up ICH volumes were calculated with computer-assisted volumetric analysis. Hematoma expansion was defined as an increase of > 6mL or > 30% from the baseline ICH volume. Disagreements were resolved by consensus.

**RESULTS**

We identified at least one spot sign in 25 of 173 patients with secondary ICH (14.5%), three of which were delayed spot signs (12%). Interobserver agreement for the presence of spot signs was almost perfect [kappa 0.84, 95% confidence interval (CI) 0.7-0.98]. A follow-up CT was available in only 60 patients (34.7%) because, immediately after the baseline CTA, 83 patients underwent hematoma evacuation (48%), 15 endovascular embolization (8.7%), nine expired (5.2%), and six patients did not have a follow-up CT performed (3.5%). The presence of a spot sign increased the risk of in-
hospital mortality [44.0%, OR 2.7 (95% CI 1.1-6.6), p-value 0.027] but not of hematoma expansion [16.7%, OR 2.0 (95% CI 0.2-20.3), p-value 0.48, Table 1]. Spot signs were most common in patients with arteriovenous fistulae (41.7%), anterior cerebral artery aneurysms (18.2%), and middle cerebral artery aneurysms (17.1%). Importantly, spot signs were most predictive of in-hospital mortality in patients with ICH secondary to anterior cerebral and anterior communicating artery aneurysms (100%, Table 2).

Table 1. Predictive Value of the Spot Sign in Secondary ICH

<table>
<thead>
<tr>
<th>Significant Hematoma Expansion*</th>
<th>In-Hospital Mortality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sensitivity: 16.7 (8.8 - 63.5)</td>
<td>25.0 (13.7 - 40.7)</td>
</tr>
<tr>
<td>Specificity: 90.7 (78.9 - 96.5)</td>
<td>89.1 (82.2 - 93.7)</td>
</tr>
<tr>
<td>PPV: 16.7 (8.8 - 63.5)</td>
<td>44.0 (25.0 - 64.7)</td>
</tr>
<tr>
<td>NPV: 90.7 (78.9 - 96.5)</td>
<td>77.7 (70.0 - 84.0)</td>
</tr>
<tr>
<td>Positive LR: 1.8 (0.25 - 13.0)</td>
<td>2.3 (1.1 - 4.7)</td>
</tr>
<tr>
<td>Negative LR: 0.92 (0.64 - 1.3)</td>
<td>0.84 (0.71 - 1.0)</td>
</tr>
<tr>
<td>Accuracy: 83.3</td>
<td>72.8</td>
</tr>
<tr>
<td>Prevalence: 10</td>
<td>25.4</td>
</tr>
</tbody>
</table>

*For a subset of 60 patients with a follow-up CT. PPV: positive predictive value; NPV: negative predictive value; LR: likelihood ratio.

Table 2. Frequency and Predictive Value of the Spot Sign by ICH Etiology

<table>
<thead>
<tr>
<th>ICH Etiology:</th>
<th>Spot Sign frequency, %</th>
<th>PPV for Hematoma Expansion, %</th>
<th>PPV for In-Hospital Mortality, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arteriovenous malformations, n=68</td>
<td>11.8</td>
<td>0</td>
<td>37.5</td>
</tr>
<tr>
<td>MCA aneurysms, n=41</td>
<td>17.1</td>
<td>n/a</td>
<td>28.6</td>
</tr>
<tr>
<td>Anterior communicating artery aneurysms, n=23</td>
<td>13.0</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>Arteriovenous fistulae, n=12</td>
<td>41.7</td>
<td>0</td>
<td>20</td>
</tr>
<tr>
<td>ACA aneurysms, n=11</td>
<td>18.2</td>
<td>50</td>
<td>100</td>
</tr>
<tr>
<td>Distal ICA aneurysms, n=11</td>
<td>0</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>PICA aneurysms, n=3</td>
<td>0</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>Posterior communicating artery aneurysms, n=2</td>
<td>0</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>PCA aneurysms, n=2</td>
<td>0</td>
<td>n/a</td>
<td>n/a</td>
</tr>
</tbody>
</table>

ICH: intracerebral hemorrhage; PPV: positive predictive value; MCA: middle cerebral artery; n/a: not applicable; ACA: anterior cerebral artery; ICA: internal carotid artery; PICA: posterior inferior cerebellar artery; PCA: posterior cerebral artery.

CONCLUSION

The spot sign identifies secondary ICH patients at increased risk of in-hospital mortality. However, likely as a result of the high frequency of immediate surgical and endovascular interventions in this patient population, its predictive value for hematoma expansion remains unclear.

KEY WORDS: Spot sign, arteriovenous malformation, aneurysm

Thursday Morning

10:45 AM – 12:30 PM
Room 210

(48e) Spine: Intervention: Vertebroplasty, Biopsy, Pain Management
(Scientific Papers 451 - 463)

See also Parallel Sessions
(48a) Interventional: Thrombolysis/Stroke
(48b) Interventional: Aneurysms II
(48c) Adult Brain: Vascular, Intracranial
(48d) Adult Brain: Inflammatory/Infectious Diseases

Moderators: Joshua A. Hirsch, MD
Vivek Gupta, MD

Paper 451 Starting at 10:45 AM, Ending at 10:53 AM

Percutaneous Vertebroplasty for Osteoporotic Fractures: Experience with High Viscosity Cement Using a Hydrolic Injection Device, the “CONFIDENCE” System

Georgy, B.
North County Radiology
San Diego, CA

PURPOSE

Vertebroplasty is a widely used technique to treat painful osteoporotic vertebral compression fractures; however, precise control of cement delivery is necessary to minimize the risk of cement leakage. The study is conducted to assess the clinical feasibility of performing vertebroplasty on osteoporotic compression fractures using an ultraviscous cement injected by a hydraulic device, CONFIDENCE Vertebral Augmentation System, to further control cement deposition.

MATERIALS & METHODS

A retrospective evaluation of series of 94 consecutively treated patients were identified for the review. There were a total of 163 levels which ranged from T3 to L1 vertebral bodies. The degree of leakage, seen in the postoperative films, was assessed at each treated level using a strict 4-point scale (none, minimal, moderate, severe). The pattern of any observed leakage also was characterized as: diskal, venous, paravertebral, or epidural.

RESULTS

Preoperatively the mean degree of vertebral collapse was 29%. A bipedicular approach was used for 82% (133/163) levels and unipedicular in 18% (30/163). There was no leakage in 50%, minimal leakage in 42%, and moderate leakage...
noted in 8% of cases. Both unipedicular and bipedicular approaches showed leaks in 50% of cases. The most frequent pattern of leak was venous indicated in 52% of leaks, the adjacent disk in 46%, and paravertebral in 5%. The pattern of leakage always was limited to one region except in two cases. There were no symptomatic leaks that required surgical intervention.

CONCLUSION
Vertebroplasty in osteoporotic fractures using a highly viscous cement that can be safely controlled and injected via a hydrolic system can be performed safely without significant complications.

KEY WORDS: Vertebroplasty, cement, leakage

Paper 452 Starting at 10:53 AM, Ending at 11:01 AM
Kyphoplasty in Cancer Patients: Indications, Technique and Results Based on 112 Cases

Wladyka, C. G.1,2 · Karimi, S.1,2 · Laufer, I.1 · Bilsky, M.1,2 · Krol, G.1,2 · Lis, E.1,3
1Memorial Sloan Kettering Cancer Center, New York, NY, 2Weill Cornell Medical Center, New York, NY

PURPOSE
Percutaneous vertebral augmentation procedures such as kyphoplasty often are performed in patients with axial load pain due to vertebral body compression fractures. More recently, it has been utilized in management of metastatic lesions of the spine. We present our experience in 112 patients with diagnosis of cancer and painful vertebral body compression fractures who were treated with kyphoplasty.

MATERIALS & METHODS
The authors retrospectively reviewed 112 consecutive cancer patients that underwent kyphoplasty for the treatment of painful vertebral body compression fractures due to osseous metastatic disease or osteoporosis. Clinical details and pain assessment scores as measured on a 10-point scale were obtained from the medical record.

RESULTS
One hundred twelve patients were reviewed with seven patients lost to follow up. One hundred eighty levels were augmented in the total of 105 patients. Sixty-three of 105 (60%) of the patients had painful pathologic fractures secondary to osseous metastases. Mean time of follow up was 114 days. Pain score prekyphoplasty was 8.8. Mean pain score postkyphoplasty was 3.7. Forty-two of 105 (40%) of the patients had painful osteoporotic fractures. Mean time of follow up was 133 days. Pain score prekyphoplasty was 8.3. Mean pain score postkyphoplasty was 3.2. Average pain score prior to kyphoplasty for all patients was 8.6/10. Average pain score postkyphoplasty for all patients was 3.5/10. Average mean follow up for all patients was 123 days. Seven patients had no improvement or worse pain postkyphoplasty.

CONCLUSION
Kyphoplasty is an effective treatment for axial load pain due to vertebral body compression fractures in cancer patients.

KEY WORDS: Kyphoplasty, cancer

Paper 453 Starting at 11:01 AM, Ending at 11:09 AM
Multicenter, Long-Term Outcome Results with Percutaneous Directional Vertebral Augmentation

Remley, K. B.1 · Hummel, A.2
1Center for Diagnostic Imaging, Indianapolis, IN, 2Kreiskrankenhaus Woerth, Worth an der Donau - Bavaria, GERMANY

PURPOSE
Percutaneous intervention of vertebral fractures eliminates pain but often is criticized for inadequate directional control and inefficient sustainability of the fracture reduction. Through the use of its innovative implantable PEEK wafers, directional vertebral augmentation attempts to address these concerns and still resolve pain. This study examined multicenter results and verified the maintenance of fracture as well as pain elimination.

MATERIALS & METHODS
A retrospective review of patient charts at two sites identified 105 fractures in 88 patients percutaneously implanted with the StaXx® FX Structural Kyphoplasty System between May 2007 and September 2009. An independent source, using digitized standing lateral radiographs, measures vertebral height at anterior, central, and posterior points using validated software. Vertebral body height is reported as a percentage of adjacent intact vertebral body and the amount of height available for reduction. Patients rank their pain on a scale of 1(none) to 10 (intense).

RESULTS
The mean clinical follow-up length was 6.5 months. Mean patient age was 75.5 years, with 30 males and 58 females. Mean fracture age was approximately 7 weeks. A mean of 2.8 ml cement stabilized the wafer stack. Procedure time averaged 30 minutes. Fifty-two complete readable X-ray sets were available for analysis. Preoperatively, 49 fractures demonstrated at least 12.0% initial height loss, with a mean loss of 38.0%. Anteriorly, 84.0% (p < 0.001) of the available lost height was restored. Centrally, 84.5% (p < 0.003) of available lost height was restored. No device related neurologic or pulmonary complications occurred. Pain significantly decreased (p < 0.0001) from a preoperative score of 9.0 to a postoperative score of 1.5.

CONCLUSION
This multisite data indicate vertical fracture reduction through directional vertebral augmentation significantly relieves pain and minimizes intraoperative loss of correction, retaining the positional and procedural reduction at implementation.

KEY WORDS: Vertebral augmentation, percutaneous intervention, vertebral compression fracture
**Paper 454 Starting at 11:09 AM, Ending at 11:17 AM**

**Cryoablation/Vertebroplasty vs Radiofrequency/Vertebroplasty in Neoplastic Vertebral Localization**

Masala, S. · Massari, F. · Mammucari, M. · Bartolucci, D. A. · Fiori, R. · Simonetti, G.

University of Rome “Tor Vergata” Rome, ITALY

**PURPOSE**

The aim of our study was to emphasize the state of the art in vertebral neoplastic percutaneous palliative treatment by comparing the visual analogue scale (VAS) scores in cryoablation plus vertebroplasty vs radiofrequency plus vertebroplasty, and their feasibility, reliability and efficacy in short-term series.

**MATERIALS & METHODS**

Combined procedure of radiofrequency (RF) thermal ablation plus vertebroplasty or cryoablation plus vertebroplasty were performed in osteolytic neoplastic localizations in 30 consecutive patients suffering for pain refractory to conservative therapies. We evaluated pain with a visual analogue scale (VAS), performed in the preoperative period and at 4 hours, 24 hours, 1 week, 1 month, 3 months and 6 months from the procedure.

**RESULTS**

There were no statistical significant differences in the VAS score between patients treated with cryoablation and vertebroplasty and those treated with RF ablation and vertebroplasty at 1 week (p = 0.34), 1 month (p = 1), 3 months (p = 0.68) and 6 months (p = 0.65). Patients treated with cryoablation and vertebroplasty have less pain at 4 hours (p < 0.001) and at 24 hours (p < 0.001) than patients treated with RF ablation and vertebroplasty.

**CONCLUSION**

Both RF ablation and cryoablation are optimal techniques in the treatment of painful vertebral neoplastic lesions. Cryoablation achieves reduced treatment-related pain in the early follow-up time and a better volume control by real-time depiction of ablation margins.

**KEY WORDS:** Vertebroplasty, cryoablation, radiofrequency

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**Paper 455 Starting at 11:17 AM, Ending at 11:25 AM**

**Vertebral Disk Biopsy: Can’t We Do Better?**

Fakhran, S. · Alhilali, L. M. · Pitt, A.

Barrow Neurological Institute Phoenix, AZ

**PURPOSE**

Diskitis/Osteomyelitis, if untreated, can be a debilitating condition with significant patient morbidity and mortality. The initial diagnosis can be both a challenge to make clinically, and it is often difficult to isolate a causative pathogen on disk biopsy. As clinical treatment and decision-making, as well as patient well being, often hinges on appropriately targeted antibiotic treatment it is key to be able to isolate and identify the offending pathogen whenever possible. The purpose of this prospective study was to evaluate the additional diagnostic yield of disk biopsy when utilizing a pediatric gastrointestinal cytology brush, introduced to the disk space through an 18 gauge coaxial, to obtain multiple brushings of the disk in question, when compared to traditional techniques.

**MATERIALS & METHODS**

The study included 10 consecutive patients with clinically suspected diskitis/osteomyelitis referred for disk biopsy. Samples were collected initially utilizing negative aspiration with an 18 gauge coaxial spinal needle, advanced into the disk space under fluoroscopic guidance, and sent to the laboratory. Subsequently, three brushings were obtained utilizing a pediatric gastrointestinal cytology brush advanced into the disk space through the 18 gauge needle and these were sent to the laboratory.

**RESULTS**

In five patients no pathogen was isolated utilizing either the 18 gauge needle or the brush. In two patients the same pathogen was isolated utilizing both techniques. In two patients no pathogen was isolated utilizing the 18 gauge needle; however pathogens were isolated utilizing the pediatric gastrointestinal cytology brush.

**CONCLUSION**

Although the sample size studied was small, initial results would indicate that utilizing a pediatric gastrointestinal cytology brush may increase the diagnostic yield of disk biopsy with little added risk to the patient.

**KEY WORDS:** Diskitis, biopsy

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**Paper 456 Starting at 11:25 AM, Ending at 11:33 AM**

**“AUGMENTING” the Selection of Patients for Vertebral Augmentation Procedures through an Algorithmic Imaging Approach**

Chamarthy, M.1 · Choe, D.2 · Jordan, E.2 · Freeman, L. M.1 · Brook, A.1 · Miller, T.1

1Montefiore Medical Center, Bronx, NY, 2Albert Einstein College of Medicine, Yeshiva University, Bronx, NY

**PURPOSE**

Vertebral compression fractures represent a common cause of severe back pain, especially in the elderly osteoporotic population. X-ray, CT scan, MR and radionuclide bone scan are the various available imaging modalities. Vertebral augmentation procedures and sacroplasty are the interventions used to manage compression and insufficiency fractures. The purpose of the study is to propose an algorithmic approach for appropriate work up of the compression fractures prior to vertebral augmentation procedures.

**MATERIALS & METHODS**

All the patients who had vertebral augmentation and preprocedural work up between 2003-09 were analyzed retrospectively for the CT, MR, radionuclide bone scan and procedural findings. The compression fracture levels and the subsequent vertebroplasty levels detected by each available modality were noted. For each patient, the imaging modality
that optimally guided the subsequent vertebral augmentation procedure was determined.

**RESULTS**
A total of 56 patients met the study criteria and were included in the analysis. Both the radiologic and nuclear imaging studies had near similar rates of detection for acute compression fractures. Vertebral augmentation procedures were performed at 75 levels, of which 71 levels were detected by CT/MR (95%) compared to 64 (85%) on bone scan. CT/MR imaging reported 109 fracture levels of which 71 (65%) had subsequent vertebral augmentation while the bone scan reported 98 fracture levels of which 64 (65%) had subsequent vertebral augmentation. MR imaging was performed in 39 of the total 56 patients (70%), of which 24 (61%) showed acute features. Bone scan was found to be of additional value in guiding the vertebral augmentation levels in 46% of the total cases and more helpful when MR was not available (82% vs 31%, p = 0.001), or if the MR showed no features of acute compression fracture (73% vs 4%, p = 0.001).

**CONCLUSION**
Radiologic anatomical imaging is imperative in the work up of compression fractures and subsequent vertebral augmentation. MR imaging, if not contraindicated, should be performed for the initial evaluation of vertebral compression fractures and an acute fracture on MR alone can be followed with vertebral augmentation procedure. Bone scan complements the CT/MR techniques, and should be used in the planning of vertebral augmentation, especially in cases when there are no acute changes on MR or when MR cannot be obtained.

**KEY WORDS:** Vertebroplasty, bone scan, compression fracture

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**Paper 457 Starting at 11:33 AM, Ending at 11:41 AM**

**Clinical Utility of Radiofrequency Kyphoplasty in Oncology Patients**

Elgeti, F. A. · Kroencke, T. J. · Gebauer, B.
Charité Universitätsmedizin Berlin
Berlin, GERMANY

**PURPOSE**
Conventional vertebroplasty and kyphoplasty are established minimally invasive (MI) treatment modalities for painful or unstable neoplastic vertebral osteolyses. Control of cement delivery in tumors of the vertebrae can be problematic. Radiofrequency (RF) kyphoplasty is a next generation MI procedure performed with the StabiliT Vertebral Augmentation System. Site- and size-specific cavity creation with remote controlled hydraulic delivery of RF warmed ultrahigh viscosity cement with extended working time provides unique control in the treatment of larger vertebral osteolyses, especially with spinal or foraminal involvement.

**MATERIALS & METHODS**
Thirty-four vertebrae in 15 patients with malignant neoplastic osteolyses including posterior wall, foraminal or endplate defects were treated. All patients underwent spine CT and chest X-ray pre and postprocedure. Technical success was assessed posttreatment with respect to cement deposition. Six-month clinical (VAS, ODI) and radiologic follow up was performed.

**RESULTS**
CT evaluation confirmed optimal cement filling in 30 of 34 vertebra. Clinically no symptomatic foraminal or spinal cement extravasations were observed. Pain and disability scores (VAS, ODI) improved posttreatment and were maintained 6-month postop in all patients. Careful radiographic examination confirmed no pulmonary cement embolism postop.

**CONCLUSION**
Radiofrequency kyphoplasty facilitates controlled vertebral augmentation in malignant vertebral osteolyses including high risk lesions with foraminal or posterior wall defect.

**KEY WORDS:** Radiofrequency kyphoplasty, kyphoplasty, oncology

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**Paper 458 Starting at 11:41 AM, Ending at 11:49 AM**

**Maintenance of Vertebral Body and Spinal Canal after Percutaneous Vertebroplasty**

Hiwatashi, A. · Yoshiura, T. · Yamashita, K. · Kamano, H. · Dashjamts, T. · Honda, H.
Kyushu University
Fukuoka, JAPAN

**PURPOSE**
The purpose of this prospective study was to evaluate the maintenance of the spinal canal and the restoration of vertebral height and wedge angle after percutaneous vertebroplasty.
**PURPOSE**

Fluoroscopic-guided CT myelography and blood patching can be performed in a single modality procedure which allows for immediate scanning and diagnosis of spinal cerebrospinal fluid leaks. This approach facilitates immediate treatment of the leaks with CT fluoroscopic-guided targeted bloodpatching. **KEY WORDS:** Cerebrospinal fluid leaks, intracranial hypotension, bloodpatching

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**Paper 459 Starting at 11:49 AM, Ending at 11:57 AM**  
**Expedited Technique for Fluoroscopically-Guided CT Myelography and Blood Patching in the Setting of Spinal Cerebrospinal Fluid Leaks**

Gray, L. · Kranz, P.  
Duke University  
Durham, NC

**PURPOSE**  
We describe an expedited technique whereby the thecal sac access, and cervical, thoracic, and lumbar myelography are performed without tilt table capabilities using fluoroscopic-guided CT. This allows for rapid imaging of the thecal sac and improved detection of CSF leaks in the setting of low cerebrospinal fluid pressure syndromes. We emphasize the importance of routine immediate scanning during the myelographic portion of the procedure, a technique facilitated by this single modality approach. Targeted bloodpatching at potential or observed sites of leak was performed immediately.

**MATERIALS & METHODS**  
One hundred and two patients were referred to our institution for suspected spinal cerebrospinal fluid leaks and underwent fluoroscopic-guided CT myelography. After obtaining consent, CT fluoroscopic-guided lumbar puncture was performed, and opening pressure obtained. Assisted pelvic lift on the gantry obviated the need for a tilttable procedure table. Contrast flow was monitored with CT fluoroscopy. Once contrast had opacified the cervical subarachnoid space, immediate CT myelographic images were obtained, which then were evaluated for sites of potential leaks. CT fluoroscopy-guided blood patches were performed for immediate treatment. Myelographic findings from these patients were evaluated retrospectively to determine the utility of routine use of immediate scanning.

**RESULTS**  
A total of 102 patients were evaluated who were referred for suspected spinal fluid leak between 2005 and 2009 underwent fluoroscopic-guided CT myelography and blood patching. Our single modality procedure allowed for both diagnosis and therapy, without requiring utilization of both fluoroscopy and CT suites. Immediate scanning technique provided additional diagnostic information that guided therapy in these patients.

**CONCLUSION**  
Fluoroscopic-guided CT myelography and blood patching can be performed in a single modality procedure which allows for immediate scanning and diagnosis of spinal cerebrospinal fluid leaks. This approach facilitates immediate treatment of the leaks with CT fluoroscopic-guided targeted bloodpatching.

**KEY WORDS:** Cerebrospinal fluid leaks, intracranial hypotension, bloodpatching

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**Paper 460 Starting at 11:57 AM, Ending at 12:05 PM**  
**Operator Doses in Interventional Spine Procedures Performed with CT**

Zapton, D. T. · Huda, W. · Tipnis, S. · Mah, E. · Cianfoni, A.  
Medical University of South Carolina  
Charleston, SC

**PURPOSE**  
To quantify operator doses in interventional spine procedures performed with CT, and relate these to the radiation used to perform the CT examination (Dose Length Product).

**MATERIALS & METHODS**  
Various percutaneous interventional spine procedures were performed under CT guidance using intermittent repeated low dose acquisitions to view needle advancement. The radiologist performing these procedures wore a personal dosimeter above the lead apron to record the incident air kerma (μGy) for the total procedure, as well as the total time during which a significant exposure was present. The operator remained in the CT room during image acquisition. The amount of radiation used to perform the CT imaging was quantified by the dose length product (mGy-cm), as determined in a 32 cm diameter acrylic dosimetry phantom. Data on operator and CT DLP doses were obtained for 10 consecutive patients undergoing CT-guided spine procedures on a GE Lightspeed 16 CT scanner.

**RESULTS**  
The average number of CT imaging sequences was 7 ± 1, with an average cumulative patient DLP value of 39 ± 10 mGy-cm. The average air kerma incident on the operator ranged from ~ 0.5 μGy/procedure to a high of ~ 7 μGy/procedure, with an overall average of 3 μGy. These dosimetry...
data indicate that the operator dose can be estimated from the Dose Length Product used to perform CT-guided spine procedures using a conversion factor of $\sim 0.1 \mu\text{Gy per mGy-cm}$. Assuming 1,000 procedures per annum (i.e., 4 per day), the air kerma incident on the operator is estimated at $\sim 3 \mu\text{Gy}$. Operators performing CT-guided interventional spine procedures are likely to receive annual effective doses $< 1 \text{ mSv}$, which may be compared with the current U.S. regulatory dose limit for radiation workers of 50 mSv.

**CONCLUSION**

Operators wearing lead aprons to stay below regulatory dose limits, and effective doses estimates need to take into account attenuation by lead aprons.

**KEY WORDS:** Spine interventions, radiation, fluoroscopy

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**Paper 461 Starting at 12:05 PM, Ending at 12:13 PM**

**Radiation Exposure Doses to the Operator during Fluoroscopy-Guided Interventional Spine Procedures**

Cianfoni, A. · Zapton, D. T. · Tipnis, S. · Mah, E. · Huda, W.

Medical University South Carolina

Charleson, SC

**PURPOSE**

To quantify radiation exposure doses to the operator during fluoroscopy-guided interventional spine procedures.

**MATERIALS & METHODS**

A wide variety of 47 consecutive fluoroscopy-guided interventional spine procedures were performed on a single plane C-arm mounted system from August 2009 to October 2009. The interventional radiologist performing these procedures wore a personal electronic dosimeter above the lead apron on the chest, to record the cumulative incident air kerma (\(\mu\text{Gy}\)) for each procedure. The personal dosimeter also provided the total time (minutes) the dosimeter was registering any measurable radiation exposure. Total fluoroscopy time for each patient was obtained from the operators console at the end of each procedure. Dosimetry and exposure duration data were obtained and recorded at the end of each procedure.

**RESULTS**

The median operator air kerma was 7.5 microGy per procedure, with the 10th and 90th percentile values of 0.6 microGy and 51.1 microGy, respectively. The median fluoroscopy time per procedure was 3.5 minutes, with the 10th and 90th percentile value 0.6 and 18.3 minutes, respectively. Operator dose correlated well with exposure time ($\sim 3$ microGy per minute) with a correlation coefficient (r) of 0.73. Exposure time recorded by the personal dosimeter showed an excellent correlation with fluoroscopy time ($r = 0.91$), and indicated that the operator was significantly exposed only during $\sim 1/3$rd of the active fluoroscopy time. Assuming 1,000 procedures per annum (i.e., four per day), the total radiation intensity incident on the radiologists was estimated at $\sim 15 \mu\text{Gy}$. For a lead apron transmission factor of 10%, the estimated annual effective operator dose is therefore $\sim 1.5 \text{ mSv}$.

**CONCLUSION**

Operator doses for fluoroscopy-guided procedures can result in air kerma rates comparable to US regulatory dose limits (i.e., 50 mSv per annum). It is essential that operators wear lead aprons to stay below regulatory dose limits, and effective doses estimates need to take into account attenuation by lead aprons.

**KEY WORDS:** Spine interventions, radiation, fluoroscopy

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**Paper 462 Starting at 12:13 PM, Ending at 12:21 PM**

**Bone Healing Using a Bi-Phasic Ceramic Bone Substitute Demonstrated in Human Vertebral Compression Fractures**

Hatten, H. · Voor, M. J.

1Indian River Radiology, Vero Beach, FL, 2University of Louisville Health Sciences Center, Louisville, KY

**PURPOSE**

Vertebral compression fractures are the cause of severe morbidity leaving patients with incapacitating back pain for months (1). Pain improvement with vertebroplasty using PMMA is seen in greater than 90% of patients (2). PMMA polymerizes through an exothermic process which may exceed $100^\circ \text{C}$, potentially causing thermal necrosis and a fibrous tissue layer (3). PMMA results in a permanent barrier which does not allow for the fusion of the fractured bone interfaces via bone healing. Current thinking is that pain relief is due to elimination of micro-motion and not necessarily due to thermal effects (4). Therefore a nonexothermic material that promotes bone healing while eliminating micromotion is desirable. Our objective was to investigate a novel injectable biphasic ceramic cement (Cerament™, BoneSupport AB, Lund, Sweden) and to demonstrate and compare the time course of healing of vertebral compression fractures in humans with cancellous bone defects in rabbits using radiographic and histologic analyses.

**MATERIALS & METHODS**

Cerament comprises a powder of 60% calcium sulfate and 40% sintered hydroxyapatite, mixed with iohexol for radiopacity. The flowable paste hardens isothermally and reinforces compromised bone while allowing the host's own bone to grow in to replace the implanted material. Twenty patients with vertebral compression fractures (ranging from T6 to L5) were treated by percutaneous transpedicular injection of the fracture site. They were evaluated with X-rays, CT scans and VAS (0-10 scale). Six-month-old female New Zealand white rabbits had bilateral distal femoral cancellous defects (drill-hole 8 x 5 mm diameter) left Empty or filled with Cerament. Rabbits had in vivo \(\mu\text{CT}\) scans (voxel resolution of 28 \(\mu\text{m}\)) of each femur at 3, 7, and 12 weeks to observe volumetric defect occupancy with mineralized material and were sacrificed after 12 weeks. Histologic analyses were performed on decalcified samples to quantify the bone tissue in the defect.

**RESULTS**

Radiographic follow-up of patients showed fracture healing (disappearance of the fracture surfaces) with time as well as incorporation of Cerament. Pain relief was achieved in 90% of the patients treated. Average VAS improved from 8.4 preop to 1.9 at 1 week and 1.4 after 6 months. No adjacent level fractures have been experienced. The rabbit \(\mu\text{CT}\) analysis showed significantly more mineralized material in the filled defect compared to the empty defects at each time.
point \((p < 0.05)\). Decalcified histology healing and the amount of new bone formation were significantly greater in the Cerament group compared to Empty \((p < 0.05)\).

**CONCLUSION**

The rabbit \(\mu\)CT and histologic results quantified the cancellous bone healing response with and demonstrated replacement of Cerament with active new bone formation. Rabbit \(\mu\)CT data at 12 weeks and human CT data at 6 and 12 months are comparable. The favorable histologic progression in the rabbit helps to explain the successful bone healing process in human vertebroplasty using the novel biphasic ceramic material.

**REFERENCES**


**KEY WORDS:** Vertebroplasty

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**Paper 463 Starting at 12:21 PM, Ending at 12:29 PM**

Local Anesthesia with Bupivacaine and Lidocaine for Vertebral Fracture Trial (LABEL): Preliminary Results

Brinjikji, W. · Gray, L. · Kallmes, D. F.

Mayo Clinic

Rochester, MN

**PURPOSE**

The INvestigational Vertebroplasty Efficacy and Safety Trial (INVEST) demonstrated that blinded patients undergoing simulated vertebroplasty, with administration of local anesthesia over the affected fracture, achieved similar benefit as compared to patients undergoing full vertebroplasty. The purpose of the current study was to determine if an unblinded treatment with local anesthesia would yield similar benefit as compared to blinded, control patient in INVEST.

**MATERIALS & METHODS**

Following IRB approval, 16 patients were enrolled in this unblinded, prospective, optional-crossover study. Patients presenting to a vertebroplasty clinic underwent injection of subcutaneous lidocaine and periosteal bupivacaine, similar to that infused during vertebroplasty. They were told that they could elect to crossover to a full vertebroplasty at any time, as early as 1 day post-enrollment. Baseline Roland Modified Disability Questionnaire Score (RDQ), and average pain over 24 hours were obtained. These scores also were collected at days 1, 3, 7 and 14 following the procedure. Data on RDQ scores and 24 hour pain average were compared to INVEST data at baseline and days 1, 3 and 14. Statistical analysis was performed by T-test.

**RESULTS**

Of the 16 patients enrolled, three (19%) patients found that local anesthesia produced sufficient pain relief and did not pursue vertebroplasty (mean follow up = 1.3 months). Thirteen (81%) patients chose to cross over to vertebroplasty after a mean of 4.9 days. The average baseline RDQ score was 17.9 (4.3); averages RDQ scores were 17.3 (4.6) at day 1 and 17.7 (5.6) at day 3 \((P = .71\) and \(P = .92\) at days 1 and 3 respectively). Baseline 24-hour pain average score was 6.2 (2.6) and the scores were 5.4 (2.1) at day 1 and 5.4 (2.5) at day 3 \((P = .37\) and \(P = .45\) at days 1 and 3 respectively.) When comparing RDQ scores to data from the blinded, control cohort in INVEST \((n = 63)\), we found that patients in INVEST had similar baseline pain \((7.2 \pm 1.8, P = .08)\) and RDQ scores \((17.5 \pm 4.1, P = .73)\). Average pain for INVEST patients at day 3 was 4.1 \pm 2.6 \((P = .09\) when compared to LABEL patients). Average RDQ score at day 3 was 12.5 \pm 5.5 \((P = .007\) when compared to LABEL patients). As previously published, one (3%) of 63 INVEST control patients crossed over within 1 month after randomization. Further data are provided in Table 1.

Average 24-Hour Pain and RDQ Scores at Baseline and Follow-up: INVEST vs. LABEL

<table>
<thead>
<tr>
<th></th>
<th>INVEST RDQ</th>
<th>LABEL RDQ</th>
<th>INVEST 24 Hour Pain Score (SD)</th>
<th>LABEL 24 Hour Pain Score (SD)</th>
<th>INVEST 24 Hour Pain Score (SD)</th>
<th>LABEL 24 Hour Pain Score (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline</td>
<td>17.9 (4.3)</td>
<td>17.5 (4.1)</td>
<td>0.73</td>
<td>6.2 (2.6)</td>
<td>7.2 (1.8)</td>
<td>0.08</td>
</tr>
<tr>
<td>Day 1</td>
<td>17.3 (4.6)</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>5.4 (2.1)</td>
<td>4.1 (2.6)</td>
</tr>
<tr>
<td>Day 3</td>
<td>17.7 (5.6)</td>
<td>12.5 (5.5)</td>
<td>0.007</td>
<td>5.4 (2.5)</td>
<td>3.8 (2.8)</td>
<td>0.093</td>
</tr>
<tr>
<td>Day 7</td>
<td>13.4 (4.0)</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>4.2 (3.1)</td>
<td>N/A</td>
</tr>
<tr>
<td>Day 14</td>
<td>15.5 (3.0)</td>
<td>12.3 (5.9)</td>
<td>0.29</td>
<td>4.5 (2.4)</td>
<td>4.5 (2.8)</td>
<td>1.00</td>
</tr>
</tbody>
</table>

**CONCLUSION**

A majority of patients who received an unblinded injection of local anesthesia went on to receive vertebroplasty. In the current study patients who received bupivacaine did not demonstrate any significant improvement in pain or function as compared to baseline. In addition, at day 3, patients in LABEL had significantly worse back-pain related function at 3 days than INVEST patients. These findings suggest that factors other than local anesthesia were responsible for the observed improvement in the control group in INVEST.

**KEY WORDS:** Vertebroplasty, osteoporotic compression fractures, local anesthesia

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**Paper 463a Starting at 12:29 pm, Ending at 12:37 pm**

Imaging the Temporal Mandibular Joint - ENRS

Pramanik, B. K.

NYU Langone Medical Center

New York, NY

The temporomandibular joint (TMJ) is a diarthodial joint (having both rotational and translational movement) between the mandibular condyle and the glenoid fossa of the temporal bone. It is divided by a fibrocartilaginous disc or meniscus into a superior and inferior compartment which usually do not communicate. The disc has a biconcave shape and is composed of a triangular anterior band and a larger posterior band which are connected by a thin intermediate zone. The posterior band is attached to the posterior joint by the bilaminar zone which is surrounded by the retrodiscal soft tissue. When the mandible is in the closed-mouth position, the disk is located between the anterosuperior aspect of the condyle and the posterior aspect of the articular eminence with the posterior band of the disk at roughly the 12 o’clock position of a clock. Temporomandibular disorder (TMD) is a recent general term used to describe myofascial pain and TMJ dysfunction. The etiology of TMD’s remains controversial and many factors have been implicated among them trauma, bruxism, malocclusion and stress. The most frequent cause of TMJ dysfunction is internal derangement.

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**Paper 464 Starting at 12:45 pm, Ending at 1:15 pm**

Rochester, MN

Mayo Clinic

**PURPOSE**

The purpose of this clinical trial was to determine if there was a significant difference in the outcome of TMJ patients that were treated with cerametallic Cerametallic. The hypothesis was that the Cerametallic group would have better results than the control group.

**MATERIALS & METHODS**

All patients were enrolled in the study. They were divided into two groups: Cerametallic and control. The Cerametallic group received Cerametallic, while the control group received standard treatment. The patients were followed over a period of 12 months. Statistical analysis was performed using the chi-square test.

**RESULTS**

The results showed a significant difference in the outcome of TMJ patients between the two groups. The Cerametallic group had a lower percentage of failure compared to the control group. The difference was statistically significant at the 0.05 level.

**CONCLUSION**

The Cerametallic group had a lower percentage of failure compared to the control group. The difference was statistically significant at the 0.05 level. The study supports the use of Cerametallic for the treatment of TMJ disorders.
which is defined as an abnormal relationship of the disc to the condyle. Signs and symptoms of TMJ dysfunction are common and according to some studies affect up to a quarter of the general population. Symptoms include pain, clicking of the joint and limitation of movement. TMJ dysfunction may be either a progressive disorder or one that resolves. In fact, nearly 80% of cases resolve spontaneously. Treatment initially is conservative with the goal of improving function and reducing pain. Nonsurgical treatments include pharmacological therapy (nonsteroidal anti-inflammatory drugs and muscle relaxants), moist heat, physical therapy, a soft mechanical diet, and stretching. Patients that are refractory to medical management may undergo surgical therapy including arthrocentesis and lavage, arthroscopy, condylotomy and open joint surgery. TMJ abnormalities cannot be reliably assessed by clinical examination. Indications for imaging include failure of conservative therapy, progression of symptoms or atypical symptoms and preoperative assessment. Conventional radiography and plain tomography have no role in the assessment of internal derangement. Computed tomography is useful for trauma and identification of osseous abnormalities such as bony ankylosis or the post operative joint. Magnetic resonance imaging (MRI) has become the mainstay in the assessment of internal derangement of osseous abnormalities such as bony ankylosis or the post operative joint. Magnetic resonance imaging (MRI) has become the mainstay in the assessment of internal derangement as it allows direct visualization of the TMJ and disc allowing for assessment of disc morphology, position and function. In addition, MRI can assess for joint effusion, bone marrow edema, and signal abnormalities within the retrodiscal tissue.

**Eastern Neuroradiology Society (ENRS) Award Winning Paper**

### Thursday Afternoon

**1:30 PM – 3:00 PM**

**Ballroom ABC**

**See also Parallel Sessions**

(49a) Adult Brain: Functional Imaging
(Scientific Papers 464 - 474)

(49b) Interventional: Arteriovenous Malformations/Fistulae

(49c) Spine: Other

(49d) Adult Brain: Anatomy of Brain and Other

(49e) Excerpta Extraordinaire: Interventional and Spine

**Moderators:** Andrei I. Holodny, MD
Joseph A. Maldjian, MD

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**Paper 464 Starting at 1:30 PM, Ending at 1:38 PM**

Inter-Subject Spatial Normalization of Diffusion Tensor Imaging Data in the Presence of Image Artifacts

Orlichenko, A. · Dawe, R. J. · Peng, H. · Arfanakis, K.

1. Illinois Institute of Technology, Chicago, IL, 2. Washington University in St. Louis, St. Louis, MO

**Purpose**

Diffusion tensor imaging (DTI) is a noninvasive MR imaging technique that can be used to probe the local microstructure of tissue (1). Accurate normalization of DTI data is crucial for voxel-based comparison of white matter integrity (2) and brain connectivity (3) across populations. This work seeks to assess the effects of image artifacts on the accuracy of spatial normalization of DTI data.

**Materials & Methods**

Ten normal subjects (30 ± 5 years of age, 20 - 40 years of age, 8 male, 2 female) participated in this study. Diffusion tensor imaging data with minimal image artifacts were obtained with Turboprop-DTI, while data with visible image artifacts were obtained with SE-EPI-DTI. All scans were conducted on a 3 T GE scanner (General Electric, Waukesha, WI). The SNR for SE-EPI-DTI and Turboprop-DTI was matched. Field maps were processed to correct for most of the effects of field inhomogeneities on the SE-EPI-DTI data. Diffusion-weighted data from the Turboprop-DTI and SE-EPI-DTI acquisitions were processed initially to remove skull and noise outside the brain. Diffusion tensors then were estimated for both groups of data. A group-based approach (4) was used to normalize each subject’s DTI data to the corresponding average space of the group. Individual registrations were performed by a piecewise-affine registration algorithm with millions of degrees of freedom and explicit optimization of tensor orientation (DTI-TK, University of Pennsylvania, PA) (5). The accuracy of spatial normalization for the two groups of data was assessed by means of the coherence of primary eigenvectors in white matter (6).

**Results**

In general, coherence was found to increase significantly in white matter for data with minimal artifacts compared to data with visible artifacts. For example, in the genu of the corpus callosum (min artifacts: 0.922 ± 0.019, visible artifacts: 0.903 ± 0.016, p < 3 x 10^-7), in the splenium (min artifacts: 0.944 ± 0.011, visible artifacts: 0.929 ± 0.007, p < 10^-20), and in the internal capsule (min artifacts: 0.936 ± 0.016, visible artifacts: 0.926 ± 0.013, p < 0.002). Two-tailed t-tests were used to assess the significance of any differences.

**Conclusion**

Since higher coherence values suggest improved matching of the primary eigenvector of diffusion tensors across subjects, it was concluded that data with minimal artifacts increase the accuracy of spatial normalization of DTI data. It should be noted that the amount of artifacts in SE-EPI-DTI data varies for different subjects, and different imaging parameters (e.g., slice thickness, TE, acceleration factor, etc.). However, the purpose of this work was not to compare the two acquisition schemes and imaging parameters, but to assess the effect of artifacts on spatial normalization. Data with more severe artifacts can be expected to further reduce the accuracy of spatial normalization, while data with less...
severe artifacts will give coherence values closer to those obtained from Turboprop-DTI.

REFERENCES

KEY WORDS: Artifacts, spatial normalization, DTI

Paper 465 Starting at 1:38 PM, Ending at 1:46 PM
Microstructural Correlations of White Matter Tracts in the Human Brain

Wahl, M. · Li, Y. · Ng, J. · LaHue, S. C. · Cooper, S. R. · Sherr, E. H. · Mukherjee, P.
University of California San Francisco
San Francisco, CA

PURPOSE
The purpose of this diffusion tensor imaging (DTI) study is to investigate patterns of correlation in tract-based fractional anisotropy (FA) measurements across white matter pathways in the normal adult human brain.

MATERIALS & METHODS
3 T DTI was acquired from 44 healthy adults (24 men, mean age 30.8 ± 7.8 years) with 1.8-mm isotropic voxels and 55 diffusion directions at \( b =1000 \, \text{s/mm}^2 \). Tractography-based FA measurements were performed in the dorsal cingulum bundles (CB), arcuate fasciculi (AF), inferior fronto-occipital fasciculi (IFO), inferior longitudinal fasciculi (ILF), uncinate fasciculi (UF), and corticospinal tracts (CST) bilaterally (1). A matrix of the Spearman rank coefficient \( \rho \) was generated by pairwise correlation of the 44 FA values in each of the 12 tracts with those in each of the 11 other tracts. The FA correlation matrix was tested for significant correlations and for significant variations in correlation strengths (2). Specific patterns of inter-tract FA correlation were investigated using hierarchical clustering, with multiscale bootstrapping to assess the statistical significance of the tract groupings (3).

RESULTS
The FA correlation matrix showed significant correlations (\( p < 0.0001 \)) and significant variations in correlation strengths (\( p < 0.0001 \)). Fractional anisotropy correlations varied widely between homologous tracts, from low values of 0.50 for the AF and 0.57 for the CB to a high of 0.88 for the IFO. Surprisingly, \( \rho \) between certain nonhomologous tracts exceeded that between some homologous tracts, e.g., left ILF - right IFO (\( \rho = 0.73 \)). Hierarchical clustering of FA correlational distances displayed as a dendrogram (Figure) shows that the 2 projection pathways (left and right CST) were the most distant outgroup compared to the 10 association pathways at a 99% confidence level. Also, the two limbic pathways (left and right CB) clustered separately from the eight neocortical pathways (bilateral AF, IFO, ILF, & UF) at an 85% confidence level.

CONCLUSION
Significant variations of intertract FA correlations exist in the normal adult brain and may reflect phylogenetic and functional similarities between fiber pathways. Tracts with the greatest known hemispheric asymmetry, such as AF and CB, had the weakest left-right correlation. Certain pairs of nonhomologous tracts were coupled more strongly than some pairs of homologous tracts. Projection tracts correlated weakly with association tracts and, among association tracts, limbic tracts correlated weakly with neocortical tracts. Greater knowledge of the microstructural relationships between white matter pathways might provide a revealing new perspective with which to investigate neurologic disorders.

REFERENCES

KEY WORDS: DTI, white matter, diffusion

Paper 466 Starting at 1:46 PM, Ending at 1:54 PM
A Novel Variational Bayesian Method for Spatiotemporal Decomposition of Resting-State fMRI

Li, Y. · Nagarajan, S. · Attias, H. · Mukherjee, P.
1University of California San Francisco, San Francisco, CA,
2Golden Metallic Inc., San Francisco, CA

PURPOSE
We apply a novel variational Bayesian factor partition (VBFP) to resting-state fMRI data and compare it with the standard independent component analysis (ICA) algorithm (1). It is shown that VBFP identifies similar functionally coherent brain networks and their temporal fluctuations as ICA does. The potential advantages of VBFP are the inference of noise model and robustness on small sample size.

MATERIALS & METHODS
Image acquisition: Ten healthy subjects were studied on 3T EXCITE MR scanners (GE Healthcare, Waukesha, WI) using an 8-channel head coil. BOLD fMRI images of the supratentorial brain were obtained using a 2D multislice gra-
dient-echo planar acquisition with FOV 22 x 22 cm, 64 x 64 matrix, ASSET factor 2, 4 mm interleaved slices with no gaps, and TR of 2 sec and TE of 28 sec. Two hundred (T = 200) brain volumes are collected over a period of 7 minutes with the subject’s eyes closed to minimize exogenous visual activation. Preprocessing: (a) Motion correction (b) In-brain voxel extraction (c) Spatial smoothing (d) Temporal filtering. Data analysis: ICA and VBFP are applied to the fMRI data to achieve a spatiotemporal decomposition as Y = AX where Y is the TxN spatiotemporal fMRI data matrix with N in-brain voxels in each row and T time points, X is the set of decomposed spatial activation maps, A is the time course matrix containing the temporal fluctuations of the sources in X. The spatial sources are normalized to unit variance and threshold at 1.5 standard deviation with the suprathresholded voxels displayed on the brain anatomy.

RESULTS
Figures 1a and 1b each show a pair of activation maps and their time courses estimated by ICA (top panel in 1a and 1b) and VBFP (bottom panel). It can be observed that: in (a), the strongest regions of functional connectivity are in the bilateral posterior cingulate gyri, part of the brain default mode network; in (b), VBFP better shows anticorrelated networks than ICA, specifically, a bilateral perirolandic somato-motor network (blue regions are negatively correlated with the time course) vs a bilateral occipital network (red regions are positively correlated with the time course).

CONCLUSION
In this work, VBFP is applied to achieve a sparse spatiotemporal decomposition of resting state fMRI data and incorporates automatic relevance determination in a fully Bayesian inference framework. Hence, the VBFP method provides a general framework for the data-driven analysis of functional imaging data such as fMRI and MEG.

REFERENCES

KEY WORDS: Resting state, Functional connectivity, Bayesian inference

Paper 467 Starting at 1:54 PM, Ending at 2:02 PM
Diffusion Tensor Imaging as a Clinical Trial Outcome Metric: Sample Size Estimates
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PURPOSE
Conventional MR imaging methods detect areas of brain tissue damage, but do not provide a good measure of the degree of injury. Advanced MR imaging modalities such as diffusion imaging might provide finer measures of brain tissue injury to evaluate efficacy of putative neuroprotective therapies (1, 2). In order to be feasible for clinical studies, advanced MR imaging techniques must be useful with an acceptable sample size.

MATERIALS & METHODS
A longitudinal multiple sclerosis (MS) patient population was used to estimate the sample size needed to evaluate a potential neuroprotective therapy. Twenty-one MS patients were imaged at baseline, 0.5, 1, 2, 6 and 12 months, and data were gathered from 20 normal-appearing brain regions of interest drawn and coregistered longitudinally with AFNI (3) and FSL (4). We performed sample size calculations for hypothetical neuroprotective therapies assumed to slow worsening of diffusion tensor imaging (DTI) measures by 30% and 50% relative to those observed in our patient sample, and for varying numbers of scans over the time period. F tests with multivariate analysis of variance for repeated measures with a correlation over repeated measurements of 0.85 were used to estimate the sample size.

RESULTS
For fractional anisotropy (FA), alpha = 0.05, five scans and a slowing of 50% in FA decline, 29 subjects per group are needed for 80% power, and 36 subjects per group for 90% power. With 30% slowing in FA decline, 74 subjects per group are needed for 80% power and 94 for 90% power. For each of the above scenarios but using only three scans, the number of subjects per group needed to detect a slowing of FA decline by 50% is similar, with 29 subjects needed for 80% power and 37 for 90% power. For two scans, a 50% change is detectable with 80% power in 34 subjects, and with 90% power in 44 subjects, while a 30% change required 78 subjects per group for 80% power. Power analyses for additional DTI measures, different scanning intervals and projected treatment effects will be presented.

CONCLUSION
Based on our longitudinal dataset and hypothesized treatment effects, we show feasible sample size estimates for using DTI in clinical trials for neuroprotective agents. Only modest increase in sample size requirements was found for three scans vs five scans.

REFERENCES
Reproducible Fast MR Activation Maps during Interictal Epileptiform Spikes

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PURPOSE
We recently have described a new functional imaging method, encephalographic functional MR imaging (efMRI), designed to track and correlate fast MR signal changes with scalp electroencephalography (EEG), using concurrently acquired EEG and rapid gradient-echo echo planar MRI. For this study, we acquired multislice volumes, at the expense of slower sampling rate, in order to study the contiguity of responses in adjacent cortical regions, as well as the reproducibility of efMRI activation patterns in focal epilepsy patients.

MATERIALS & METHODS
All subjects signed informed consent approved by our Institutional Review Board. We imaged 10 patients (4 male, 6 female; 20-57 years old) with medically-refractory focal epilepsy with varying locations (predominantly temporal and frontal lobes). Subjects were instructed to relax and lie still during the scan. We originally acquired concurrent efMRI and EEG with the following MR scan parameters, on a 3 T GE Signa scanner: repetition time (TR) 47 ms, echo time (TE) 22 ms, flip angle 20°, field of view 28 cm, 64 X 64 image matrix, slice thickness 5 mm. For this study, in four epilepsy subjects, we acquired 3-slice and 5-slice interleaved volumes (time series of 341 and 204 samples respectively, interslice gap 0.5 mm) resulting in effective TRs of 141 ms and 235 ms respectively. The 32-channel MR-compatible EEG was acquired inside the scanner continuously at 5000 Hz and underwent software-based gradient and cardioballistogram artifact removal. A TTL pulse from the scanner was delivered to the EEG amplifier at each TR. The mean efMRI scan time per subject was 28.9 minutes. Two epileptologists blinded to the MRI images reviewed each subject’s EEG and identified focal interictal epileptiform spikes.

RESULTS
The volume efMRI scans showed large amplitude, fast magnitude and phase changes temporally coupled to the EEG interictal spike. There was spatial continuity in the magnitude and phase responses between adjacent slices. For nine of the 10 patients, we observed diffuse regions of activation consistent with multiple foci. In one patient with pure left temporal lobe epilepsy who had left mesial temporal sclerosis on MRI, focal hypometabolism on an interictal brain PET/CT, and later confirmed to have hippocampal sclerosis on pathologic specimen postoperatively, we observed a consistent focal MR magnitude signal increase concurrent with the EEG spike in the left temporal area prior to her epilepsy surgery. Repeated imaging during different EEG spikes in this patient consistently demonstrated fast activity in the same cortical area. This was consistent with the focal nature of the patient’s epilepsy.

CONCLUSION
In this study, we demonstrate reproducible, fast, focal MR signal changes showing spatial contiguity between slices, concurrent with EEG interictal spike in patients with focal epilepsy. While our initial findings are promising, the clinical utility of our technique for presurgical seizure focus localization will require confirmation in a larger cohort of patients, as well as comparison with invasive cortical recordings.

KEY WORDS: Intercital spikes, echo planar imaging, MR imaging

Nicotine Suppresses the Default Mode Network in Resting States

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PURPOSE
The default mode network (DMN) is a robust neuronal network of synchronous low frequency fluctuations in resting brain and is thought to be involved in a wide range of functions including self-referential thought, internal awareness and emotional processing. The default mode is suppressed or “deactivated” when the brain is engaged in goal-directed tasks proportionally to the attentional demands of the task. Nicotine increases attentional vigilance and information processing. Enhanced visuospatial attention by nicotinic agonists is associated with suppression of DMN and increased extrastriate cortex activity. It is unknown, however, if nicotine’s effects are observed only during attentionally demanding tasks or whether nicotine might directly suppress DMN and increase extrastriate activity in the absence of a task. We investigated the effect of nicotine on resting state to test two hypotheses: 1) Compared to placebo, nicotine would suppress DMN in the absence of a goal-directed task. 2) Compared to placebo, nicotine would increase activity in visual association cortex in the absence of visual stimulation.

MATERIALS & METHODS
Single-blind, cross-over study of 19 subjects had fMRI resting-state scans following placement of either a 7 mg nicotine or placebo patch. Subjects were instructed to rest quietly with eyes closed. Group independent component analysis was performed using GIFT software (http://icatb.sourceforge.net). For each drug condition the default mode component was identified by spatial correlation with the GIFT DMN mask. Differences in DMN were evaluated with a paired t-test, threshold p < .05, family-wise error corrected. Differences in DMN were evaluated with a paired t-test, threshold p < .05, family-wise error corrected. To determine whether nicotine-enhanced activity in extras-
MEG, as a part of their clinical presurgical assessment.

19.7 years) underwent functional motor mapping with patients [59 females, 63 males, age range: 6-65 years (mean: 26.8 years)] for the treatment of patients refractory to medication. A reliable, efficient method for localizing motor cortex preoperatively would facilitate this procedure by eliminating the need for intraoperative mapping or large craniotomy sites. The

MEG, as a part of their clinical presurgical assessment.

Results
Compared to placebo, nicotine significantly suppressed activity in brain regions corresponding to DMN (global maxima: posterior cingulate and precuneus) (Figure). No modulation of the DMN by placebo was observed. Nicotine was associated with a significant increase in extrastriate visual association cortex activity.

Conclusion
This study provides the first evidence that nicotine suppresses DMN activity in the resting state with eyes closed. Furthermore, nicotine increased extra-striate activity, consistent with previous studies using nicotinic agonists during tasks requiring attentional vigilance. Our results suggest that nicotine’s attention-enhancing effects may in part involve a shift from internal (DMN) to external processes (visuospatial attention). This is a potentially important mechanism of therapeutic cholinergic agonists in diseases where DMN dysfunction has been observed such as Alzheimer disease, schizophrenia, and attention deficit/hyperactivity disorder.

Key Words: Default mode, nicotine, resting states

Results
Localization of the PMC via ERD was graded as 1 or 2 in at least one upper extremity in 117/122 (95.9%). Localization with ERD was graded as 2 in 99/122 (81.1%). Grade 0 with ERD was most commonly due to patient motion (7), excess abnormal interictal activity (4), or artifact from metal (3). SDM was performed in 19 patients (15.6%), and was grade 1 or 2 bilaterally in seven (36.8%), and grade 1 or 2 unilaterally in seven (36.8%). Poor localization with SDM was due most commonly to patient motion (6) or artifact from metal (3).

Conclusion
In the overwhelming majority of our clinical cases, ERD analysis for motor mapping with MEG was successful and accurate. Event-related desynchronization methods localize function as a power change measured for an active time window with respect to prestimulus baseline activity. Abnormal cortical activity, or a change in cortical rhythmicity, may account for ERD failure. When ERD analysis is unsuccessful, SDM may assist in localization of the PMC, particularly in patients with large amounts of abnormal interictal activity.

References

Key Words: Magnetoencephalography, functional, motor mapping

Results
Indications included medically-refractory epilepsy (112), neoplasm (6), and vascular malformation (4). Motor mapping was performed using a 275-channel biomagnetometer, with a self-paced button press task. All subjects were monitored for task performance. Recordings were subjected to a beamforming analysis, assessing for ERD in the beta (12-30 Hz) band in a 500 ms latency window surrounding the button press (-300 ms to 200 ms), and significant pixels were highlighted in a color overlay. In the event of a failure to localize contralateral MI using beta ERD, SDM from the peak of the motor evoked field was added. Accuracy of mapping for both analysis methods was determined morphologically, and was graded on a 0-2 scale (0 = no localization or remote from the appropriate precentral gyrus, 1 = localization near the appropriate precentral gyrus, 2 = localization at the hand-knob region of the appropriate precentral gyrus).

Conclusion
Using previously conventional methods, mapping motor function with MEG has been considered “not sufficiently sensitive”, “nonspecific, and thus not clinically useful”. The purpose of the present study was to evaluate the more recently developed event-related desynchronization (ERD) differential beamformer method for mapping of the primary motor cortex (PMC) with MEG in the work up of presurgical patients.

Materials & Methods
Over a 2-year period, 122 consecutive adult and pediatric patients [59 females, 63 males, age range: 6-65 years (mean: 19.7 years)] underwent functional motor mapping with MEG, as a part of their clinical presurgical assessment.
The purpose of this study was to demonstrate the utility of transcranial magnetic stimulation (TMS) in the localization of motor cortex prior to epidural stimulator placement. Unlike other functional imaging techniques such as MEG and fMRI which require data postprocessing, TMS provides functional localization within minutes, requires no expensive equipment and is portable and so can be performed easily at the bedside.

**MATERIALS & METHODS**

Following IRB approval, TMS was performed for motor cortex localization in a group of six patients with chronic facial pain (5 females, 47-72 years). Single-pulse TMS was applied over the expected location of motor cortex using a figure-8 coil (Magstim Company). The patients were observed for a visible twitch of the orbicularis oris musculature. The coil then was adjusted until the optimal location for stimulus induction was identified (location that consistently gave maximal contraction). This location was marked with a fiducial placed on the scalp surface. The patients subsequently underwent craniotomies for placement of epidural grids (Medtronics, Specify™ Lead). Intraoperatively, the incision was made at the fiducial site and underlying bone was drilled out to a slim rectangular shape measuring 4 cm in length, just large enough to accommodate the grids. The grids were externalized. Postoperatively, all patients underwent cortical stimulation via the implanted epidural grids providing a comparison of preoperative TMS stimulation with the postoperative epidural grid stimulation. In one patient, a postoperative CT was merged onto the preoperative MRI using coregistration software (Statistical Parametric Mapping) (Figure). The epidural grids (CT bone window in red color) can be seen overlying the frontal lobe.

**RESULTS**

Transcranial magnetic stimulation successfully identified facial motor cortex: in all patients, postoperative epidural grid stimulation resulted in expected motor activation at higher intensities (confirming preoperative TMS localization) and pain relief at lower power settings (100% success rate). This rate is significantly higher than average reported trial response in the literature of 65%. To date, 78% of the sample continues to report clinically meaningful pain control.

**CONCLUSION**

Transcranial magnetic stimulation (a noninvasive, painless method for motor cortex activation) is useful in the preoperative planning of surgical procedures in which motor cortex localization is necessary.

**KEY WORDS:** TMS, functional, motor

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**Paper 472 Starting at 2:34 PM, Ending at 2:42 PM**

**First Episode Schizophrenia: What Is the Best Therapy for Cognitive Deficits? A fMRI Study**

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**PURPOSE**

To examine whether the prefrontal dysfunction, which seems to be related to the working memory deficits of schizophrenic patients, may be detected and whether changes may be shown after different therapy methods using functional magnetic resonance imaging (fMRI).

**MATERIALS & METHODS**

Nine drug-naïve schizophrenic patients and three healthy controls were tested. A 1.5 T MR scanner was used to examine the fMRI sequence during the performance of a 1-back working memory test. In schizophrenic patients the fMRI was repeated after 4 weeks of therapy with atypical antipsychotics (n = 6) or a combination of atypical antipsychotics and cognitive remediation therapy (n = 3), respectively.

**RESULTS**

We found that drug-naïve schizophrenic patients show increased brain activation in the prefrontal cortex performing the 1-back working memory test (Figure A). After 4 weeks of therapy schizophrenic patients receiving a combination of atypical antipsychotics and cognitive remediation therapy showed a greater reduction of prefrontal cortex activation (Figure B), similar to the brain activation pattern of the healthy controls, than those patients with atypical antipsychotics, only.

**CONCLUSION**

We conclude that the increased brain activation in the prefrontal cortex during the performance of the 1-back working memory test can be interpreted as a prefrontal dysfunction. The fact that additional cognitive remediation therapy leads to a greater reduction of prefrontal brain activation suggests that cognitive remediation therapy may improve prefrontal dysfunction in schizophrenic patients.

**KEY WORDS:** fMRI, functional MR imaging, schizophrenia
**Language Lateralization in Brain Tumor Patients: A Retrospective fMRI Study**

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**PURPOSE**

Language lateralization (LI) is an essential point of assessment for neurosurgical patients undergoing tumor resection in proximity to the language network. Preoperative fMRI studies of tumor patients have shown activity in both ipsilateral and contralateral homologous areas of the language network. Yet the factors leading to this bilateral activity is unclear. Multiple factors including age, gender, lesion volume, lesion distance to language areas have been linked to LI in various normal and patient populations (1-3). This study retrospectively explored the relationship of these factors to LI in brain tumor patients.

**MATERIALS & METHODS**

Subject information was drawn from a database of consented brain tumor patients who underwent preoperative functional imaging to locate their dominant language hemisphere. Sixty-four right-handed patients were analyzed, 45 male and 16 female, ranging from 3-68 years of age, with a mean and std of tumor volume of 37 cc and 42 cc respectively. Threshold of fMRI task activation was set on an individual basis to optimize visualization. Language lateralization was used as a measure of how bilateral a particular individual’s language areas were. This index was determined for Broca’s and Wernicke’s areas by measuring area of fMRI task activation in left (L) and right (R) homologous brain regions and calculated using the formula (L-R)/(L+R). Nonparametric statistical methods were employed for data analysis including Wilcoxon-Ranked sum test and Kruskal-Wallis test.

**RESULTS**

See Table 1. Highly significant relationships were found between decreasing tumor distance to a language area and decreasing LI in that language area (Broca’s area: p = 0.0006, Wernicke’s area: p = 0.0119). Moreover, there was a significant relationship between decreasing tumor distance to a language area and decreasing LI in other areas of the language network [tumor distance to Broca’s area vs Wernicke’s area LI (p = 0.020); Tumor distance to Wernicke’s area vs Broca’s area LI (p = 0.026)]. No significant relationships were found between gender, age, or tumor volume and LI in language areas.

**CONCLUSION**

Decreasing tumor distance to a language area may lead to lower LI in that area or an increase in activity in the contralateral homologous area. It also may have a network effect with less lateralization in other language areas or an increase in activity in other contralateral homologous areas of the language network. Tumor distance to language areas may dominate other putative factors linked to LI. Future studies need to address tumors disrupting neurovascular coupling, which may affect BOLD response and measured LI.

**REFERENCES**


**KEY WORDS:** fMRI, language, tumor

**Table 1 (*statistically significant*)**

<table>
<thead>
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<th>Broca</th>
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<td>Gender v. LI</td>
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<tr>
<td>Age v. LI</td>
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<td>p=0.69</td>
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<td>Tumor Volume v. LI</td>
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<td>Distance to area1 v. LI</td>
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<td>Distance to area1 v. LI</td>
<td>p=0.02</td>
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**Correlation of 3 T Diffusion Tensor Imaging Metrics with Proliferation Index and Survival Analysis in Glioblastomas**

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**PURPOSE**

Glioblastoma is the most common primary intracranial tumor; however, despite the use of aggressive combinations of surgery, radiation and chemotherapy, the prognosis of these patients remains poor. Tumor cellularity and proliferation index has been associated with patient prognosis and survival. Diffusion tensor imaging (DTI) provides quantitative information about the magnitude and directionality of water diffusion along a vector in a 3-dimensional space. Although DTI has been shown to be useful in preoperative grading and postoperative assessment of gliomas its value for predicting survival has not been discussed fully. The purpose of our retrospective study was to correlate various DTI metrics in patients with glioblastomas with the degree of tumor proliferation index determined histologically and also with patient survival analysis.

**MATERIALS & METHODS**

Thirty-four treatment-naïve patients underwent MR imaging (MRI) including DTI on a 3.0 T scanner. Diffusion tensor
imaging was performed in the axial plane with single-shot spin-echo echo planar imaging and data was processed and evaluated using DTI Studio (Version 2.5). Fractional anisotropy (FA) and apparent diffusion coefficient (ADC) values were obtained from enhancing, nonenhancing part of tumor and normal-appearing white matter. Kaplan-Meier estimates and Cox proportional hazards regression methods were used to assess the relationship of FA, ADC (×10-3 mm2/s) and MIB-1 (%) with progression free survival (PFS).

RESULTS
For FAmean, the cutpoint of 0.2 was associated with PFS (p = 0.035). Patients with FAmean ≤ 0.2 (n = 17) had a 6-month PFS rate of 48.6% compared to 73.7% for patients with FAmean > 0.2 (n = 17). For ADCmin, the cutpoint of 0.6 was associated with PFS (p = 0.106). Patients with ADCmin ≤ 0.6 (n = 8) had a 6-month PFS rate of 23% compared to 68% for patients with ADCmin > 0.6 (n = 26). For ADCmean, the cutpoint of 1.5 was associated with PFS (p = 0.074). Patients with ADCmean ≤ 1.5 (n = 25) had a 6-month PFS rate of 64.2% compared to 66.7% for patients with ADCmean > 1.5 (n = 9). For MIB-1, the cutpoint of 0.3 was associated with PFS (p = 0.011). Patients with MIB-1 ≤ 0.3 (n = 23) had a 6-month PFS rate of 72.7% compared to 28% for patients with MIB-1 > 0.3 (n = 10). Correlations between MIB-1 and ADCmin (r = -0.162, p = 0.266) and MIB-1 and FAmean (r = -0.105, p = 0.562) were not statistically significant.

CONCLUSION
Our results suggest that pretreatment tumoral ADC and FA values could be used as prognostic indicators in patients with glioblastomas. Our observation of low ADC associated with poorer survival rate is similar to what has been reported in previous studies. Patients with lower FAmean had a significantly lower PFS rate or worse outcome than those with favorable prognosis. No significant positive correlation between FAmean and MIB-1 indicates that cellularity is not the only factor that affects the directionality of water diffusion. We speculate that FA value in glioblastomas is largely affected by the lack of neuron or axon destruction rather than cellularity. In conclusion, various DTI metrics can be used as a sensitive and early indicator for PFS in patients with glioblastomas. This could be useful for treatment planning as high-grade gliomas with lower ADC and FA values can be treated more aggressively.

KEY WORDS: Diffusion tensor imaging, glioblastomas, survival analysis
ed venous system with or without a venous pocket at the site of the shunt. Type 3 is a giant fistula, fed by multiple large caliber spinal arteries, demonstrating very high flow and dysplastic veins.

Pretreatment and posttreatment ambulation and micturition symptoms were quantified using the Aminoff & Logue scale (ALS) scoring system.

RESULTS
Between 1983 and 2009, our institution diagnosed 32 patients with PMAVFs (mean age = 37 years; 13 men, 19 women). Thirty patients underwent corrective procedures, four by embolization alone, 11 by surgery alone, and 15 patients received a combination of the two. Twenty-eight patients underwent follow-up spinal angiography, with residual shunting noted in only five patients. Mean follow-up period was 54 months (range 1-228). Analysis of the ALS scores revealed that treatment of PMAVFs, independent of modality, resulted in significant improvement in ambulation, but inconsistent changes in micturition. In addition, residual fistula at the time of follow-up angiogram was associated with worsened neurologic status or lack of improvement. Outcome analysis based on fistula type showed dramatic improvement in ALS ambulation scores (62%) for type 3 fistulas, compared with type 1 and 2 (26%, 27% respectively).

CONCLUSION
We report the long-term outcome of 32 patients with PMAVF. Significant improvement in ambulation, but not micturition, was observed following treatment. Residual fistula on follow-up angiography was associated with progressive worsening or lack of improvement in neurologic function. Patients with type 3 fistulas were shown to benefit most from treatment, with marked improvement in posttreatment ambulation scores. As endovascular and surgical techniques and our understanding of this disease entity continue to evolve, further studies are warranted.

REFERENCES

KEY WORDS: Intervention, fistula, spine

Paper 476 Starting at 1:38 PM, Ending at 1:46 PM

Liquid Embolization Material Reduces the Delivered Radiation Dose: Myth or Reality?

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PURPOSE
High Z atomic number material (radio-opaque material) is susceptible to attenuate a photon beam. This is called the shielding effect. Consequently, radio-opaque embolization material may decrease the radiation dose delivered to an embolized AVM (1). This shielding effect has been invoked to explain the observation that, in some series, radiotherapy is less effective for previously embolized AVMs (2,3). To measure the radiation dose delivered at the center of an in vitro embolized AVM model, following a clinical plan of treatment (stereotactic radiotherapy) using a linear accelerator (LINAC) at 6 MV.

MATERIALS & METHODS
Two in vitro AVM models were constructed by drilling interconnected tubular perforations in commercially available plastic water phantoms (water equivalent cylindrical blocks). Those calibration phantoms were designed specifically to allow the positioning of a water equivalent detector at their center. (Gafchromic EBT film). The first model (A), measuring 2 x 2 x 4 cm, with 1 mm diameter channels was embolized with Onyx 18. The second model (B), measuring 4 x 4 x 8 cm, with 1 mm to 5 mm diameter channels was embolized using multiple embolization products in greater quantity: histoacryl and lipiodol, histoacryl and tungsten powder and Onyx 18. X-rays of the models were taken to ensure that radio-opaque embolization material filled the channels. The embolized AVM models then were irradiated with 250 cGy, using a standard 4 arc stereotactic treatment plan. The radiation dose delivered was measured with Gafchromic film and compared to the measured dose recorded on the same size nonembolized phantom. The experiment was repeated twice for each model.

RESULTS
Without embolization, the mean dose of radiation delivered to the center of phantom A was 243.7 cGy ± 5 cGy . After embolization with Onyx-18, the mean dose delivered was 246.4 cGy ± 5 cGy. For model B, embolized with various radio-opaque materials, the mean baseline radiation dose delivered was 241.5 cGy ± 5 cGy, and 257.0 cGy ± 5 cGy postembolization. Due to the measurement uncertainty, there was no definitive difference in pre and postembolization doses delivered for model A; however, a slight increase in dose was apparent in model B: embolization material increased the dose of radiation delivered at the center of model B embolized network.

CONCLUSION
Contrary to expectations, embolization material did not reduce the radiation dose delivered by a LINAC to the center of our experimental AVM models. The slight increase (5%) in dose delivered for model B may potentially be explained by scattered and reflected radiation.

REFERENCES

KEY WORDS: Arteriovenous malformation, embolization, radiotherapy
PurposE

To analyze angioarchitecture (AA) and clinical signs and symptoms associated with spinal vascular malformations; different treatment techniques and outcome.

Materials & Methods

Retrospective analysis of spinal vascular lesions diagnosed at All India Institute of Medical Sciences from 1989 to 2005. Pertinent important points evaluated: Malformation type: Spinal cord arteriovenous malformation (SCAVM); Spinal cord arteriovenous fistula (SCAFV); Spinal dural AV (SDAVF); Paraspinal/epidural malformations (EDAVM). Feeding artery, Venous drainage. SCAVs (spinal cord AV shunts) were divided into: SCAVM - Nidus type (small superficial or large intramedullary); SCAFV - micro fistulae (mAVFs) or macro fistulae (MAvFs). AA of the intradural spinal vascular lesions analyzed according to reappraised classification by Rodesch et al. AA variables were arterial stenosis, proximal/distal arterial aneurysms, arteriovenous fistulae, pial venous drainage/reflux, venous ectasia, venous stenosis/ thrombosis, pseudo aneurysms. Correlations between AA, location, age groups, hemorrhage and symptoms and signs were made. The localization of the SCAVs, type, multiplicity and potential segmental links evaluated. Records reviewed for treatment performed, extent of obliteration, posttherapy neurologic status, re-do procedures, residual lesion and neurologic status on follow up.

Results

Ninety-three patients were diagnosed (36 SDAVFs, 35 SCAVMs, 18 SCAFs 4 EDAVMs). Except for MAFVs, most lesions were seen in males. Mean age in SDAVF group was 52.16 years. No cord hemorrhage seen. Most lesions were upper lumbar (2 metachronous/synchronous) and sacral. Twenty-nine patients were treated [20 surgery (18 primary, 2 following embolization)], 11 embolizations. Adequate embolization achieved in 7/11 patients. No statistical significance between age, duration of symptoms, location and venous drainage with outcome or between surgical or embolization treatment outcome. Fifty-three SCAVs (18 SCAFs/ 35 SCAVMs). Eighty percent of the lesions were solitary, 10 multiple shunts (6 metameric/4 multimyelomeric). Fifteen (43%) SCAVM patients presented with hemorrhage (SAH / hematomyelia); 1/18 patients of SCAVFs presented with hematomyelia. The incidence of hemorrhage was 37.5% in cervical, 50% in cases of dorsolumbar SCAVMs. Correlation was seen between type of the malformation and location, p value (.028). Focal SCAVMs more common in TL region (88%), metameric in cervical region (67%), and multimyelomeric were distributed equally in cervical and TL cord. Thirty-one of 35 patients with SCAVM were treated (25 embolized, 6 surgery). Eighteen cases of SCAVFs were seen (5MAVFs/8 filar AVFs/5 m AVFs). Macro fistulae were more common in younger females (M/F 1:4). Fourteen patients received treatment [7(MAVFs 4, filar AVFs 1, mA VFs 2) embolized; 8 (MAVFs 1, filar AVFs 5, m AVFs 2) operated]. There was no statistical significance between treatment outcomes. Three quarters of EDAVMs were treated with embolization with good outcomes.

Conclusion

There was no precise correlation between the angioarchitecture of spinal vascular malformations and clinical symptoms, except for false aneurysms which relate to hematomyelia. Although, statistically insignificant, results favor surgery over embolization for filar AVFs and SDAVFs due to easy access, low cost and low complication rates. For SCAVMs /SCAVFs/EDAVMs we favour embolization. The treatment outcomes did not vary with the time of onset of symptoms, or with presence of hemorrhage indicating no need for emergent management.

Key Words: Spinal vascular malformations, embolization, hemorrhage

Paper 478 Starting at 1:54 PM, Ending at 2:02 PM

Does Early Endovascular Intervention Have a Higher Complication Rate in Ruptured Brain Arteriovenous Malformations?

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Purpose

To assess the results of early vs late endovascular treatment (EVT) of brain arteriovenous malformations (AVM).

Materials & Methods

We audited our practice from Jan 2007 and Jan 2009. There were 415 cases of suspected brain AVMs, of which 96 had a brain AVM and 43 had at least one embolization procedure. Thirty-two of 43 had a ruptured AVM. For the purpose of this study patients were divided into two groups according to the timing of treatment. Group A (22 patients) included patients who had an early EVT (< 30 days from onset of symptoms) and group B (10 patients) included patients who had a delayed EVT (> 30 days). In group A 16/22 patients underwent EVT within 1 week of symptom onset, 4/22 within 2 weeks, and 2/22 more than 3 weeks from onset of symptoms.

Results

In group A there were six microAVMs (< 1 cm AVM nidus), 11 Spetzler-Martin grade 2-3 and three grade 4-5 AVMs. The goal of EVT was curative in 12 cases, targeted embolization in eight cases and preoperative embolization in two cases. In group B there were four microAVMs and six grade 2-3 AVMs. The goal was curative in eight cases, targeted embolization in one case and preoperative embolization in one case. In group A occlusion was complete in 6/22 (immediate = 6, delayed = 6). In group B complete occlusion occurred in 4/10 cases (immediate = 2, delayed = 4). Embolization could not be performed in 1/22 in group A and 5/10 in group B. Complications occurred in five cases in group A and included thromboembolism (3 cases), guidewire dissection-perforation (1 case) and one early rebleed (1 case).
case). In group B, there were two complications (thromboembolism in 1 case and guidewire dissection-perforation in another case). All patients had at least one follow-up MR scan. Follow-up DSA was obtained in 14 patients in group A and five patients in group B.

CONCLUSION
Our results showed that early EVT does not have a significantly higher risk of complications (22% vs 20%). Interestingly, group B had a higher failure rate presumably reflecting the higher percentage of microAVM (40% vs 27%).

KEY WORDS: Brain arteriovenous malformation, interventional neuroradiology, embolization

Paper 479 Starting at 2:02 PM, Ending at 2:10 PM

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PURPOSE
For a number of years descriptions in the neuroradiologic literature of the phylogenetic basis for certain human ECA-ICA anastomoses have been limited primarily to line drawings and textual descriptions. We investigated whether CT scanning of preserved vertebrate specimens with arterially-filled barium mixture would demonstrate these anastomoses.

MATERIALS & METHODS
This investigation consisted of CT scanning of 2 rhesus monkey, 2 dog, 2 cat, 2 rabbit, 2 lamb, and 2 opossum specimens with an injected arterial system. The injections were performed into the thoracic aorta using a micropaque based gelatin compound*. Following the injection, the specimens were cooled for 24 hours to permit the gelatin to solidify. Bilateral parietal burr holes were made to expose the tissues to 10% buffered formalin. Following fixation, the contrast media remained solid and the tissues could be dissected without damaging the injected vascular tree. These specimens were preserved for 25 years in a 10 percent formalin solution, and during the last 10 years in a WardSafe solution. CT scanning was performed on the Toshiba Aquillion 64, using the following parameters: Helical Scan mode 0.5 x 64 slice; helical pitch = 41.0; pitch factor 0.641. 120 kV, 235 eff. mAs, D-FOV 240 (S), small focus with a slice thickness of 0.5 mm. The CT images were analyzed on an Apple MacBook Pro computer using the OsiriX v3.6.1 32-bit Dicom viewer.

RESULTS
Considering the fact that the vertebrate specimens had been maintained in a preservative solution for over 35 years, no CT artifacts were detected in the scanned specimens. The multiplanar scans demonstrated arteries with a visualized lumen as small as 0.5 mm in diameter. The following anastomotic relationships were identified on the scans: (1) the maxillary artery-carotid rete mirabile-ICA in the cat and lamb, (2) the internal and external rete mirabile in the cat, (3) the maxillary artery-ramus anastomoticus-ICA in the dog, (4) the network of internal and external ophthalmic arteries in the dog, (4) middle meningeal artery-anastomotic artery-external ophthalmic artery in the dog, (5) prominent supply to the eye is from the external carotid in the opossum. Because of the limitation in scanner slice thickness of 0.5 mm, smaller vessels involved in ECA-ICA anastomoses could not be visualized.

CONCLUSION
Multiplanar CT imaging of the vascular anatomy of vertebrate specimens, injected with a barium gelatin mixture, demonstrated the vascular detail of vessels larger than 0.4 mm in diameter. Previous dissections of barium gelatin injected specimens have demonstrated an extensive vascular network of arteries as small as 0.1-0.2 mm in diameter. As clinical scanners capable of smaller slice thickness become available, these specimens likely will demonstrate a more detailed view of some of the evolutionary aspects of potentially “dangerous” ECA-ICA anastomoses. This CT comparative anatomical study provides a useful visual modality that compliments the recent textual and diagrammatic literature.

REFERENCES

KEY WORDS: Vertebrates, angiography, CT

Paper 480 Starting at 2:10 PM, Ending at 2:18 PM
Long-Term Outcome after Coil Embolization of Cavernous Sinus Arteriovenous Fistulas

Bink, A. · Goller, K. · Lüchtenberg, M. · Neumann-Haefelin, T. · Düttmann, S. · Zanella, F. · Berkefeld, J. · du Mesnil de Rochemont, R.
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PURPOSE
Cranial nerve palsies are observed regularly in patients with arteriovenous fistulas of the cavernous sinus. To determine the long-term clinical outcome - with a special focus on extra-ocular muscular dysfunctions - in patients who had undergone endovascular treatment of the cavernous sinus fistula with detachable coils.

MATERIALS & METHODS
Sixteen patients were recalled for an ophthalmoneurologic control examination (mean interval of 4.4 years). The modified Rankin Scale (mRS) and the EQ-5D questionnaire were
used for the description of general outcome. Age, duration of symptoms, character of the fistula (direct or dural) and coil volume were tested to assess their relevance for persistent symptoms.

RESULTS
All patients displayed complete regression of chemosis, exophthalmus and pulsating tinnitus with no evidence of recurrences. Oculomotor disturbances persisted in nine out of 13 patients and caused permanent diplopia in seven patients. In 15 patients mRS 1 or 2 was achieved; however, seven patients reported some limitations in life quality (EQ-5D). A significant correlation was found between coil volume and persistent diplopia (p = 0.032) and persistent N. VI paresis (p = 0.037).

CONCLUSION
Coil embolization of the cavernous sinus led to durable closure of AVF and reliable regression of acute symptoms. However, long-term follow up showed a 44% rate of persist- ent cranial nerve deficits with disturbances of oculomotor and visual functions. This may be explained by the underly- ing fistula size itself and/or the space-occupying effect of the coils. As neuroophthalmologic outcome is crucial for control of therapeutic success, the patients should be examined rou- tinely by ophthalmologists.

KEY WORDS: Cavernous sinus fistula

Paper 481 Starting at 2:18 PM, Ending at 2:26 PM
Long-Term Follow Up of Intracranial Dural Arteriovenous Fistulas with Cortical Venous Drainage Treated with Onyx Embolization of a Single Pedicle

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PURPOSE
The therapeutic strategy for intracranial dural arteriovenous fistulas (DAVF) is not yet well established. We now report on the treatment of intracranial DAVFs using Onyx-18, a nonadhesive liquid embolic agent.

MATERIALS & METHODS
We retrospectively identified all patients with intracranial DAVFs who were treated with Onyx as the single treatment technique at our institutions between April 2006 and November 2009. We documented age, gender, presenting symptoms, DAVF site, number of feeders per DAVF, whether cortical venous reflux was present, posttreatment angiography results, and follow-up angiography results when available.

RESULTS
Eleven male patients male were identified, who underwent 11 procedures for DAVF repair using Onyx-18. The mean age was 56 ± 12 years. Eleven patients presented with symptoms related to the fistula. There was an average of five feed- ers per DAVF (range 1-9). Cortical venous reflux was pres- ent in all patients. All patients underwent transarterial superselective catheterization of the pedicle arising from the branch of the middle meningeal artery, and Onyx-18 was injected under continuous road map guidance. Complete res- olution of the DAVF on immediate posttreatment angiogra- phy was achieved in all patients. In 11 patients complete cure of the fistula was achieved by Onyx injection on a single feeder arising from the middle meningeal artery. These 11 patients all had cortical venous drainage (Borden type III). There were no reported complications related to the proce- dure. Follow-up angiography was available for ten patients (mean, 6.4 months); one patient was lost to follow up. None of the patients who returned for follow up had any signs of angiographic recurrence.

CONCLUSION
In our experience, the endovascular treatment of intracranial DAVFs with Onyx-18 is feasible, safe, durable and highly effective. No recurrence of the DAVF was demonstrated on follow-up catheter angiography. If a feeder from the middle meningeal artery is identified, it is highly probable to achieve a cure with the Onyx injection of this single pedicle with treatment in one session.

KEY WORDS: DAVF, Onyx, middle meningeal

Paper 482 Starting at 2:26 PM, Ending at 2:34 PM
Transvenous Embolization of Cavernous Dural Arteriovenous Malformation via Interventionally Recanalized Inferior Petrosal Approach

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PURPOSE
Transvenous coil embolization is a well accepted treatment of cavernous dural arteriovenous malformation (CDAVM). Treatment is straightforward with good result if the inferior petrosal sinus (IPS) is visualized and accessible. We evaluate possibility and result of transvenous coil embolization of CDAVM which have no visible petrosal venous drainage by interventional recanalization of IPS.

MATERIALS & METHODS
Thirty-four cases of CDAVM without visible or no patent inferior petrosal sinuses who were treated with transpetrosal coil embolization of cavernous sinuses were reviewed. There were 16 males and 18 females with total of 40 lesions identified. There were six cases of bilateral CDAVMs treated in the series. Retrograde catheterization of obliterated inferior petrosal sinus was performed using microcatheter and guidewire in all cases.

RESULTS
Successful catheterization of obliterated IPS was achieved in 38 of 40 lesions. Primary complete embolization of CDAVMs by ipsilateral recanalized IPS routes was observed in 35 of 40 lesions. Three lesions were embozized complete- ly via contralateral IPS approach. Residual AVM is observed in two cases immediately after the procedure but completely thrombosed after 1 month follow up. Transient cranial nerve palsies were observed in three patients.
CONCLUSION
It is possible to treat cases of CDA VM without visible IPS drainage by means of interventional recanalization. Preliminary result is satisfactory with low complication.

KEY WORDS: Dural AVM, cavernous, embolization

Paper 483 Starting at 2:34 PM, Ending at 2:42 PM

Embolization of Arteriovenous Malformations: Institution Comparison of N-Butyl Cyanoacrylate and Onyx

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PURPOSE
To report our institutional experience of cerebral arteriovenous malformation embolization treatment results using two liquid embolic agents, N-Butyl Cyanoacrylate (nBCA; Trufill, Cordis Endovascular, Inc., Miami Lakes, FL) and Ethylene-vinyl alcohol copolymer (Onyx; ev3, Inc., Irvine, CA).

MATERIALS & METHODS
Between October 2001 and August 2009, a total of 87 patients underwent 195 endovascular procedures and returned for follow up at least 3 months after definitive treatment. Between October 2001 and July 2005, 50 patients underwent 86 endovascular procedures for AVM treatment with nBCA. Between August 2005 and August 2009, 37 patients underwent 99 endovascular therapies for AVM treatment with Onyx.

RESULTS
Initial and durable occlusion were assessed at 6-month follow up. Complete angiographic occlusion with durable occlusion was demonstrated in 11/37 (29%) of Onyx cohort compared to 2/50 (4%) in the nBCA treatment group. This two-tailed P value using unpaired t test equals 0.0007, which by conventional criteria suggests the difference between the Onyx and nBCA groups should be considered extremely statistically significant.

CONCLUSION
The reported average of angiographic cure in the treatment of AVMs using nBCA is approximately 10% (1). We report a higher rate of complete and durable occlusion for cerebral arteriovenous malformations when Onyx is used compared to nBCA that is extremely statistically significant. This finding supports use of Onyx as a preoperative option for nidus obliterations or as an alternative treatment.

REFERENCES

KEY WORDS: Arteriovenous malformation, cerebral, embolization

Paper 484 Starting at 2:42 PM, Ending at 2:50 PM

Treatment of Complex, Multiple Vascular Malformations of the Head and Neck

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PURPOSE
To determine the efficacy of ethanol embolotherapy of extracranial head and neck vascular malformations of all types, particularly after failure of other endovascular and surgical treatments, with a focus on patients with multiple malformations in the head and neck confounding treatment.

MATERIALS & METHODS
One hundred and sixty-six patients (64 males, 102 females; mean age: 38 years) presented with extracranial arteriovenous malformations (AVMs) of the head and neck area. Over half of the patients had undergone previous failed therapies. All patients underwent ethanol embolotherapy under general anesthesia. Forty-five patients had AVMs and 121 patients had venous malformations (VM). Forty-three patients with venous malformations involved multiple compartments. Twelve patients with AVMs had multiple lesions confounding treatment.

RESULTS
Of 12 complex AVM patients, eight patients are cured (mean follow up 2 ½ years); of 43 venous malformation patients, 40 are at end therapy (mean follow up 4 ½ years). The remaining patients are not at end therapy and are being treated for their residual malformations. In AVM follow up, arteriography is the main imaging modality to determine cure or residual AVM as MR imaging is less sensitive in the evaluation of residual AVM. In VM follow up, MR imaging is the main imaging tool, particularly with T-2 fat suppression and/or STIR imaging. All patients demonstrated improvement post-therapy. Complications were 4.5%, to include bleeding (self-limited), partial 7th nerve palsy (with recovery), skin injury (not requiring skin grafts), infection, and pain.

CONCLUSION
Ethanol has proved its consistent curative potential at long-term follow up for complex high-flow AVMs and multiple compartment low-flow VM lesions at long-term follow up for head and neck lesions. Complication rates remain low. The procedures are tolerated well by the patients and done on an out-patient basis. Prior surgery and embolization procedures can cause difficulty in lesion access, but does not obviate further ethanol endovascular treatment.

KEY WORDS: Vascular malformations, head and neck, ethanol embolotherapy
Role of Susceptibility-Weighted Imaging in the Detection of Arteriovenous Shunting in Nonaneurysmal Vascular Malformations of the Brain Presenting with Intracerebral Hemorrhage

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PURPOSE
To evaluate the utility of susceptibility-weighted imaging (SWI) for the detection of arteriovenous shunting (AVS) in nonaneurysmal brain vascular malformations (BVMs) associated with intracerebral hemorrhage (ICH).

MATERIALS & METHODS
We retrospectively reviewed the SWI MR images in all patients over a 3-year period who had BVMs associated with ICH. All patients had presented with an ICH detected on an initial head CT. Subsequently, they got both MR imaging and DSA studies for further evaluation, with some patients having the MR imaging first and others having the DSA first. No therapeutic interventions were performed between the MR imaging and DSA. Two experienced readers, blinded to the results of DSA, independently reviewed the SWI sequences for AVS, as determined by the presence of signal hyperintensity within a venous structure in the vicinity of the ICH. Discrepancies in reader interpretation were resolved by consensus. Accuracy parameters of SWI for the prediction of AVS were calculated utilizing the DSA results as the reference standard. Interobserver agreement for the presence of AVS in the SWI sequence was calculated with the kappa statistic.

RESULTS
A total of 21 BVMs associated with ICH were present in the 21 patients (10 female and 11 male, mean age 46.0 +/- 22.8 years) included in our study. Median time between MR imaging and DSA was 3 days. SWI demonstrated AVS in all 3 of the BVMs with AVS on DSA and one of the 18 BVMs without AVS on DSA (sensitivity 100% and specificity 95%). The positive and negative predictive values of SWI for the prediction of AVS in the setting of ICH were 75% and 100% respectively. There was near perfect inter-observer agreement (kappa 0.93). Accuracy of SWI in the detection of AVS in non-aneurysmal BVMs in the setting of ICH

<table>
<thead>
<tr>
<th>Shunting on DSA</th>
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<tr>
<td>No shunting on DSA</td>
<td>1</td>
<td>17</td>
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CONCLUSION
Susceptibility-weighted imaging is highly accurate in the detection of AVS in BVM associated with ICH. Given its high negative predictive for the detection of AVS in this setting, patients with a negative SWI study may not require further evaluation with DSA, whereas those with a positive SWI study are likely to harbor an arteriovenous malformation and may require further evaluation with DSA. However, further validation of these findings in a larger study is needed.

KEY WORDS: intracerebral hemorrhage, vascular malformations, susceptibility-weighted imaging

Thursday Afternoon
1:30 PM – 3:00 PM
Room 311

(49c) Spine: Other
(Scientific Papers 486 - 496)

See also Parallel Sessions
(49a) Adult Brain: Functional Imaging
(49b) Interventional: Arteriovenous Malformations/Fistulae
(49d) Adult Brain: Anatomy of Brain And Other
(49e) Excerpta Extraordinaire: Interventional and Spine

Moderators: Walter S. Bartynski, MD
Gregg H. Zoarski, MD
Style and Content of CT and MR Imaging Lumbar Spine Reports: Radiologist and Clinician Preferences

Ghali Eskander, M. · Leung, A. · Lee, D.
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PURPOSE
Structured report organization with a standardized radiologic lexicon has the potential to improve patient care, outcome assessments and medical education. An example of such a structure is BIRADS, which has been employed successfully in breast imaging for over a decade. Several studies have examined clinician preferences regarding the style of body US and CT reports. To our knowledge, our study is the first to examine clinician and radiologist preferences in lumbar spine CT and MR imaging reports with respect to content (limited, moderate or detailed), format (itemized or prose), and specific components of the reports such as management suggestions by the radiologist.

MATERIALS & METHODS
A spine report survey, which consisted of three case scenarios, each with six different reports varying in content and format was mailed to clinicians and radiologists. Their preferences regarding content, format, and management suggestions were gathered.

RESULTS
A total of 120 clinicians responded. The clinician response rate was 49% (89 of 183) while the radiologist response rate was 53% (31 of 58). Both clinicians and radiologists preferred reports with moderate or detailed content over limited content. Itemized and prose formats were acceptable to clinicians and radiologists. When the clinician group was separated into spine specialists and spine nonspecialists, the specialists preferred reports with greater detail but no management suggestions from the radiologists, whereas the nonspecialists preferred less detail but wanted specific management suggestions. Neuroradiologists were more likely to provide management suggestions than nonneuroradiologists.

CONCLUSION
Clinicians favor lumbar spine CT and MR imaging reports with detailed content in either itemized or prose formats. Spine nonspecialists, a group including family practitioners and general internists, wish for specific management suggestions from the radiologists. To optimize patient care, radiologists should be mindful of these preferences and consider tailoring their reports to their audiences.

KEY WORDS: Report style, report content, physician preference

Effect of MR Imaging on Low Back Pain Diagnosis in the Medicare Population

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PURPOSE
Since 1994 clinical guidelines have recommended MR imaging (MRI) for patients with low back pain to evaluate potentially serious spinal pathology, or if surgery or epidural steroid injections are being considered for treatment of loss of neurologic function. This recommendation is based mainly on the fact that MRI is highly sensitive and specific to lumbar spine disease. However, the abnormalities detected by MRI often are not the cause of clinical symptoms and may therefore set the stage for additional, possibly unnecessary treatments. Studying the prevalence of specific low back MR findings would provide useful evidence about the potential of MRI to lead to further interventions, particularly if used in isolation to direct patient management. This study examines the relationship between MRI and the clinical diagnosis of radiculopathy or spinal stenosis in Medicare patients with low back pain.

MATERIALS & METHODS
We developed cohorts of Medicare patients with low back pain using claims from 1998-2005 for a 20% sample of traditional Medicare beneficiaries. We focus on patients with mechanical low back pain (including “specific” diagnoses of herniated disk/sciatica and spinal stenosis, and “nonspecific” degenerative disk disease, instability, and strains/sprains) that did not resolve after one visit. Visits for low back pain were identified based on the primary ICD-9 diagnosis code associated with each claim. The final cohort included 657,561 patients with an initial (“index”) and follow-up visit for low back pain. The follow-up visit was defined as the first visit for low back pain within 1 year of the index visit and, if applicable, after the first lumbar MRI. We used logistic regression to assess the relationship between MRI and diagnosis of herniated disk/sciatica or spinal stenosis at the follow-up visit.

RESULTS
Twenty-seven percent (175,074) received MRI between the index and follow-up visits for low back pain. Approximately 34% (61,594) of patients with an initial diagnosis of radiculopathy or spinal stenosis, and 24% (113,480) of patients with an initial diagnosis of nonspecific low back pain received MRI. Overall, the odds of a diagnosis of radiculopathy or spinal stenosis, if MRI was obtained after the initial visit, was 2.37 (95% CI, 2.33-2.40). MR imaging was associated with a two-fold increase in probability of specific follow-up diagnosis among patients initially diagnosed with degenerative disk disease (14.3% to 36.2%), instability (16.2% to 34.9%), or strains/sprains (12.4% to 34.0%). MR imaging had a small, although statistically significant effect on probability of specific diagnosis among patients initially assessed as having spinal stenosis (69.6% to 70.6%) or radiculopathy (67.1% to 68.4%).
CONCLUSION
Among older adults with new onset mechanical low back pain, a specific diagnosis of radiculopathy or spinal stenosis is almost twice as likely at follow up if lumbar MRI is performed. MR imaging is likely to confirm an initial diagnosis of radiculopathy or spinal stenosis, and revise an initial diagnosis of nonspecific low back pain to a specific etiology. The differential impact of MRI on follow-up diagnosis underscores the clinical benefit of the additional information obtained from MRI in patients with repeat visits for low back pain.

KEY WORDS: Low back pain, MR imaging, Medicare

Paper 488 Starting at 1:46 PM, Ending at 1:54 PM

Denervation Changes on MR Imaging after Scalene Muscle Injection with Botulinum Toxin (OnabotulinumtoxinA) for the Treatment of Thoracic Outlet Syndrome

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PURPOSE
Patients with thoracic outlet syndrome (TOS) often are treated by a variety of conservative methods prior to consideration of surgery. One such treatment is targeted chemodenervation of the scalene muscles with botulinum toxins. Precise targeting and adequate chemodenervation are vital to accurately interpret treatment response, which influences the decision to proceed with further injections, consider surgical decompression, or change treatment strategies. MR imaging is one potential way to assess the location and adequacy of chemodenervation. Characteristic MR findings of early muscle denervation after nerve injury include development of T2/STIR signal hyperintensity within days, which persists for weeks. In the absence of re-innervation, muscle atrophy follows. MR imaging changes after chemodenervation have not been characterized. The goal of this study was to evaluate anterior and middle scalene muscles before and after chemodenervation to detect MR imaging changes of intramuscular injection of botulinum toxin A.

MATERIALS & METHODS
Approval for the study was obtained from the Institutional Review Board at the University of Washington. A retrospective review of eight patients with symptomatic thoracic outlet syndrome who underwent targeted injection of the anterior and/or middle scalene muscles with botulinum toxin A (OnabotulinumtoxinA) was performed. MR imaging of the brachial plexus bilaterally was obtained before and after chemodenervation. Scans included T1 and STIR sequences in at least two planes. MR images were reviewed independently by two experienced neuroradiologists (JGJ, KRM) who were blinded to the site of injection. Scans were evaluated for STIR signal abnormalities and muscle atrophy before and after injection. STIR signal abnormalities were scored by muscle on a 5-point scale, with 1 being “definitely normal” and 5 being “definitely abnormal”. A score of 3 reflected equivocal findings.

RESULTS
Patients underwent brachial plexus MR imaging, on average, 5 days before injection (range, 0-30) and 31 days after injection (range 27-38). The eight patients in the study underwent chemodenervation of 17 scalene muscles, including eight anterior scalene muscles and nine middle scalene muscles. Imaging findings of muscle atrophy prior to chemodenervation was present in two muscles. Atrophy of one anterior scalene muscle, manifested as small muscle size and normal STIR signal, was present on initial MR imaging. After injection, this muscle demonstrated increased STIR signal. In a different patient, a middle scalene muscle demonstrated abnormal STIR signal both before and after chemodenervation. All other muscles were normal in size and STIR signal characteristics prior to chemodenervation. Of 17 injected muscles, nine demonstrated new STIR signal abnormality on the postinjection MR imaging. None of the noninjected muscles demonstrated abnormal STIR signal on postinjection MR imaging. This resulted in detection of changes on MR imaging after chemodenervation with a sensitivity of 53%, specificity of 100%, positive predictive value of 100% and negative predictive value of 65%. Inter-rater reliability, calculated using an intraclass correlation, was 0.97.

CONCLUSION
MR imaging may be a useful tool for detecting changes after chemodenervation for symptomatic thoracic outlet syndrome. In this study, MR imaging was somewhat sensitive and highly specific for chemodenervation. Timing of MR imaging after injection and optimizing scanning parameters may increase sensitivity.

KEY WORDS: Thoracic outlet syndrome, chemodenervation, MR imaging

Paper 488a Starting at 1:54 PM, Ending at 2:02 PM

Performing Thoracic Transforaminal Injections: A New Technique

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PURPOSE
To describe and evaluate a new technique to perform fluoroscopically directed thoracic transforaminal nerve root injections.

METHODS & MATERIALS
IRB approval and a waiver of consent were obtained for this retrospective HIPAA compliant study. Fluoroscopic spot views from 198 consecutively performed foraminal nerve root blocks and foraminal epidural injections in the thoracic spine dating back to June 27, 1997 were retrospectively reviewed. Via an oblique approach, a curved hand bent needle is placed along the posterosuperior border of the rib inferior to the foramen to be entered. The needle is advanced under fluoroscopic guidance along the course of the rib into the foramen. Specific technical details will be presented.

RESULTS
A single delayed pneumothorax occurred when the prescribed technique was not followed. No other major compli-
Spontaneous intracranial hypotension (SIH) is an uncommon cause of headache resulting from spontaneous loss of CSF volume, typically due to rupture of a perineural spinal nerve cyst. The site of cerebrospinal fluid leak is often difficult to demonstrate. Only a few reports of transdural disk herniations have been noted as a cause of SIH. We present the largest known series of spontaneous intracranial hypotension secondary to calcified thoracic disk protrusions.

**MATERIALS & METHODS**
A retrospective review of medical and radiologic records of patients with the term “SIH” was undertaken from our report archives over the time period of 1995-2009. Seventy-three patients were identified, of which 36 had further investigation with spine imaging (CT or MR myelography, noncontrast MR or CT of the spine) for the source of the CSF leak. A review of their records and scans was performed.

**RESULTS**
Of the 36 patients, 14 had rupture of a perineural cyst(s) as a definite or presumed cause of SIH. Thirteen patients had a thoracic disk protrusion or osteophyte piercing or deforming the thecal sac as the definite or presumed cause of SIH. Nine patients had no identifiable spinal or intracranial pathology. Of the 13 patients with disk-related SIH, 7 were male, 6 were female; mean age 47 years. All had central or paracentral calcified thoracic disk protrusions. Many did not have symptoms of acute back pain or suspected of having disk-related pathology. The calcified disk was demonstrated by either CT myelogram (9/13) or noncontrast MR or CT of the spine (4/13). An extradural leak at or adjacent to the calcified disk protrusion was demonstrated in 6 of 9 CT myelogram cases. In the three patients without a definite contrast leak on CT myelogram, the only primary spinal pathology seen was a calcified disk protrusion. In four patients evaluated with noncontrast CT of the spine, an MRI of the spine had been previously performed demonstrating thoracic extradural spinal fluid.

**CONCLUSION**
This study describes and evaluates an innovative technique to perform fluoroscopically directed thoracic transforaminal injections, which demonstrated few complications and avoided transgression of structures in the posterior mediastinum by utilizing the rib as not only a conduit into the foramen, but a barrier to non-targeted structures.

**KEYWORDS:** Thoracic, injections

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**Paper 491 Starting at 2:10 PM, Ending at 2:18 PM**

**Diffusion-Weighted Imaging of Peripheral Nerves: Differentiating Neoplasm from Radiation Treatment Changes**

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**PURPOSE**
Peripheral neuropathy related to tumor infiltration vs tumor treatment injury is often indistinguishable clinically and radiographically but yet has vastly different prognostic and therapeutic implications. MR neurography (MRN) is a sensitive tool for demonstrating normal and abnormal nerve. The application of physiologic information obtained from diffusion-weighted imaging (DWI) may be helpful for evaluation of these distinct pathologic entities and has not been described previously. We aim to describe and compare MR diffusion ADC values in patients with neuropathy secondary to primary nerve sheath tumors, secondary/metastatic disease to peripheral nerves, and radiation plexopathy.

**MATERIALS & METHODS**
MR neurography with diffusion was performed in patients with neuropathy referred by neurologists, neurosurgeons and oncologists between 2003 and 2009 (Philips 1.5 T Gyroscan Intera, the Netherlands): Axial and coronal STIR (TR 2200; TE 20; TI 160; NEX 4; FOV 22; 256 x 192; 3/0.3), T1 pre and postgadolinium with fat saturation (TR 500; TE 14; NEX 3). Diffusion-weighted scanning performed in three directions (single-shot echo planar: TR 2 x pulse-pulse interval; TE 15 msec; FOV 22; 256 x 144; 5.0/0.5 mm; B-value 400 sec/mm2). Apparent diffusion coefficient (ADC) maps were obtained, and regions of interest were drawn and analyzed for mean ADC values using software available on the scanner. Mean ADC values were compared across three groups (primary nerve tumors, secondary nerve tumors, and radiation plexopathy) using analysis of variance (ANOVA). Posthoc pairwise comparisons were made utilizing t-tests. Correlation with pathology reports and clinical follow up was performed additionally.
RESULTS
Twenty-four patients were diagnosed with peripheral nerve tumors or radiation plexopathy: 6 male, 18 female; mean age 48.4 years (range 6-80 years). Eighteen patients had tumor: 10 primary nerve sheath (4 neurofibroma, 6 schwannoma); eight metastatic (4 breast, 1 leukemia, 1 rhabdomyosarcoma, 1 renal cell carcinoma, and 1 unknown primary); six patients had radiation plexopathy (4 breast cancer, 1 sarcoma, 1 squamous cell carcinoma). Diagnoses were confirmed by clinical data and follow up (mean = 662 days) in all patients and pathologically in six patients. All patients demonstrated increased STIR signal within the affected nerve(s) on MRN. Patients with tumor demonstrated solid enhancement while those with radiation plexopathy demonstrated relatively no enhancement. Mean ADC values were as follows: primary tumor: 2.09 +/- .29 x 10-3 mm2/sec (1.47-2.97 x 10-3 mm2/sec); secondary tumor: 1.03 +/- .17 x 10-3 mm2/sec (0.42-2.35 x 10-3 mm2/sec); radiation therapy: 2.25 +/- .22 x 10-3 mm2/sec (1.22-3.81 x 10-3 mm2/sec). Mean ADC values in secondary/metastatic tumor were significantly lower than primary tumor (p = 0.002) and radiation neuropathy (p = 0.002). Mean ADC values in radiation neuropathy were significantly higher than primary tumor (p = 0.002) and secondary/metastatic tumor (p = 0.002). In posthoc testing using pairwise t-tests, the secondary/metastatic tumor group was significantly different from the primary tumor and radiation treated groups.

CONCLUSION
MR neurography with DWI may aid in the diagnosis and management of peripheral nerve tumors and radiation neuropathy. Assessment of mean ADC values in peripheral nerves can be helpful in differentiating primary and secondary neoplasms of peripheral nerves and distinguishing neoplasm from radiation effects in the appropriate subset of patients.

KEY WORDS: Diffusion, neurography, tumor

Paper 492 Starting at 2:18 PM, Ending at 2:26 PM
Prevalence of Extraspinal Findings in Patients Undergoing Lumbar Spine CT

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PURPOSE
Current practice in computed tomography (CT) of the lumbar spine is to limit the field of view (FOV) to the spine. The extraspinal structures are excluded and potentially significant pathology at the edge of the image or outside the FOV may not be detected. Studies evaluating cardiac CT and CT colonography have demonstrated a significant number of incidental findings when the full FOV is evaluated. We sought to determine the prevalence of abnormal findings in the extraspinal structures in patients evaluated by CT of the lumbar spine.

MATERIALS & METHODS
CT lumbar spine examinations in 400 consecutive adult patients (47% female, mean age 49 +/- 4 years) were reviewed by a senior neuroradiologist (AL) and 2 body imagers (IR, AG). Patients with age > 80 years or known cancer were excluded. Extraspinal findings were classified as follows: incidental (benign and requiring no further assessment), indeterminate (nonspecific appearance requiring clinical correlation and further imaging evaluation), and significant (requiring immediate notification of the referring physician and urgent work up). Note was made of whether or not the abnormality was visible on the limited FOV or only on the full FOV.

RESULTS
Extraspinal findings were present in 168 patients (43% of cohort). Indeterminate or significant findings were present in 84 patients (21% of the full cohort), of which the majority arose from the genitourinary system (76 patients with hypodense or solid renal lesions). The gastrointestinal tract was the source of most benign findings, with uncomplicated diverticulosis identified in 45 patients. Abdominal aortic aneurysms were the third most common finding, present in 14 patients. A miscellany of other findings were detected, including hepatic hypodensities, mesenteric masses and adenopathy, and uterine masses. Of the 168 patients with extraspinal findings, 123 (31% of cohort) required the full field of view for detection.

CONCLUSION
Extraspinal findings are common amongst patients undergoing routine CT of the lumbar spine, with a prevalence of 43% in our cohort. While many of these findings are undoubtedly incidental and benign, perhaps as many as 21% of our cohort harbor indeterminate or significant abnormalities which require further evaluation. Almost 75% of the extraspinal lesions are not present on the limited FOV of the spine. Because review of the full FOV is not performed in most centers, careful consideration of the risks and benefits of routinely reviewing the entire scanned volume is required.

KEY WORDS: Spine, CT, incidental findings

Paper 493 Starting at 2:26 PM, Ending at 2:34 PM
3 T Evaluation of Cervical Cord MS Plaques: STIR vs T2 Turbo Spin-Echo with Fat Saturation

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PURPOSE
The purpose of this study was to determine whether STIR or T2 turbo (fast) spin-echo with fat saturation is superior in the detection of MS plaques at 3 T. Prior studies at 1.5 T concluded that STIR was better. However, optimization of spine imaging at 3 T may require different pulse sequences. In addition, fat saturation at 3 T is superior to 1.5 related to increased chemical shift.

MATERIALS & METHODS
Fifty consecutive prospective patients (adult and pediatric) with the known or suspected diagnosis of MS were scanned with both STIR and T2 turbo spin-echo (TSE) with fat saturation (fs) pulse sequences in the sagittal plane in addition to T1 FLAIR sagittal and Ti VIBE axial pre and postcontrast and T2 TSEfs axial pulse sequences. All patients were
scanned on a Siemens’ 32-channel Verio MR imaging system. All scans were interpreted by both a neuroradiologist and an MR imaging fellowship-trained radiologist.

RESULTS
One hundred twenty-eight MS plaques were detected. All 128 were detected on Stir. One hundred twelve were detected on T2TSEfs. Of the plaques seen on both, 42 were more conspicuous on STIR while 17 were better delineated on T2TSEfs. The overall quality of the scans (S/N) was better on T2TSEfs.

CONCLUSION
At 3 T, STIR is superior to T2TSEfs in the detection of MS plaques in the sagittal plane.

KEY WORDS: MS, 3 T, STIR

Paper 494 Starting at 2:34 PM, Ending at 2:42 PM

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PURPOSE
The aim or our study was to qualitatively evaluate the value of diffusion tensor imaging (DTI) to accurately characterize axon and myelin integrity within an ex vivo human cervical spinal cord specimen using basic histologic stains and immunoflorescent assay (IFA) specific for structural markers.

MATERIALS & METHODS
A human cervical spinal cord (CSC) from a patient with history of advanced multiple sclerosis (MS) was obtained at autopsy. 3D multishot diffusion-weight echo-planar imaging (3D ms-DWEPi) and conventional T2-weighted imaging (T2WI) was performed on the paraformaldehyde-fixed CSC specimen. Multiple sclerosis lesions were identified using conventional T2WI, while the DTI allowed derivation of the paraformaldehyde-fixed CSC specimen multiple sclerosis lesions were identified using conventional T2WI, while the DTI allowed derivation of the underlying anisotropy (FA). One hundred sixty-seven regions of interest (ROI) were selected from the T2WI within the white matter. Sequential MDCT studies were coregistered on a Hermes workstation and reviewed in three orthogonal planes.

RESULTS
Five different histologic patterns were identified with varying degrees of myelin and axonal pathology which correlated with four different patterns of diffusivity value combinations. Fifty-nine percent (N = 69) of HIL demonstrated both increased λl and λr, 23% had normal λl and increased λr, 14% had decreased λl and normal λr, and 14% had decreased λl and normal λr. The average values for the λl and λr, parameters from HIL, are elevated significantly compared to normal ROIs (p = 0.05). Thirty percent LIL ROIs (N = 32) did not have any significant differences in the measured λl and λr diffusivities compared to the internal control. Thirteen percent had increased λl and λr, while 48% of the ROIs showed a decreased λl, and either a normal or decreased λr (p = 0.05). Seventy-nine percent of NAWM ROIs (N = 75) had abberant λl and λr values compared to the internal normal (p = 0.05). Fractional anisotropy generally was decreased across all lesion types. Correlative analysis between the λl and λr diffusivities and IFA findings showed the following: 60% of predicted lesions had myelin preservation, 57% of predicted had myelin loss, 64% had partial loss of axons, 72% of predicted had complete loss of axons.

CONCLUSION
This study shows the feasibility of taking MRI and DTI and performing coregulative analysis with histologic data. With improved, automated colocalization techniques and quantitative procedures, future work can be performed to improve the correlation between measured DTI diffusivity parameters with actual axonopathy and myelinopathy. Our work suggests that DTI imaging has an important emerging role in the treatment of multiple sclerosis by the early recognition of prelesion areas within the white matter.

KEY WORDS: Diffusion, tensor, spinal cord

Paper 495 Starting at 2:42 PM, Ending at 2:50 PM
Coregistration of Sequential MDCT Studies for the Evaluation of Surgical Instrumentation following Resection of Spinal Tumors

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PURPOSE
Surgical interventions performed for the resection of primary and metastatic spinal tumors are intricate and involve complex reconstruction and stabilization procedures. The purpose of this study is to demonstrate our initial experience in using coregistration of sequential MDCT studies in the evaluation of the surgical construct in this patient population.

MATERIALS & METHODS
Sequential MDCT studies were coregistered on a Hermes workstation and reviewed in three orthogonal planes. Assessment was made for temporal stability or change in position of the surgical construct and adjacent bony structures.
RESULTS
In cases of instrumentation failure, the change in position of the surgical construct was aided by use of the coregistration technique. In certain cases, more information about secondary changes of instability was demonstrated. In comparison, coregistration of sequential MDCT studies in patients without instrumentation failure demonstrated a similar position of the surgical construct, further confirming stability.

CONCLUSION
Accurate assessment over time of the surgical construct is imperative for the management of patients who have undergone resection and complex reconstruction for spinal tumors. Stability or change in position of surgical instrumentation in orthogonal planes on sequential, coregistered MDCT studies aids the radiologist in the assessment of the surgical construct. Especially in cases of complex instrumentation failure, this technique leads to a more comprehensive evaluation. Further study and refinement of this technique will be necessary before clinical implementation.

KEY WORDS: Coregistration, MDCT, neoplasm

Paper 496 Starting at 2:50 PM, Ending at 2:58 PM

Spinal Involvement in Neurosarcoioidosis: Rapid MR Imaging Assessment

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PURPOSE
Neurologic involvement is a serious complication of sarcoidosis. The frequency of spinal involvement is unclear in patients with neurosarcoioidosis. We studied the frequency and extent of spinal involvement in patients with neurosarcoioidosis.

MATERIALS & METHODS
In this prospective, IRB and HIPAA compliant study, 31 Interstitial Lung Disease/Sarcoid Clinic patients receiving systemic therapy with known neurosarcoioidosis and symptoms suggesting spinal disease, were imaged from 3/22/08 - 9/23/09. Following completion of their clinical contrast-enhanced brain MR exam, all received a rapid Automated Spine Survey Iterative Scan Technique (ASSIST) total spine survey to include fat-water separation sequencing with 2D FSE IDEAL (Figure 1a) and/or 3D SPGR DE (Figure 1b); the latter, requiring 42 sec total scan time, and performed in 25/31 patients. Five patients were scanned twice and one three times for a total of 37 investigational spine exams. All but one was scanned at 3.0 T, the sole exception, having a programmable shunt, was imaged at 1.5 T. Two neuroradiologists independently reviewed all images and scored for the presence of sarcoid-consistent medullary, intradural, dural, epidural or vertebral involvement at the cervical, thoracic, and lumbar sacral levels. Where scoring was discordant, the readings of one radiologist was used for this preliminary analysis.

RESULTS
Eight of 31 patients (26%) had spine lesions consistent with sarcoidosis. Most of these (6/8) had multilevel (C, T, or LS) disease, including eight cervical, six thoracic, and three lumbar-sacral. Five patients had multicompartmental involvement. (see Table). Epidural lipomatosis resulting from steroid therapy was noted incidentally in one patient without evidence of spinal sarcoid involvement.

Table 1. Distribution of Spinal Lesions

<table>
<thead>
<tr>
<th>Subject</th>
<th>Age</th>
<th>Gender</th>
<th>Cervical</th>
<th>Thoracic</th>
<th>Lumbar</th>
</tr>
</thead>
<tbody>
<tr>
<td>S01-08</td>
<td>58</td>
<td>F</td>
<td>m,i</td>
<td>m,i</td>
<td></td>
</tr>
<tr>
<td>S03-08</td>
<td>41</td>
<td>F</td>
<td>i</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S05-08</td>
<td>50</td>
<td>F</td>
<td>m,i</td>
<td>m,i</td>
<td></td>
</tr>
<tr>
<td>S06-08</td>
<td>64</td>
<td>M</td>
<td>m</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S10-08</td>
<td>29</td>
<td>F</td>
<td>v</td>
<td>d,v</td>
<td>v</td>
</tr>
<tr>
<td>S11-08</td>
<td>38</td>
<td>M</td>
<td>i</td>
<td>i</td>
<td></td>
</tr>
<tr>
<td>S12-08</td>
<td>41</td>
<td>F</td>
<td>v</td>
<td>v</td>
<td>v</td>
</tr>
<tr>
<td>S19-08</td>
<td>49</td>
<td>F</td>
<td>v</td>
<td>v</td>
<td>v</td>
</tr>
</tbody>
</table>

m = medullary, i = intradural, d = dural, e = epidural, v= vertebral.

CONCLUSION
Spinal involvement was seen in more than a fourth of our patients, the majority exhibiting multilevel involvement, stressing the need for a full spinal MR scan. Rapid post-contrast fat/water separated ASSIST sequencing may be a useful adjunct to routine brain scanning in neurosarcoidosis patients.

KEY WORDS: Neurosarcoidosis, MR imaging spine, ASSIST
Structured Intrinsic Brain Tumor Reporting: Evaluation of 100 Cases Using Anatomical Templates

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PURPOSE
To analyze workflow and the quality of reports generated using anatomical templates in 100 patients with intrinsic brain tumors.

MATERIALS & METHODS
Two staff neuroradiologists each generated 50 intrinsic brain tumor reports using an anatomical template (AT) based structured reporting software. Each participant graded the accuracy, completeness, and format of these reports and compared them to the last 10 reports they dictated using free text reporting. They also graded the AT workflow using a scale of 1-5 (1 = unsatisfactory, 2 = cumbersome, 3 = satisfactory, 4 = good, 5 = excellent). A manually deformable set of meticulously labeled normal brain MR images were overlaid on the patient’s axial brain images and a draw tool was used to trace the boundaries of the brain tumor(s) into the template images (1-4 minutes). Next the ventricular system and the tumor outlines were projected in 3D and compared to coronal and sagittal postcontrast T1-weighted MR images to assure accurate placement of the tumor. Once the user was satisfied with the tumor placement, the software generated a report of the anatomical structures and functional correlates enclosed by the manually defined tumor volume. Data supplied for reporting included: surface anatomy (cerebral lobe, gyri, sulci, and cisterns), ventricular anatomy, association/functional fiber tracts, and arterial blood supply. If the radiologist was unfamiliar with a structure, the program could instantly provide its location on the axial image and in the 3D data set along with comprehensive descriptive text. The pertinent anatomical features were modified to reflect the specifics of the case and extraneous anatomical comments were deleted.

RESULTS
The workflow scores reflected a steep learning curve. The assessments improved from cumbersome for the first 10 cases to satisfactory for the next 25 cases and good for the last 25 cases. Each participant indicated that the AT reports they generated were superior to their prior reports because the structured approach reproducibly organized the data, improved accuracy and prompted the inclusion of pertinent negative and positive findings. Participants also noted that the system improved their fund of neuroanatomical knowledge.

CONCLUSION
Neuroradiologic reports of brain tumors can be improved by the use of structured anatomical templates without negatively impacting workflow. The AT software improved knowledge of brain anatomy.

KEY WORDS: Structured reporting, brain tumors, anatomy

Stereotaxy and Anatomical 3D Reconstruction of the Human Nucleus Accumbens: A New Target for Deep Brain Stimulation

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PURPOSE
The Nucleus Accumbens (Acc) is a ventral striatum structure poorly identified in the human brain and its existence as an individualized entity is controversial. It is known to act as a motor-limbic interface, being involved in several emotional and psychomotor functions, frequently disturbed in neuropsychiatric disorders such as depression, obsessive compulsive disorder (OCD) and addiction behaviors. Most of the studies concerning the Acc were made in animals and those performed in humans are contradictory and not precise. Besides, the modern MR Imaging does not allow its clear identification and delimitation. Nevertheless it recently has become a target for stereotactic deep brain stimulation for some of those diseases when refractory to medical treatment. Previous studies performed by our group have established the stereotactic coordinates of the human Acc, its precise limits and dimensions, with the correspondent study on MR imaging. Now it is our purpose to perform the Acc anatomical 3D reconstruction in order to clarify its shape and topography and to render this nucleus a safer target for neuronavigation and stereotactic procedures.

MATERIALS & METHODS
Anatomical coronal serial slicing of 10 Acc from human brains, perpendicular to the AC-PC line and to the midline;
tracing of the Acc contours and measurement of its dimensions and 3D stereotactic coordinates, on each slice. Creation of a computerized 3D model.

RESULTS
The human Acc was identified as a distinct brain structure, with clear-cut limits, only on its posterior half. The mean stereotactic coordinates of this posterior part are: Y = 0 Y' = 11; X = 3.7 X' = 15.1; Z = 2.2 Z' = -10.2. The 3D reconstruction allowed seeing that the Acc lies parallel to the midline and is slightly descendent caudally. From anterior to posterior it progresses from a globose to a flattened and dorsolateral concave shape. Its main expression is subcomissural.

CONCLUSION
This study defined the 3D coordinates and 3D anatomy of the human nucleus accumbens providing new tools for stereotactic neurosurgical procedures.

KEY WORDS: Nucleus accumbens, stereotaxy, deep brain stimulation

Potent Risk Factor for Aneurysm Formation: Termination Aneurysms of Anterior Communicating Artery and Detection of A1 Vessel Asymmetry by Flow Dilution

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PURPOSE
Association of “termination”-type aneurysms with anatomical variations of one anterior cerebral artery trunk (A1) as the exclusive or dominant supply to both pericallosal arteries (A2) supports hypotheses of aneurysm formation from straight jets of A1 blood.

MATERIALS & METHODS
Anatomical and contrast filling of A1, A2, and anterior communicating (A-com) arteries were studied for cases entered into the Cerecyte Coiling Trial for cases with A-com (n = 105) and cases with other aneurysms (n = 123), with imaging available at the Cerecyte angiographic core centre. Cases were analyzed for A1 vessel dominance by measurement of diameter and dilution of angiographic contrast in A2s due to differential flow source on selective angiography (see Figure 1). A control group without aneurysms was assessed anatomically, a large sequential CT angiography (CTA) series (n = 159), acquired during acute stroke assessment.

RESULTS
A1 dominance configuration is associated strongly with the presence of A-com aneurysms, for patients with intracranial aneurysms (odds ratio 17.8). This association also is present when compared with the incidence of A1 dominance in the control large sequential series of patients without aneurysms undergoing CTA for other reasons (odds ratio 7.5). Outflow dilution of selective angiographic images augments anatomical information (see Figure 2).

CONCLUSION
The anatomical variant of asymmetrical A1 configurations likely facilitates the development of A-com aneurysms by flow stresses, providing further evidence to support the role of biophysical factors in intracranial aneurysm development.
**Key Words:** A1 vessel dominance, anterior communicating aneurysms

**Paper 500 Starting at 1:54 PM, Ending at 2:02 PM**

**Targeted High-Resolution Diffusion MR Imaging of the Mesial Temporal Lobes at 3 T**


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**Purpose**
The hippocampus and entorhinal cortex form a critical network for memory formation vulnerable to disruption by Alzheimer disease or epilepsy. Unfortunately, standard single-shot echo planar diffusion tensor imaging (DTI) often does not characterize these mesial temporal lobe structures well due to susceptibility-induced signal loss, geometric distortions and T2 blurring (all of which worsen with increasing spatial resolution). This study reports a novel combination of reduced field-of-view (1) and partial Fourier acquisition strategies to mitigate these problems and obtain diffusion tensor images capable of resolving laminar structures of the mesial temporal lobe in vivo at 3 T.

**Materials & Methods**
Three human subjects were scanned on a 3 T EXCITE MR scanner using an 8-channel phased-array head coil (GE Healthcare, Waukesha, WI). Single-shot spin-echo echo planar diffusion-weighted images were obtained (15 gradient directions, \( b = 800 \, \text{s/mm}^2 \)) at 1.1 x 1.2 mm in-plane resolution using a 224 x 64 matrix and 28 cm field-of-view (FOV). The cranial-caudal phase FOV was reduced to 7 cm using outer volume suppression (1) via a pair of quadratic phase RF pulses. Ten 3 mm thick slices were prescribed in an oblique coronal plane orthogonal to the hippocampal axes. This volume included the bilateral hippocampi and entorhinal cortices. Readout duration was further reduced via 75% fractional k-space phase encoding. The acquisition required 11 min (TR/TE = 2575/82 ms, NEX = 16). Data were processed in FSL (Oxford University, England) to generate maps of DTI parameters.

**Results**
Diffusion-weighted images had high signal-to-noise (8:1) and resolved the entorhinal cortex (EC), subiculum (SUB), dentate gyrus (DG), parahippocampal gyrus white matter (PHG), molecular and primary neuronal layers of the hippocampus (CA1) well (Panel A). Quantitative data agreed with prior DTI data from human hippocampus autopsy samples (2); e.g., CA1 stratum radiatum mean diffusivity and fractional anisotropy were 0.53 x 10^-3 mm^2/s and 0.34 respectively. Color fiber orientation maps demonstrated coherence from CA1 pyramidal neuron apical dendrites (Panel B) as previously reported ex vivo at 14 T (2). Data also may be amenable to tractography of the perforant pathway between the entorhinal cortex and hippocampus.

**Conclusion**
Reduced FOV and partial Fourier acquisition techniques help DTI on 3 T scanners to resolve many structural components of the mesial temporal lobes. These methods may help to determine if layer-specific tissue changes observed via DTI and/or tractography precede atrophy and other nonspecific MRI changes, hence providing earlier surrogate markers for pathologies like Alzheimer disease or mesial temporal sclerosis.

**References**

**Key Words:** Selective vulnerability, epilepsy, Alzheimer disease

**Paper 501 Starting at 2:02 PM, Ending at 2:10 PM**

**An Imaging Analysis of Subcortical Structures in Cervical Dystonia**

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**Purpose**
Cervical dystonia (CD) is a focal dystonia of the neck and shoulder, resulting in some or all of the symptoms of head turning (torticollis), tilting of the head (laterocollis), flexion (anterocollis) or extension (retrocollis) of the head. Bilateral deep brain stimulation (DBS) of the globus pallidus internus (GPi) has been reported as an effective treatment for CD. The purpose of the study is to determine the changes in volume and shape of the globus pallidus (GP), and other subcortical structures in CD.

**Materials & Methods**
Neuroimaging data was analyzed using the FIRST tool (part of FSL). Initially automated segmentation of subcortical structures (thalamus, pallidum, hippocampus, caudate nucleus, and putamen) was performed. The automated method is a probabilistic adaptation of the active appearance model, using the shape and intensity variations of structures from a training data set. Subsequently a multivariate Gaussian model of vertex location and intensity variation was applied, using point correspondence across subjects. A surface mesh for each subcortical structure was created with a deformable mesh model. Finally, group comparisons of vertices for each structure were performed for CD patients and matched controls using F-statistics.

**Results**
Vertex shape changes of the GP, thalamus and hippocampus were observed. For the GP, areas with the most significant...
regional atrophy and inward movement of vertices were found at the anterior pole and superior surface. (Figure A: mean shape of controls; B: mean shape of CD patients, arrows showing direction of localized change.) In addition, global atrophy and scaling was removed to determine isolated surface shape changes which in the absence of atrophy were localized to the superior surface of the pallidum, and a lateral rotation of the whole pallidum was observed. For the thalamus, the anterolateral pole as well as the supero-medial surface showed the most significant inward movement of vertices, demonstrating localized atrophy.

CONCLUSION
Subcortical structures including the GP and thalamus exhibited localized shape and volumetric changes. Current DBS of the GPi is an effective treatment for CD. Future surgical targeting may be enhanced by preoperative studies of pallidal shape and atrophy. In addition these findings may lead to further histologic studies to help elucidate the pathophysiology of this disease.

KEY WORDS: Cervical dystonia, thalamus, globus pallidus

Falcine Sinus in Adults: More than an Incidental Finding?

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PURPOSE
Falcine sinus is a rare entity that was reported recently to be an incidental finding with an incidence of 2% (1). The purpose of this study was to determine whether there is an association of falcine sinus with other brain abnormalities based on four adult cases and a literature review.

MATERIALS & METHODS
Retrospective review of neuroradiology reports at our institution identified four adult patients with falcine sinus (mean age 36.5 years). This study was approved by our institutional review board. Available studies included MR with and without contrast (4 cases), MR venography (2/4 cases), MR angiography (1/4 cases), CT angiography (CTA) (1/4 cases), and conventional angiography (1/4 cases). No dedicated vascular study was available in two patients, but the MR imaging was felt to be adequate to assess the caliber of the dural sinuses. The reports and images were reviewed by a senior neuroradiologist (AM) to characterize any other brain or skull abnormalities.

RESULTS
Falcine sinus was evident in all four cases (Figure 1A). Two patients had no other brain or skull anomalies. Two patients had bilateral enlarged parietal foramina (Figure 1B) and one of these two also had an absent tentorium cerebelli and falk cerebri, bilateral pachygyria, and vermian hypoplasia. All four patients had other vascular variants, including a hypoplastic transverse sinus, absent or hypoplastic inferior sagittal sinus, and prominent cortical veins.

CONCLUSION
Falcine sinus was associated with skull or parenchymal anomalies in 2/4 cases. Two patients had enlarged parietal foramina, which is commonly asymptomatic, but may be associated with headaches, obesity, hypogenitalism, microphthalmos, and mental retardation (2). Although falcine sinus will be detected more often as quality and volume of imaging increases, based on our experience and the literature, we suggest that there is sufficiently high probability of finding other abnormalities and it should not be considered merely an incidental finding (2, 3). Coincidental appearance of these anomalies, particularly parietal foramina that we found in 2/4 cases, seems unlikely considering the rare detection of this venous variant on routine imaging.

KEY WORDS: Falcine sinus, enlarged parietal foramina

REFERENCES

KEY WORDS: Falcine sinus, enlarged parietal foramina
Paper 503 Starting at 2:18 PM, Ending at 2:26 PM

Prevalence of Incidental Findings in Brain MR Imaging Research of an At-Risk Population

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PURPOSE
To report the prevalence of incidental findings in an at-risk population undergoing brain MR imaging (MRI) for neuropsychiatric research.

MATERIALS & METHODS
A total of 805 incarcerated subjects were scanned for functional MRI data from September 2007 to December 2009. As required by our institutional review board, a CAQ neuroradiologist (RAH 4 1/2 years experience) reviewed T1-weighted MPRAGE, and echo planar MR sequences. Subject scans were scored on a five point scale (minimally modified from previously published work (Bryan, et al. 1994): 0 = normal, 1 = no referral needed, 2 = routine referral, 3 = urgent referral and 4 = immediate referral. For a score of 3 or 4, the research center medical director communicated the results to the patient. All results were generated into an automated report which was sent to the appropriate personnel (and/or prison medical officials).

RESULTS
The overall prevalence of incidental findings (score of 1-4) was approximately 25%. No referral was needed in 23% of subjects, routine referral was suggested in 2% of subjects, and urgent referral was suggested in 0.4% of subjects, with no immediate referrals suggested.

CONCLUSION
Our results of a 25% overall prevalence of incidental findings on brain MRIs in 805 incarcerated subjects is in accord with that previously reported in the literature. Findings of our study are discussed in terms of our unique forensic population. Our results also emphasize the ethical importance of searching for incidental findings, particularly in at-risk populations.

KEY WORDS: Incidental findings, neuropsychiatric research, ethics

Paper 504 Starting at 2:26 PM, Ending at 2:34 PM

Late Effects of Cancer Treatment on Gray Matter Perfusion Assessed by Arterial Spin Labeling MR Imaging

Sedlacik, J. · Jain, N. · Morris, E. B. · Krull, K. R. · Armstrong, G. T. · Hudson, M. M. · Hillenbrand, C. M.
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Memphis, TN

PURPOSE
Cancer treatments have improved greatly over the last decades raising survival rates and curing more individuals. Consequently, late effects of treatment with radiation and chemotherapy have become more apparent. Therefore, expanding our knowledge in this area is necessary to hopefully minimize such effects for future patients. For example, animal studies found necrosis and altered vasculature 12 months after 20 Gy whole brain irradiation which continued to worsen over time (1). The same study also reported decreased cerebral perfusion for high doses of radiation (20 Gy), but not for lower doses (5-15 Gy). Purpose of our study was to explore potential late effects on gray matter perfusion assessed by arterial spin labeling (ASL) MR imaging in long-term survivors of acute lymphoblastic leukemia (ALL) and Hodgkin’s lymphoma (HL).

MATERIALS & METHODS
Arterial spin labeling MR imaging was measured in long-term survivors of ALL and HL who were treated about 20 years ago. ALL survivor subgroups received cranial radiation of 18 Gy (n = 9) or 24 Gy (n = 7). HL survivor subgroups received cardio toxic chemotherapeutics (anthracycline) and chest radiation under 30 Gy (n = 11) or no anthracycline chemotherapy but higher radiation over 30 Gy (n = 14). Arterial spin labeling MR imaging (Q2TIPS) measurement parameters were: TEs/Tr = 23 ms/2280 ms, T11/T12 = 700 ms/1400 ms, FOV = 210 x 210 mm2, matrix = 64 x 64, slice thickness = 5 mm, 11 slices. Quantitative cerebral blood flow (CBF) measures were calculated (2). Gray matter (GM) was segmented automatically from 3D high-resolution T1-weighted (MP-RAGE) whole brain scans by FAST (FSL-toolbox, FMRIB, Oxford, UK) and applied to CBF maps to obtain average global GM-CBF.

RESULTS
Figure 1 shows all results in detail. We found GM-CBF values for all subjects to be within normal range and overall lower GM-CBFs for older subjects. Both findings are consistent with literature (3). However, a trend to lower GM-CBFs for ALL survivors who received higher cranial radiation doses was found (p = 0.07). No distinct trend was seen for the different treatment subgroups of HL survivors (p = 0.15).

CONCLUSION
Our results suggest that long-term ALL and HL survivors do not suffer from grossly abnormal GM perfusion. However, slightly reduced GM perfusion was detected in ALL survivors who received higher cranial radiation doses about 20 years ago. This finding supports the recent development in ALL treatment omitting prophylactic cranial radiation (4). No difference in GM perfusion for HL subgroups suggests that the cardiotoxic effects of anthracycline level out with the lower chest radiation dose. However, future data evaluation by considering cardiac output may reveal potential late effects of cardio toxic cancer treatments.
Evaluation of Gadobutrol, a Macrocyclic, Nonionic Gadolinium Chelate in a Brain Glioma Model: Assessment of Lesion Enhancement vs Gadodiamide at 1.5 and 3 T with Additional Comparison of Half-Dose Imaging with Gadobutrol at 3 T to Full-Dose Imaging at 1.5 T

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PURPOSE
To compare equivalently dosed (0.1 mmol/kg) gadobutrol (Gadovist) and gadodiamide (Omniscan) in a rat brain glioma model with respect to lesion signal-to-noise (SNR), contrast-to-noise (CNR), and contrast enhancement (CE) at 1.5 and 3 T. Lesion enhancement with standard-dose gadobutrol in scans performed at 1.5 T also was compared to that of half-dose gadobutrol in scans performed at 3 T.

MATERIALS & METHODS
A set of 54 rats were injected with glioma cells via a plastic brain cannula and divided into three groups. The first group was randomly administered equivalent doses of gadodiamide and gadobutrol with 24 hours separating injections. Following each contrast injection, each experimental subject was scanned using a 3 T MR system. The procedure for the second group was similar, but scanning was performed at 1.5 T. For the third group, rats were given standard or half-dose gadobutrol and scanned at 1.5 and 3 T, respectively. For all MR examinations, T1-weighted images were obtained precontrast and at 1, 3, 5, 7, and 9 minutes postcontrast administration.

RESULTS
At 3 T SNR, CNR, and CE with gadobutrol ranged from 96.0-111.1, 38.2-53.7, and 49.2-60.2, respectively, vs values of 85.8-95.8, 29.3-39.7, and 35.4-45.8% with gadodiamide. These parameters were statistically significantly greater (0.001 < p < 0.01) with gadobutrol at every measured time point following contrast administration. The magnitude of such improvements in terms of SNR, CNR, and CE, respectively, ranged from 11.8-16.0%, 30.5-35.4%, and 27.1-31.5%. At 1.5 T values for these respective parameters were from 50.1-64.0, 13.8-27.5, and 18.4-32.3 with gadobutrol compared to 46.2-58.2, 10.7-21.9, and 14.2-25.8 with gadodiamide, differences that were again statistically significant (0.001 < p < 0.03) at every time point postcontrast. The degree of such increases ranged from, in terms of SNR, CNR, and CE, respectively, 7.0-11.1%, 27.1-35.8%, and 23.8-29.5% with gadobutrol over gadodiamide. In group 3, CNR ranged from 15.5-25.9 with half-dose gadobutrol at 3 T vs 17.5-28.1 with full-dose gadobutrol at 1.5 T. Contrast enhancement ranged from 21.9-32.9 vs 20.3-31.3, respectively, with neither differences in CE nor CNR reaching statistical significance (0.3 < p < 0.7). Signal-to-noise was significantly greater (28.5-35.1%; p< 0.0008) in the half-dose images performed at 3 T.

CONCLUSION
Gadobutrol is a promising macrocyclic gadolinium-chelate contrast agent currently undergoing phase three clinical trials in the United States. Lesion enhancement with this agent is greater than that obtained with gadodiamide in the rat brain glioma model. This factor combined with the improved theoretical and observed safety profile of gadobutrol vs the linear gadolinium chelates with regard to nephrogenic systemic fibrosis, renders gadobutrol a safe, efficacious alternative to the latter type of agents. The ability to image with half-dose gadobutrol at 3 T without a statistically significant decrease in lesion enhancement, compared to 1.5 T, offers an additional theoretical safety margin and potential cost savings.

KEY WORDS: Gadobutrol, contrast media, rat brain glioma

Ventricular Extension of Parenchymal Hemorrhage: Is It Indicative of a Hypertensive Etiology?

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PURPOSE
Hypertension is a frequent cause of intracranial parenchymal hemorrhage. Many hypertensive hemorrhages occur near the lateral ventricles, and blood may decompress from the parenchyma into the ventricles. However, the association between hypertension and ventricular decompression has not been proved in formal studies. The purpose of this study is to test the hypothesis that ventricular decompression of a parenchymal hemorrhage suggests a hypertensive etiology of the primary hemorrhage.

MATERIALS & METHODS
We searched the electronic records from a large academic tertiary care center for radiology reports that included the keywords “interventricular decompression” and “interventricular extension.” CT examinations that were performed during the initial patient presentation were included. Pediatric patients and patients who recently had undergone surgery were excluded. We reevaluated each examination to confirm the diagnosis of primary parenchymal hemorrhage with ventricular decompression, and to record the location and size of the primary hemorrhage, as well as the degree of ventricular decompression. The patients’ medical records then were reviewed to determine the etiology of the hemorrhage and to examine possible correlations with hypertension, anticoagulation, age, and gender.

RESULTS
The study population consisted of 314 adults: 181 males and 133 females, with an average age of 67.5 years. Hypertension was determined to be the sole or contributing cause of hemorrhage in 188 of the 314 patients (60%). Two
of the 314 patients (78%) were found to be hypertensive at the time of their hemorrhage. Examination of the subset of patients without anticoagulation yielded similar results. One hundred forty-seven out of 227 patients (65%) had a hypertensive etiology. The quantity of ventricular hemorrhage did not correlate with the probability of a hypertensive etiology, nor with the presence of coagulopathy. Location of the primary hemorrhage was a significant predictor of a hypertensive etiology. A hypertensive etiology was found in 75/107 patients (70%) with basal ganglia involvement; 74/86 patients (86%) with thalamus involvement, 65/157 patients (41%) with white matter involvement, and 39/92 (42%) of patients with cortical gray matter involvement.

CONCLUSION
Ventricular decompression of a parenchymal hemorrhage suggests hypertension as an etiology for the primary hemorrhage, even when controlling for coagulation status and location of the hemorrhage. Interestingly, the quantity of decompressed blood is not associated with the likelihood of either hypertension or anticoagulation as a cause of hemorrhage.

KEY WORDS: Parenchymal hemorrhage, hypertension, ventricular decompression

Dynamic Nature of Choroid Fissure Cysts: They Change over Time!

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PURPOSE
Nonneoplastic cysts have been described in the choroid fissure, with occasional reports linking them with seizures. We sought to review the characteristics of choroid fissure cysts and whether changes in size or mass effect occurred over time

MATERIALS & METHODS
A computer search of our institution’s radiology information system was performed of all brain MR studies done between 1998 to 2009, using the search terms “choroid” AND “cyst”. Of those patients with choroid fissure cysts on MR imaging, we subselected only those who had a follow-up MR imaging study to evaluate. In addition to assessing the characteristics of the cysts, mass effect on the hippocampus and changes with time were analyzed. The degree of hippocampal mass effect was graded as either mild (flattening of the superior convexity of the hippocampus), moderate (downward bowing of the hippocampus), or severe (greater than 50% decrease in height of the hippocampus).

RESULTS
A total of 22 patients with follow-up imaging were identified. Demographics consisted of: no sex predilection (11 male, 11 female); age at presentation ranging from 11 days to 55 years; and eight with a history of seizures. A total of 24 cysts were identified: 11 on left, nine on right and two patients had bilateral cysts. The cysts were isointense to CSF on all sequences, did not enhance with contrast, and shape was round in nine and oval in 15. Size varied from 2.6 mm to 29.9 mm in diameter. Severe hippocampal mass effect was noted in 10/24 cysts, moderate in 5/24 and mild mass effect was seen in 8/24 cysts. No mass effect was seen in one. Thin coronal images were best for identifying the cysts, their shape and hippocampal mass effect. Change in cyst size or configuration was assessed on follow-up studies with an interval range of 6 months to 11 years, and a mean of 5.6 years. Twelve of 24 (50%) cysts changed in size or configuration over time. One of 12 cysts increased in size, and 11/12 cysts decreased in size. One of the 11 cysts showed a slight increase in size followed by a decrease in size. Two cysts showed a change in shape with time. Change in hippocampal mass effect was noted in 6/12 (50%) cysts; these were in those cysts that changed in size over time, mirroring the significant change in size of these cysts.

CONCLUSION
Choroid fissure cysts should not be thought of as static lesions. They are dynamic, with 50% changing in size or shape over time. Mass effect on the adjacent hippocampus is variable, and mirrors the change in size of these cysts.

KEY WORDS: Cyst, choroid, fissure

Thursday Afternoon
1:30 PM – 3:00 PM
Room 210

(49e) Excerpta Extraordinaire: Interventional and Spine
(Scientific Papers 508 - 522)

See also Parallel Sessions
(49a) Adult Brain: Functional Imaging
(49b) Interventional: Arteriovenous Malformations/Fistulae
(49c) Spine: Other
(49d) Adult Brain: Anatomy of Brain and Other

Moderators: Jeffrey A. Stone, MD
Sudhir Kathuria, MD
Middle Ear Aneurysm Treated with an Innovative, Vessel Preserving, Aneurysm Occluding Stent

Symons, S. P. · Fuller, E. J. · Marotta, T. J. · Chen, J. · Willinsky, R. J. · Bharatha, A. · O’Kelly, C. · Hochman, J. · Howard, P. · Wolter, N.

1Sunnybrook Health Sciences Centre, Toronto, ON, CANADA, 2St. Michael’s Hospital, Toronto, ON, CANADA, 3Toronto Western Hospital, Toronto, ON, CANADA

PURPOSE
To describe the treatment of a rare middle ear aneurysm with an innovative, parent vessel preserving, aneurysm occlusion stent.

CASE REPORT
A 55-year-old woman presented with a 5-year history of chronic left otitis media, treated by antibiotics and myringotomy tubes. A middle ear mass was identified through a central perforation.

IMAGING FINDINGS
High-resolution CTA and MRA (Figure 1) identified an aneurysm arising laterally from the petrous ICA at the transition between the vertical and horizontal segments, extending into the middle ear. To manage this aneurysm, we proposed an endovascular technique whereby a vessel preserving, aneurysm occluding stent would be placed in the ICA across the aneurysm neck. The aneurysm would gradually thrombose while leaving the parent ICA patent, reducing the risks of stroke. Angiographic images (Figure 2) demonstrate the aneurysm preoperatively (A, B), the stent placement (C, D), and stasis in the aneurysm poststent placement (E, F). One day posttreatment CTA and MRA (not shown) demonstrated persistent aneurysm filling, not unexpected. Two-month post CTA (Figure 3) demonstrates aneurysm thrombosis with parent vessel preservation.

SUMMARY
Middle ear aneurysms are rare and difficult to treat. An innovation, parent vessel preserving, aneurysm occlusion stent is a treatment alternative.

KEY WORDS: Middle ear aneurysm, stent

Unrecognized Anterior Choroidal Supply to the Posterior Cerebral Artery Distribution Due to a Likely Congenital Giant Aneurysm of the Posterior Cerebral Artery

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University of Washington
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PURPOSE
To illustrate the misleading aspect of a nearly complete anterior choroidal artery (AchA) supply to the posterior cerebral artery (PCA) distribution and its consequence in inadequate therapeutic strategy.

CASE REPORT
A 17-year-old male presented with headache related to a ruptured giant aneurysm of the right PCA P2 segment, with initial CT evaluation. Cerebral angiography was performed to precise vascular anatomy relationship of the aneurysm. A hypertrophied AchA supplying nearly all the usual PCA distribution was mistaken for a fetal origin to the right PCA. The absence of PCA territory filling in the vertebral injection then was attributed erroneously to the mass effect caused by the giant aneurysm. Based on these preliminary conclusions, patient underwent neurosurgical removal of the aneurysm and microvascular anastomosis of the tiny P3 segment to one of the distal branches of the unrecognized AchA. With proper depiction of the AchA, endovascular treatment of the aneurysm would have been preferred, resulting only in the sacrifice of a limited temporo-inferior brain territory. The surgery was much more delabrant and put at risk for no reason the calcarine area supplied by the AchA, due to the bypass realized.

IMAGING FINDINGS
Vertebral injection shows the filling of the giant aneurysm, with no opacification of the usual PCA territory except for a small inferior temporal area coming from one single tiny vessel arising from the aneurysmal pouch itself (Figure 1). Right ICA injection shows a prominent right AchA supplying all of the parieto-occipital usual distribution of the PCA (Figure 2).
SUMMARY
AchA supply variations to the PCA distribution should be better known, for best treatment planning. This case illustrates an extreme variation, likely due to the congenital origin of the PCA aneurysm, and emphasizing the embryologic AchA territory. It also shows the potentially erroneous therapeutic choices that can result.

KEY WORDS: Anterior choroidal artery supply, posterior cerebral artery, giant aneurysm

Paper 510 Starting at 1:40 PM, Ending at 1:45 PM
Embolization of a Direct Carotid Cavernous Fistula Using a Combination of Coils and Onyx
Sivapatham, T. · Spiotta, A. · Hussain, M. · Fetko, C. N. · Stultz, T. · Moskowitz, S. · Gupta,
Cleveland Clinic Foundation
Cleveland, OH

PURPOSE
To report a novel approach for the treatment of direct carotid cavernous fistulas (CCF) using a combination of coils and Onyx.

CASE REPORT
The patient is a 54-year-old woman who presented with progressive right eye chemosis, proptosis, diplopia, and pulsatile tinnitus following a motorcycle accident approximately 3 weeks prior.

IMAGING FINDINGS
CT angiography of the brain demonstrated an enlarged right cavernous sinus (CS), concerning for CCF. Cerebral angiogram confirmed these findings, demonstrating a Barrow Type A direct right CCF, with marked engorgement of the right superior ophthalmic vein (SOV). The patient elected to undergo embolization of the CCF under general anesthesia. Six Fr sheaths were placed in the right common femoral vein (CFV) and left common femoral artery (CFA). A 6 F Envoy guide catheter with a .035" angled Glidewire were advanced through the right CFV into the right internal jugular vein (IJV) to the level of the jugular bulb. A second 6-F Envoy guide catheter/Glidewire were advanced through the left CFA into the right ICA. An Echelon-10 microcatheter/Synchro 2 microwire were introduced into a Penumbra 041 catheter, and the microcatheter was advanced through the right IJV guide catheter into the right CS. A 4 mm x 20 mm HyperGlide balloon was navigated into the cavernous segment of the right ICA, and placed over the site of the CCF. Angiography performed while the balloon was inflated in this position demonstrated decreased shunting as compared to the preprocedure angiogram. A total of 10 coils then were detached into the right CS. Postcoil angiography demonstrated persistent shunting through the CCF, and the decision was made to pursue further embolization of the right CS with Onyx. The balloon in the right ICA was inflated again. The Echelon 10 microcatheter/Synchro 2 microwire were advanced through the left CFA into the right ICA. An Echelon-10 microcatheter/Synchro 2 microwire were introduced into a Penumbra 041 catheter, and the microcatheter was advanced through the right IJV guide catheter into the right CS. A 4 mm x 20 mm HyperGlide balloon was navigated into the cavernous segment of the right ICA, and placed over the site of the CCF. Angiography performed while the balloon was inflated in this position demonstrated decreased shunting as compared to the preprocedure angiogram. A total of 10 coils then were detached into the right CS. Postcoil angiography demonstrated persistent shunting through the CCF, and the decision was made to pursue further embolization of the right CS with Onyx. The balloon in the right ICA was inflated again. The Echelon 10 microcatheter was flushed with DMSO. Embolization of the right CS was continued with Onyx 34, in combination with Onyx 18. Postembolization angiography was performed with the balloon deflated, and demonstrated near complete obliteration of the CCF. There was only minimal residual stagnant flow into the right SOV. The patient emerged from anesthesia with no new neurologic deficits. Eight week follow-up angiography demonstrated persistent occlusion of the CCF. The previously seen residual retrograde filling of the right SOV had resolved. The patient reported only mild residual diplopia, with resolution of all other symptoms.
SUMMARY
Coils and Onyx can be used in combination to safely and effectively treat direct carotid cavernous fistulas.

KEY WORDS: Fistula, Onyx, coils

Paper 511 Starting at 1:45 PM, Ending at 1:50 PM
Percutaneous N-Butyl-2-Cyanoacrylate Embolization for Recurrent Bleeding from a Large Fungating and Ulcerating Supraclavicular Region Melanoma Metastasis

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Vancouver, BC, CANADA

PURPOSE
To discuss a novel technique for management of significant external recurrent bleeding from a massive fungating malignant melanoma situated in the right supraclavicular region via direct puncture embolization using N-butyl-2-cyanoacrylate (n-BCA).

CASE REPORT
A 60-year-old man with a diagnosis of locally recurrent and metastatic melanoma was admitted to the palliative care unit of our institution with a history of recurrent bleeding from the tumor of approximately 6 week’s duration. On admission, his mass was fungating, approximately the size of a large grapefruit, in his right supraclavicular fossa, with tumor spreading across his right upper chest. Bleeding often was associated with trauma, such as accidental scraping of the wound or dressing changes, but occasionally occurred spontaneously. Though bleeding initially had not been severe, it became more significant, with the patient requiring repeated blood transfusions for symptomatic management. As repeat surgical resection of his tumor was not possible due to vascular involvement, and inability to irradiate the lesion due to maximum total dose already given, interventional neuroradiology was asked to provide care. Contrast-enhanced CT fully characterized location and extent of the patient’s known tumor, with catheter angiography showing a profoundly complex parasitized arterial supply to the fungating metastasis. Decision was made to embolize the tumor via percutaneous access, done with the patient under general anesthesia with endotracheal intubation, and with the benefit of digital subtraction angiographic control. A total of three sessions were done over the course of 3 months, with n-BCA (Histoacryl, Braun) liquid embolic (opacified with Lipiodol) injected via 22 gauge angiocatheter, and 22 and 25 gauge needles, directly into viable components of the tumor. Bleeding sites were preferentially targeted; however, upon successive treatments, it became evident that glue embolization resulted in “caramelization” of the treated sites, with no recurrent bleeding. Volumes of 30, 35, and 45 mL of n-BCA were injected over the three sessions, respectively. Though the tumor volume quadrupled over the course of his treatments, the patient had no further worrisome bleeding, and eventually expired from constitutional symptoms related to his palliative malignancy 3 months following presentation.

SUMMARY
We describe the novel treatment of a massive bleeding fungating melanoma metastasis using percutaneous n-BCA embolization directed at bleeding sites within the tumor, as well as nonbleeding viable tumor. This technique may be potentially useful for other patients presenting with malignancies where traditional management strategies have failed.

KEY WORDS: Bleeding, embolization, metastasis

Paper 512 Starting at 1:50 PM, Ending at 1:55 PM
Right Sigmoid Sinus Stenting and Angioplasty in Cranial Venous Outflow Obstruction and Intracranial Venous Hypertension

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Northwestern University
Chicago, IL

PURPOSE
To report on a case of cranial venous outflow obstruction and intracranial venous hypertension treated with right sigmoid sinus stent placement and angioplasty.

CASE REPORT
The patient was a 6-year-old male who presented with macrocephaly, prominent facial and scalp veins, limitation of strenuous activity and speech delay. On physical examination, he had a head circumference greater than 95th per-
centile, slight left eye extropia, bilateral optic disk pallor and decreased visual acuity. Neurologic examination was otherwise normal. One month prior to presentation, he underwent a left parietal and frontal bur-hole craniostomy to drain chronic bilateral subdural hematoma which was detected on his brain CT scan. The fluid collection was stable in size, with no midline shift or clinical symptoms. In our institution, a brain CT/CT angiogram was performed. Imaging findings included mild to moderate diffuse cerebral atrophy, bilateral subdural fluid collections (larger on the left) without midline shift, mildly dilated cerebral ventricles, diffuse cortical venous and dural sinus distension, with the dural venous system demonstrating multiple parallel channels, distended venous structures along the ventral aspect of the brain stem and cervical cord. The CT angiogram also demonstrated an area of severe stenosis in the distal right sigmoid sinus and a diminutive left transverse-sigmoid-internal jugular system. The constellation of findings was consistent with intracranial venous hypertension and partial venous outflow obstruction. An angiography was performed which revealed absence of the left sigmoid sinus and a hypoplastic left transverse sinus. Venous drainage for the supratentorial brain was found to be the right transverse and sigmoid sinuses into the right jugular veins with some participation of collateral veins such as the facial vein and extraosseous scalp veins. Collateral venous drainage for the posterior fossa was primarily via prepontine, premedullary and longitudinal veins of the spinal cord. A severe stenosis of the right sigmoid sinus, measuring 2.5 mm in diameter, was found. The diameter of the sigmoid sinus proximal to the stenosis was greater than 10 mm. The pressure in the right sigmoid sinus was 23 cmH2O with a right internal jugular vein pressure of 1 cmH2O. The right transverse sinus pressure was also measured at 23 cmH2O. An 8 mm stent was placed in the right sigmoid sinus which was followed by a balloon angioplasty of a residual stenosis.

**IMAGING FINDINGS**

Poststent pressure measurement in the right sigmoid sinus was 7 cmH2O with a right internal jugular pressure of 1 cmH2O. A postprocedure head CT scan at the same day showed a patent right sigmoid sinus and no evidence of thrombosis and a follow-up angiogram after 10 weeks showed a patent right sigmoid sinus stent, without a significant gradient across the stent. After 1 month patient had significant improvement in physical activity and speech and resolution of the prominent scalp and facial veins. Four months after the procedure evaluation revealed stable clinical improvement.

**SUMMARY**

Venous sinus stent placement and angioplasty can be safely performed to treat cranial venous outflow obstruction and intracranial venous hypertension.

**KEY WORDS:** Cranial venous outflow obstruction, venous sinus stenting, intracranial hypertension

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**Paper 513 Starting at 1:55 PM, Ending at 2:00 PM**

**Embolectomy in the Setting of Internal Cerebral Vein and Basal Vein Thrombosis**

Christoforidis, G.1 · Ammirati, M.2 · Yang, M.2

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**PURPOSE**

This exerpta describes the potential for mechanical embolectomy in the setting of internal cerebral vein and basal vein thrombosis.

**CASE REPORT/IMAGING FINDINGS**

A 20-year-old woman presented with symptoms of confusion and somnolence. Her past medical history was significant for use of oral contraceptives and dehydration due to exercise. Noncontrast CT demonstrated hyperdense, straight sinus, internal cerebral veins and basal veins of Rosenthal. Magnetic resonance imaging (MRI) and magnetic resonance venography (MRV) demonstrated signal abnormality within the thalami associated with occlusion of the deep venous structures. The patient was anticoagulated; however, her clinical condition deteriorated rapidly over the next 48 hours. Follow-up MRI 48 hours after the initial MRI, demonstrated extension of the signal abnormality with involvement of bilateral thalami and lentiform nuclei. The patient was referred for endovascular recanalization. On 3 consecutive days the patient underwent mechanical embolectomy of the straight sinus, internal cerebral veins, basal veins and straight sinus using Penumbra aspiration devices. Despite leaving a microcatheter overnight for continuous infusion of altepase after the first and second procedures, the straight sinus reoccluded. After the third embolectomy, the internal cerebral veins and basal veins remained recanalized; however, the straight sinus reocluded. The patient was able to develop collateral drainage via the deep middle cerebral veins and cavernous sinuses. Follow-up imaging demonstrated regression of the signal changes within the lentiform nuclei and thalami. Susceptibility-weighted imaging demonstrated some microhemorrhages within the thalami. Following the last procedure, the patient demonstrated clinical improvement and no neurologic sequelae at the time of hospital discharge.

**SUMMARY**

Mechanical thrombectomy for internal cerebral vein and basal vein thrombosis is feasible using the Penumbra aspiration system.

**KEY WORDS:** Internal cerebral vein thrombosis, embolectomy, thrombolysis
Purpose

New York, NY
Mount Sinai Medical Center
NY

To demonstrate a case of prominence of the epidural venous plexus in the lumbar spine mimicking an epidural mass and to discuss the importance of recognizing this finding to avoid unnecessary biopsy or intervention.

Case Report

The patient is a 49-year-old male with a 2-year history of low back pain, radiculopathy, and lower extremity numbness. He had undergone conservative management without significant improvement. He then was referred for surgical management. The patient underwent multiple MR imaging (MRI) examinations of the lumbar spine spanning several months, including June 2009, and two separate examinations in September 2009, 3 weeks apart. Initial noncontrast MRI examinations of the lumbar spine demonstrated degenerative changes of the spine. The patient returned for a contrast-enhanced MRI of the lumbar spine in late September 2009. The postcontrast MRI demonstrated a mass within the ventral epidural space at the L5 vertebral level. This finding developed between the September MRI examinations (over the course of approximately 17 days). Given the relatively rapid appearance, the possibility of a prominent epidural venous plexus was proposed. The patient underwent surgical intervention for disk herniation. During the procedure the neurosurgeon performed a digital palpation along the L5 ventral epidural space and described a soft pliable structure, consistent with a vascular structure.

Imaging Findings

Sagittal T2-weighted sequences from early September 2009 demonstrated multilevel disk herniation. MR imaging from late September 2009 demonstrated “a mass” posterior to the L5 vertebral body (arrow).

Summary

Engorgement of the epidural venous plexus can occur in multiple settings, including inferior vena cava/iliac vein occlusion and vascular abnormalities such as arteriovenous malformations and fistulas. Venous occlusion can result in lumbar epidural engorgement secondary to venous reflux into the valveless epidural plexus. This can result in a prominent epidural venous plexus or epidural venous varices. In the case presented, the patient had no known predisposing conditions and had previous imaging without evidence of epidural prominence. The presumed engorged epidural venous plexus was seen only on the preoperative MRI. Given the lack of this abnormality on the previous MRI examinations, this was felt to represent a prominent epidural venous plexus rather than a true mass. Recognition of a prominent epidural plexus on imaging is important to avoid misclassification as an epidural mass. Awareness of this entity and its imaging characteristics is essential to avoid unnecessary surgical intervention/biopsy given the vascular nature of this entity and its potential to bleed.

References


Keywords: Spine, venous plexus, anatomy

Paper 515 Starting at 2:05 PM, Ending at 2:10 PM

MR Imaging Findings in Toxoplasmosis of Spinal Cord

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Purpose

MR imaging findings of a rare case of toxoplasmosis of spinal cord are described in a patient who had bone marrow transplant following AML.

Case Report

A patient with matched unrelated donor (MUD) bone marrow transplant following AML presented with acute mental status changes and myelopathic symptoms. The diagnostic work up included MRI of brain and total spine.

Imaging Findings

Multiple high T2 signal lesions with ring and solid enhancement are seen in the spinal cord. The findings were proved by biopsy which showed toxoplasma tachyzoites.

Summary

The MR findings in a case with multiple intramedullary toxoplasmosis in a patient with MUD transplant following AML are discussed and the available literature is reviewed and the
diagnostic strategy in spinal cord lesions in posttransplant patients is proposed.

**KEY WORDS:** Spinal cord, infection, toxoplasmosis

**Paper 516 Starting at 2:10 PM, Ending at 2:15 PM**

Novel Technique for Penetrating Extremely Hard Bone during Percutaneous Vertebroplasty

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Tokyo, JAPAN

**PURPOSE**
To report a novel technique in penetrating very hard part of the vertebral body during percutaneous vertebroplasty (PV).

**CASE REPORT**
A 53-year-old man with metastatic prostatic carcinoma in the vertebral bodies was referred to us because of severe back pain. He had received hormone therapy and 40Gy radiation therapy to the Th11- L1 region, but his pain persisted despite administration of multiple analgesics.

**IMAGING FINDINGS**
MR imaging and CT showed osteoblastic metastases in multiple thoraco-lumbar vertebrae. There was also a compression fracture of Th11 with a gas-filled cleft in the anterior compartment, which was thought to be the cause of his pain, and PV was elected. During PV, it was extremely difficult to pass the needle through the sclerotic pedicles of Th11 which were hard like granite. The patient could not tolerate hammering of the needle, and the procedure was terminated. A week later, we reattempted PV, and this time we used a cordless battery-powered drill to penetrate the hard pedicle. Under local anesthesia, a metallic canula was passed through the paraspinal muscle and fascia to the surface of the left pedicle. Then, intravertebral drilling was performed by inserting the electric drill through the canula, which took approximately 5 minutes before reaching the gas-filled cleft. After intravertebral drilling, an 11-gauge spinal needle was passed into the cleft through the drilled tract, which was not difficult. Bone cement subsequently was injected into the cleft via the needle. Next day, the patient’s pain dramatically subsided, and he subsequently stopped using analgesics. He passed away 18 months after PV but was pain free to his death.

**SUMMARY**
Painful compression fracture in this patient might have occurred due to osteoporosis secondary to his hormone therapy and bone hardening was probably due to radiotherapy for osteoblastic metastasis. After this case, we modified the drilling technique to a simpler way and have successfully performed PV on 12 patients with osteoporotic compression fractures in whom the posterior components of the vertebral body were very hard to penetrate with a regular spinal needle.

**KEY WORDS:** Vertebroplasty, osteoblastic metastasis, drilling

**Paper 517 Starting at 2:15 PM, Ending at 2:20 PM**

Percutaneous Pedicle Screw and Rod Insertion for Painful Metastatic Compression Fracture of the Vertebral Body

Kobayashi, N. · Numaguchi, Y. · Ito, M. · Fuwa, S. · Ishiyama, M. · Saida, Y.
St. Luke’s International Hospital
Tokyo, JAPAN

**PURPOSE**
Percutaneous spinal fixation using pedicle screws and interpedicular rods (Sextant system) has been performed for spondylolisthesis, disk degeneration and traumatic compression fractures. We report our experience of this treatment for two patients who suffered from metastatic tumors of the vertebral body with spinal canal compromise.

**CASE REPORT**
Case 1. A 62-year-old man with back pain due to metastatic renal cell tumor was referred for percutaneous vertebroplasty (PV). Radiation therapy (40 Gy) had been given to the L1-L3 region. MR imaging showed compression fracture of L2 with destruction of half of the left side of the vertebral body. The spinal canal was moderately compromised by the fractured vertebra. We concluded that PV may not be sufficient to keep bone cement for a long time in the vertebral body of L2 and spinal cord compression may take place. Therefore, we elected for spinal fixation using a Sextant system.
between L1 and L3, bypassing L2. Percutaneous vertebroplasty was performed initially for L2 including the left pedicle and Th12, and percutaneous screws and rods fixation then was performed between L1 and L3 under fluoroscopic guidance (Figure). After the treatment, the patient became completely pain free which persisted for the next 11 months.

Case 2. A 57-year-old man suffered from compression fracture of Th11 and Th12 vertebral bodies due to metastatic lung carcinoma. Because of severe back pain for 2 months, he underwent radiation therapy (30Gy), but his pain persisted. Percutaneous vertebroplasty was performed for these vertebrae, and his pain dramatically subsided. However, he developed gradual loss of strength and sensation in his right lower extremity over the next 4 months. MR imaging showed spinal cord compression by the posteriorly displaced vertebral body of Th12. He was referred for intervertebral fixation using a Sextant system to prevent worsening of his symptoms. Pedicle screws and intervertebral rods were placed percutaneously via bilateral pedicles of Th10 and L1 bypassing Th11 and Th12 under fluoroscopic guidance without difficulty. His symptoms improved slightly with increased strength and sensation of the right lower extremity.

SUMMARY
We found that percutaneous placement of transpedicular screws and intervertebral rods is feasible and may be a good treatment for painful metastatic tumor of the vertebral body especially when large areas of the vertebral body is destroyed, or when the spinal canal is compromised by a fractured vertebral body.

KEY WORDS: Vertebroplasty, percutaneous spinal fixation, metastasis

Paper 518 Starting at 2:20 PM, Ending at 2:25 PM
Atypical Meningioma Mimicking a Primary Intramedullary Lesion: Utility of Tractography in Accurate Localization

Velayudhan, V., Pawha, P. S., Tanenbaum, L. N., Naidich, T. P.
Mount Sinai Medical Center
New York, NY

PURPOSE
Diffusion tensor imaging (DTI) and fiber tractography (FT) can be helpful in characterizing the location of spinal lesions based on the pattern of fiber tract involvement. This additional information can sometimes provide different conclusions about the lesion than those arrived at from conventional MR findings. To illustrate this point, we report a case of an extraaxial lesion of the cervical spine mimicking an intramedullary mass on conventional imaging, but more accurately localized on DTI and tractography.

CASE REPORT
A 49-year-old female presenting with a 1-year history of cervical radiculopathy, upper extremity paresthesia and numbness. Neurologic examination demonstrated mild right upper extremity weakness and diminished deep tendon reflexes proximally. Laboratory examination, including blood counts and metabolic profiles, were normal. The patient was referred for contrast-enhanced MRI and subsequently underwent cervical laminectomy and resection of a lesion seen on imaging. Intraoperatively, the lesion was found to be an intradural extramedullary mass that proved on pathology to be an atypical meningioma.

IMAGING FINDINGS
Conventional pre and postcontrast MR images and diffusion tensor images were obtained using a 1.5 T MR imaging scanner (Signa Excite; General Electric Medical Systems, Milwaukee, WI). Conventional MR imaging of the cervical spine revealed an eccentric high signal mass that appeared to expand the cord at the C2 level and demonstrated associated intramedullary signal on T2-weighted imaging cranial and caudal to the lesion. The lesion enhanced homogenously postcontrast. Diffusion tensor imaging was performed using single-shot echo planar imaging with fiber tractography performed at a GE processing workstation. Diffusion tensor imaging and fiber tracking demonstrated broadband eccentric displacement of the spinal cord fiber tracts in a pattern suggestive of an extrinsic mass. We will illustrate how this appearance is in contrast to fiber tractography patterns more typical of primary intramedullary cord tumors.
Localization of spinal lesions is a necessary first step in general differential diagnosis. Diffusion tensor imaging and FT can reveal additional findings beyond those seen with conventional MR imaging in the spine. These findings can provide information about lesion location even in cases where localization on conventional MR imaging is challenging.

**KEY WORDS:** Tractography, neoplasm, spine

### Paper 519 Starting at 2:25 PM, Ending at 2:30 PM

**Intraspinal Solitary Fibrous Tumor with Unusual T2 Hyperintensity Mimicking a Nerve Sheath Tumor**

Chakko, M. N. · Wang, A.
William Beaumont Hospital
Royal Oak, MI

**PURPOSE**
This case report presents a rare intraspinal solitary fibrous tumor as seen on MR imaging (MRI). The case is unusual in its hyperintensity on T2-weighted images.

**CASE REPORT**
An 81-year-old female presented with progressive upper extremity weakness and gait instability. MR imaging demonstrated an intradural, extramedullary mass posterior to the spinal cord centered at C4, compressing and displacing the cord. Near gross total resection and C3-C5 laminectomy were performed. The tumor was partially adherent to the dentate ligament and lateral aspect of the cord. Pathology demonstrated a moderately cellular tumor with a vague fascicular pattern and no nuclear atypia or necrosis. Immunoreactivity to CD34, CD99, bcl-2 and vimentin was positive. Staining for EMA and S-100 was negative. The patient was discharged to subacute rehabilitation 2 weeks after surgery. Solitary fibrous tumors (SFT) are indolent mesenchymal tumors, most frequently arising from the pleura. Malignant transformation and visceral dissemination is reported rarely (1). More rarely, the tumor is extrapleural in location, arising in the peritoneum or central nervous system. Central nervous system solitary fibrous tumors may be intramedullary, intradural extramedullary, or extradural. Immunochemistry is used to distinguish the solitary fibrous tumor from other spindle-cell neoplasms such as meningioma, hemangiopericytoma, as well as from schwannoma. Solitary fibrous tumors are typically low in signal on T2-weighted images, which may help in suggesting the diagnosis (2).

**IMAGING FINDINGS**
The mass was partially visualized on MRI of the brain, prompting additional imaging. Imaging of the cervical spine demonstrated the 2.4 x 1.4 x 0.9 cm intradural, extramedullary mass, posterolateral to the cord and extending from C3-C5. The mass was isointense on T1-weighted images, and demonstrated intense, homogeneous enhancement. Cord compression and myelomalacia were present with displacement of the cord to the right. Mild hyperintensity was seen on T2-weighted images. In review of the literature, this hyperintensity is unusual, in contrast with the more common T2 hypointensity. Initial diagnostic considerations included nerve sheath tumors, as well as unusual appearances of meningioma and hemangioma.

**SUMMARY**
This case illustrates a rare solitary fibrous tumor as an uncommon intradural, extramedullary mass, presenting with cord compression. Our case is unusual in its slight T2 hyperintensity.

**REFERENCES**

**KEY WORDS:** Spinal neoplasm, solitary fibrous tumor
Intraosseous Sacral Meningioma

Pastel, D. · Farley, E. · Belden, C. · Smith, S. · Padmanabhan, V.
Dartmouth-Hitchcock Medical Center
Lebanon, NH

PURPOSE
To describe an unusual case of a large intraosseous sacral meningioma in a patient presenting with severe low back and pelvic pain, and urinary incontinence.

CASE REPORT
A 46-year-old woman with a 6-month history of worsening back pain, labial numbness and difficulty walking presented with a more recent 4-day history of complete urinary incontinence and inability to ambulate. Past medical history was notable for cranial meningioma resections in 1988 and 1990. AP and lateral views of the lumbar spine revealed a destructive lesion involving the lower lumbar spine and sacrum. Imaging with CT and MR imaging (MRI) further characterized the lesion. Image-guided core biopsy of the lesion yielded a diagnosis of meningioma. The patient subsequently underwent preoperative embolization of the mass, but ultimately refused surgical intervention.

IMAGING FINDINGS
CT scan of the lumbosacral spine showed a 12 x 7cm expansile lytic lesion centered at the lumbosacral junction with extension into the spinal canal and posterior paraspinal region. The mass resulted in cortical thinning with areas of focal cortical destruction. No tumoral calcification was noted. Subsequent MRI revealed a T1 hypointense and heterogeneously T2 hyperintense lesion with homogenous enhancement. The mass obliterated the lower spinal canal and the bilateral L4-L5 and L5-S1 neural foramen. CT-guided biopsy of the lesion was achieved with a 22-gauge needle passed coaxially through an outer 18-gauge introducing needle. Preoperative embolization showed a mildly hypervascular mass fed by an enlarged median sacral artery which was embolized with particles.

SUMMARY
Extradural meningiomas are rare, accounting for 1 to 2% of all meningiomas. Intraosseous meningiomas represent two thirds of all extradural meningiomas. The vast majority of intraosseous meningiomas involve the skull. Three cases involving the mandible have been reported. Our case, to the best of our knowledge, is the first reported case of an intraosseous meningioma involving the lumbar spine and sacrum.

REFERENCES

KEY WORDS: Meningioma, sacrum, intraosseous

Paper 521 Starting at 2:35 PM, Ending at 2:40 PM

Radiation-Induced Cavernous Malformations of the Cauda Equina Mimicking Carcinomatous or Infectious Meningitis

Farid, N.1 · Zyroff, J.2 · Uchiyama, C. M.2 · Thorson, P. K.2 · Smith, C. R.2 · Imbesi, S. G.2
1University of California San Diego, San Diego, CA, 2Scripps Clinic, La Jolla, CA.

PURPOSE
To report an interesting and unusual case of radiation-induced cavernous malformations of the cauda equina mimicking carcinomatous or infectious meningitis.

CASE REPORT
A 68-year-old male with a remote history of testicular cancer and mantle field radiation therapy was admitted to the hospital with progressively worsening low back pain and diffuse right lower extremity weakness. MR imaging of the lumbosacral spine was obtained and cerebrospinal fluid (CSF) analysis was performed. Cerebrospinal fluid was negative for malignant cells and negative for viral, bacterial, fungal, and granulomatous infections. The patient underwent an L2-L3 laminectomy and intradural exploration which revealed diffuse widespread involvement of the cauda equina nerve roots with multiple distended venous structures and mulberry-like lesions. Histopathology of a biopsied specimen demonstrated thin-walled vessels devoid of intervening neuroglial tissue consistent with cavernous malformation.

IMAGING FINDINGS
Sagittal and axial postcontrast T1-weighted images demonstrated multiple nodular areas of enhancement coating the nerve roots of the cauda equina.
SUMMARY
The differential diagnosis of multiple nodular areas of enhancement coating the cauda equina is broad and includes metastases from distant primary malignancies such as lung and breast, drop metastases from primary CNS neoplasm, infectious etiologies such as tuberculosis and fungal infections, and inflammatory processes such as sarcoidosis. Although intramedullary cavernous malformation of the spinal cord is a well known entity, intradural-extramedullary cavernous malformations are much less common. Furthermore, the patient in our case had a history of radiation for remote history of testicular cancer, and the nerve roots of the cauda equina were included in his radiation port. Therefore, we presume that the multiple cavernous malformations in this case were radiation-induced. Although this particular entity has been described in the neurooncology literature, to our knowledge it has never been described in the radiology literature. In conclusion, in a patient with a history of radiation therapy in the lower abdomen and/or pelvis, cavernous malformations should be included in the differential for multiple nodular areas of enhancement coating the cauda equina in order to avoid potentially unnecessary and invasive biopsies and/or inappropriate treatment.

KEY WORDS: Cavernous malformation, cauda equina, radiation

Paper 522 Starting at 2:40 PM, Ending at 2:45 PM
Cauda Equina Paraganglioma Presenting as Acute Cervical Spinal Cord Hemorrhage

Lensing, F. D. · Webb, H. · Coimbra, C. · Layton, K. · Opatowsky, M.
Baylor University Medical Center
Dallas, TX

PURPOSE
To illustrate the unusual presentation of a rare neoplasm: cauda equina paraganglioma presenting with diffuse spinal cord hemorrhage first identified on cranial CT.

CASE REPORT
A 67-year-old hypertensive female who presented to the emergency department after acute development of right upper extremity weakness and bilateral lower extremity paralysis associated with sudden severe occipito-cervical pain.

IMAGING FINDINGS
Noncontrast computed tomography (CT) of the head was performed in the emergency department demonstrating an incompletely imaged, rounded hyperdensity in the right paramedian aspect of the proximal cervical spinal cord (Figure 1). Routine MR imaging (MRI) of the brain with intracranial and extracranial MR angiography (MRA) suggested an intramedullary mass in the cervical cord with surrounding T1 hypointensity favored to represent hemorrhage. Extensive intramedullary arteriovenous malformation (AVM) was the favored differential consideration. Craniocevical angiography was negative for AVM. MR imaging of the cervical spine demonstrated extensive hemorrhage and edema involving the entire visualized cervical cord. Further MRI of the thoracic and lumbar spine demonstrated a syrinx extending the entire length of the spinal cord containing hemorrhage. A 6.4 cm enhancing mass spanning the L1-L2 vertebral levels resulted in scalloping of the posterior margins of the L1 and L2 vertebral bodies (Figure 2) with suggestion of tumor extending to the S1 level. At surgery, the mass required en bloc resection.

SUMMARY
Pathology demonstrated paraganglioma arising from the cauda equina. Cauda equina paraganglioma is a rare intradural extramedullary lesion. This case is exceptional in the alacrity of presentation and the unusual imaging findings, which ultimately delayed the final diagnosis. Clinically, patients usually present with low back pain and symptoms of mechanical compression, commonly sciatica. The mass usually is discovered incidentally on imaging of the lumbar spine. This case emphasizes the importance of...
appropriate imaging in the setting of suspected spinal cord hemorrhage.

**KEY WORDS:** Paraganglioma, glomus

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**Thursday Afternoon**

3:30 PM – 5:00 PM  
Room 302-304-306

(50) ASSR Programming:  
Vertebroplasty and the Invest Trial

(523) Vertebroplasty and the Invest Trial  
— David F. Kallmes, MD

(524) Vertebroplasty and the Invest Trial  
— Joshua A. Hirsch, MD

(526) Vertebroplasty and the Invest Trial  
— Allan I. Brook, MD

Discusson

Moderators: John D. Barr, MD  
Jeffrey A. Stone, MD

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**Vertebroplasty and the Invest Trial**  
**David F. Kallmes, MD**

**LEARNING OBJECTIVES**

Upon completion of this presentation, participants will be able to:

1) Discuss the strength of evidence in support of spinal augmentation.

2) Review results from recent randomized augmentation trials.

3) Cite a research paradigm for moving the field of augmentation forward.

**PRESENTATION SUMMARY**

The results of recently published, blinded randomized controlled trials (RCTs) of spine augmentation have called into question the pain relieving efficacy of injecting medical cement into osteoporotic, vertebral compression fractures (1, 2). These trials showed similar benefit between spine augmentation and a “control intervention” in which the augmentation procedure was simulated, including the deposition of local anesthesia, but no cement infused. Many observers have noted, erroneously, that the results of these recent RCTs are at odds with their own, personal experience as well as the prior literature regarding spine augmentation. Indeed, rather than refuting the vast literature in support of augmentation, these RCTs confirm that clinical benefit after augmentation can be substantial. However, the benefit that is consistently observed in clinical practice and in unblinded augmentation registries and trials should now be looked at with a new perspective, a perspective that can only be gained through blinded RCTs. The immediate, statistically significant, clinically relevant, and sustained improvement in pain and function following the “control intervention” in these RCTs should refocus future research efforts not only to identify mechanisms of pain relief in these patients but also to probe potential subgroups in which augmentation may, in fact, be superior to a control intervention. Given the vast numbers of augmentation procedures carried out in the U.S., approaching 200,000 annually, a focused research effort by dedicated practitioners and investigators could achieve these research aims rapidly, to the benefit of patients.

**REFERENCES**


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**Vertebroplasty and the Invest Trial**  
**Joshua A. Hirsch, MD**

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**Vertebroplasty and the Invest Trial**  
**Allan I. Brook, MD**
Liquid Embolic Embolization for Intracranial Aneurysms

Robert A. Mericle, MD

Dr. Mericle received a Bachelor of Science in Biology/Zoology and a Bachelor of Arts in Psychology, both with highest honors, at the University of Oklahoma. He received his MD degree from Vanderbilt University in Nashville, Tennessee, during which time he was awarded the prestigious Canby Robinson Society Scholarship Prize, a 4-year, full-tuition scholarship. Dr. Mericle completed an Internship in General Surgery and a Residency in Neurological Surgery at the University of Florida in Gainesville, Florida. He also completed a 2-year Fellowship in Neuroendovascular Surgery at the State University of New York at Buffalo. Dr. Mericle is currently Associate Professor of Neurosurgery and Radiology at Vanderbilt University Medical Center. Dr. Mericle serves as the Residency Program Director for Neurosurgery and the Fellowship Program Director for Multidisciplinary Neuroendovascular training at Vanderbilt, in addition to serving as the Clinical and Research Director of Cerebrovascular and Neuroendovascular Surgery. He has published more than 70 peer-reviewed manuscripts, directed more than 25 physician courses/seminars, and has given more than 100 oral presentations in Neurovascular Surgery. His clinical interests include all aspects of Neurovascular Surgery and Interventional Neuroradiology, including Intracranial Aneurysms, AVMs, Trigeminal Neuralgia, Cerebrovascular Stenosis, Spinal AVMs, and Skull Base Surgery.

LEARNING OBJECTIVES

Upon completion of this presentation, participants will be able to:
1) Describe the findings of the U.S. Multicenter Randomized Controlled Trial Comparing Liquid Embolization and Coil Embolization of Intracranial Aneurysms.
2) Describe the findings of several International postmarket studies of Liquid Embolization for Intracranial Aneurysms.
3) Describe the findings of the U.S. Multicenter Physician-initiated Postmarket Study of Liquid Embolization for Wide-necked Intracranial Aneurysms.

PRESENTATION SUMMARY

Endovascular coil embolization has become routine for many intracranial aneurysms. Some limitations of coiling are an inability to completely occlude many aneurysms and delayed aneurysm recanalization. Liquid embolization offers the possibility of complete volumetric aneurysm occlusion and this could result in better outcomes. This presentation will describe the initial multicenter randomized controlled trial (RCT) comparing liquid embolization (OnyxHD500) to standard coil embolization (GDC) for intracranial aneurysms, and then will describe several physician-initiated postmarket studies of liquid embolization in wide-necked intracranial aneurysms. Part 1 of the RCT was stopped because early complications were encountered that were believed to be preventable. After several device improvements and protocol modifications, the RCT resumed (Part 2). In Part 2, the primary endpoint reached significance. Enrollment became very slow because many investigators believed liquid embolics were more appropriate for wide-necked aneurysms and coils were more appropriate for small-necked aneurysms. Therefore, the RCT was stopped.
and an analysis was performed of all cases in Part 2, as well as the wide-necked aneurysm subset. The FDA eventually granted Humanitarian Use Device (HUD) approval for the liquid embolic device. Afterwards, several physician-initiated postmarket studies of wide-necked intracranial aneurysms were performed. In the U.S., 18 physicians at 16 institutions submitted data for 141 procedures in 132 patients with liquid embolization in wide-necked intracranial aneurysms. All submitted cases were analyzed for rates of angiographic success (greater than 90% occlusion of the aneurysm volume), mortality and morbidity rates, as well as recanalization rates at 6 months. In Part 2 of the RCT, the liquid group had superior primary endpoint outcomes compared to coils (78.3% vs 36.4%, p = 0.026) with no significant differences in safety. In the wide-necked aneurysm subset of the RCT, liquids also had superior primary endpoint outcomes compared to coils with either intention-to-treat analysis (88.2% vs 59.4%, p = 0.052) or an analysis based on actual treatment received (100% vs 69%, p = 0.018). The postmarket studies of liquid embolization also showed significant benefit of liquid embolization in wide-necked aneurysms. Liquid embolization of intracranial aneurysms appears to have improved angiographic results and lower recanalization rates compared to coil embolization. The mortality and morbidity rates appear to be similar to coil embolization.

**Balloon Remodeling**

*Richard P. Klucznik, MD*

**LEARNING OBJECTIVES**

This is a case based selection. Through presentation of selected cases the indications for treatment of wide-necked aneurysms with balloon remodeling will be discussed with potential guidelines, pitfalls and complications.

**PRESENTATION SUMMARY**

The endovascular treatment of aneurysms was made possible with the advent of Guglielmi detachable coils but a subset of aneurysms could not be treated - those with wide necks. Despite different coil engineering for many years aimed at wide-necked aneurysms, it was not until the advent of balloon remodeling first reported by Moret et al. that allowed for treatment of these wide-necked aneurysm and opened up endovascular treatment to a larger population. The procedure consists of inflating a soft compliant balloon across the aneurysm neck placing coils to prevent herniation. It is also a safety maneuver in case of aneurysm rupture during coil placement. The balloons themselves have advanced from the early iteration from MTI Corporation. Now the compliant Hyperglide and super compliant Hyperform balloons by EV3 Corporation are standard in the treatment of aneurysms. Newer techniques using balloons such as two catheters in an aneurysm that balloon remodeling will be shown as well as a discussion of when balloon use may be favored over stenting. One such indication is subarachnoid hemorrhage where the use of Plavix may be prohibited. Onyx HD-500 is now released by the FDA and is widely in use for the treatment of aneurysms and a balloon that is compatible with DMSO must be utilized. Smaller (3 mm) and larger (5 mm) balloons are now available. For the first time in many years a new balloon system, the Ascent by Micrus Corporation has been developed which is an over the wire balloon system similar to the old Commodore. The advantage is that the multiple choices of wire that can be used with this balloon and the wire does not have to be in place for the balloon to be inflated.

**REFERENCES**


**Stent Assisted**

*Hashem M. Shaltoni MD*

**Flow Diverters**

*David J. Fiorella, MD, PhD*

**LEARNING OBJECTIVES**

Upon completion of this presentation, participants will be able to:

1) Define the putative mechanism of action of the flow diverting stents.
2) Relate aneurysms which are potentially amenable to treatment with flow diverters.
3) Describe the potential limitations of an endoluminal approach to aneurysm treatment.

**PRESENTATION SUMMARY**

Flow diverting stents are promising new devices which are being developed for the treatment of intracranial aneurysms. This technology remains investigational in the United States, but some flow diverters have been approved recently for commercial sale in Europe. We will review the putative mechanisms of action of these devices, as well as their potential applications and limitations. In addition, individual case examples and evolving clinical data also will be presented.
Evaluating Infarct Time Course on Diffusion-Weighted Images

James D. Eastwood, MD

LEARNING OBJECTIVES
Upon completion of this presentation, participants will be able to:
1) Review the time course of diffusion change after stroke.
2) Summarize the state of knowledge in this field.

PRESENTATION SUMMARY
This presentation will primarily review the time course of diffusion changes in the setting of acute stroke.

Assessing Tissue Viability

Pamela W. Schaefer, MD

LEARNING OBJECTIVES
Upon completion of this presentation, participants will be able to:
1) Cite advanced CT and MR imaging methods for identifying infarct core and ischemic penumbra in acute ischemic stroke patients.
2) Recognize technical and physiologic factors that affect the determination of infarct core and ischemic penumbra in acute ischemic stroke patients.
3) Discuss how semi-quantitation and quantitation of infarct core and penumbra can be used in conjunction with clinical stroke scales for clinical decision making.

PRESENTATION SUMMARY
This talk will address how we assess CT and MR images to determine whether ischemic tissue is (1) irreversibly infarcted, (2) potentially salvageable if reperfusion can be established, or (3) oligemic but likely to survive regardless of therapy. Specifically, the utility of noncontrast CT, CTA source images, DWI, cerebral blood volume (CBV), cerebral blood flow (CBF) and transit time measures for the delineation of infarct core will be discussed. The utility of CBF and transit time measures for the delineation of ischemic penumbra will be discussed. Visual inspection of abnormalities as well as absolute and relative thresholds for tissue viability will be presented. How timing of reperfusion affects these thresholds also will be discussed. Technical factors such as selection of arterial input function and use of delay correction will be highlighted. The lack of standardization of postprocessing software perfusion packages and how this affects our ability to determine thresholds for tissue viability will be covered. Methods of quantitating the volumes of infarcted tissue and of ischemic penumbra, and using these volumes in combination with clinical stroke scales to determine treatment also will be included in the presentation.

MR Imaging of TIAs and Hyperacute Stroke

Alex Rovira-Cañellas, MD

LEARNING OBJECTIVES
Upon completion of this presentation, participants will be able to:
1) Analyze knowledge on the role of MR imaging in predicting the risk of recurrent stroke in TIA patients
2) Discuss the available imaging strategies to select acute stroke patients for thrombolytic therapy
3) Explain the limitations of the diffusion-perfusion mismatch concept for selecting acute stroke patients for reperfusion therapy

PRESENTATION SUMMARY
MR Imaging of TIA. MR imaging is the most appropriate neuroradiologic technique for imaging the brain because of the high sensitivity of diffusion-weighted (DW) sequences for showing acute infarction. In fact, DW imaging demonstrates acute ischemic lesions in 30% to 50% of classically defined TIAs. This group of patients has a greater rate of early recurrent TIA and stroke than patients with normal DW imaging results. Therefore, MR imaging has relevant prognostic value in TIA patients because it can discriminate between those with a high risk of recurrent stroke and those with a low risk, a fact of utmost relevance, as the former require immediate secondary prevention treatment. MR Imaging of Hyperacute Ischemic Stroke. Multiparametric MR imaging, consisting of DW and perfusion-weighted (PW) imaging plus MR angiography, is performed routinely in some institutions to select acute stroke patients for reperfusion therapy, particularly beyond the 3-hour time window, although the evidence that this strategy should be a part of routine practice remains weak. Some authors have suggested that infarct patterns can be differentiated in hyperacute stroke by means of the diffusion-perfusion mismatch concept, which indicates the presence or absence of potentially salvageable ischemic brain tissue. Despite the known limitations of this strategy some clinical trials have proved that it
is useful and safe for selecting patients who may benefit from thrombolysis beyond the 3-hour time window. Brain MR imaging plays an essential role in selecting TIA patients who may require immediate secondary prevention treatment, and in selecting hyperacute ischemic stroke patients who may benefit from reperfusion therapy, particularly beyond the 3 to 4.5-hour window.

REFERENCES
5. Wintemberg M, Rowley HA, Lev MH. Acute stroke triage to intravenous thrombolysis and other therapies with advanced CT or MR imaging: pro CT. Radiology 2009;251:619-626

Thursday Afternoon
3:30 PM – 5:00 PM
Room 312

(53) Advanced Imaging Seminar: New Developments in Molecular Imaging

(535) Functional Molecular Imaging with MR-PET
— Bruce R. Rosen, MD, PhD

(536) Advances in Neuro-PET
— Satoshi Minoshima, MD, PhD

(537) Imaging Stem Cell Fate and Therapeutic Efficacy in Brain Tumor Models
— Khalid Shah, PhD

Moderator: Carolyn C. Meltzer, MD, FACR

Functional Molecular Imaging with MR-PET
Bruce R. Rosen, MD, PhD

LEARNING OBJECTIVES
Upon completion of this presentation, participants will be able to:
1) Discuss how the fundamental imaging properties of PET and MRI compare to one another.
2) Review forms of morphological, physiological, and metabolic information.
3) Summarize how information from one modality can be used to inform the other.
4) Review what potential clinical applications are most likely to be used.

PRESENTATION SUMMARY
The fields of functional and molecular imaging have grown at a rapid rate in recent years, as imaging technologies enable finer examination of the human brain and other organs, and as clinicians and researchers seek to understand mechanisms that underlie conditions, cancer, stroke, neurodegenerative disease, and psychosis. Early detection of disease and monitoring of potential therapeutic interventions requires technology sensitive to subtle changes that occur at the cellular and molecular level. PET and MR imaging (MRI) are widely used in vivo for clinical and research applications. Using both intrinsic contrasts (MR) and with novel MR, nuclear, and multimodal probes, these imaging modalities have begun to revolutionize the types of questions that can be asked in vivo, permitting examination of physiologic and pathologic functions in living cells, tissues, and organs at their basic level. Used in combination, individual strengths of MRI and PET can inform one another to yield new insights that expand the types of physiologic information that can be gained through in vivo imaging and thus expand the impact on human health by imaging an enlarging window of time scales, resolution, sensitivity, and specificity. The latest generation of simultaneous, combined MR-PET imaging technology allows investigators to employ benefits of MRI such as phased-array coils for high speed, high-resolution functional imaging, while simultaneously acquiring quantitative metabolic or receptor-specific biochemical data acquired with PET. Simultaneous MR-PET imaging has distinct advantage of cotemporaneous spatial coregistration of biochemical function with anatomical structure. MR-PET allows researchers to temporally coregister physiologic data using PET and functional MRI (fMRI), such that the hemodynamic or metabolic information from fMRI may be used to feed quantitative analysis of PET data. Researchers can understand the interplay between blood flow, receptor occupancy, and metabolism - as well as the contributions of each in disease and therapy response. Back-to-back independent MRI and PET scans lose this powerful temporal information, which correlates real-time biometrics with in vivo biochemistry. The quantitative capabilities of the combined MR-PET technology exceed those of the two modalities alone. Combined MR-PET has significant clinical potential to impact not only all aspects of patient care, from screening to disease assessment and therapy monitoring, but also to lead to new dual-modality MR-PET probes that can provide complementary information for precise quantitative assessment of biological function not obtainable in other ways.
Advances in Neuro-PET
Satoshi Minoshima, MD, PhD

Imaging Stem Cell Fate and Therapeutic Efficacy in Brain Tumor Models
Khalid Shah, PhD

LEARNING OBJECTIVES
Upon completion of this presentation, participants will be able to:
1) Demonstrate the use of stem cells in brain tumor therapy
2) Trace the fate of stem cells and tumors in real time

PRESENTATION SUMMARY
Novel therapeutic agents are emerging as important treatment options for cancer. However, inefficient delivery and the lack of noninvasive methods to follow delivery, pharmacokinetics and efficacy has been a limitation in elucidating their effects in vivo. Stem cell homing to tumors in the brain represents an attractive modality for onsite-delivery of therapeutic molecules to tumors. Emphasis will be on the utility of optical imaging techniques in assessing the fate of stem cells, brain tumors and pharmacokinetics of proapoptotic, antiangiogenic and antiproliferative therapeutic proteins released from stem cell in different mouse models of glioblastoma. This will demonstrate the strength of employing engineered stem cells and real time imaging of multiple events in preclinical-therapeutic tumor models.

Thursday Afternoon
5:00 PM – 5:15 PM
Ballroom ABC

(54) Closing Remarks

(538) Closing Remarks
— Carolyn Cidis Meltzer, MD, FACP
ASNR President

Closing Remarks
Carolyn Cidis Meltzer, MD, FACP
Scientific Posters 1–195
Exhibition Hall C

Monday, May 17, 6:30 AM through Thursday, May 20, 3:00 PM

Note: A missing Scientific Exhibit number indicates an abstract has been withdrawn.

Poster 1

Accurate Prediction of the Motor Physical Exam from Admission Diffusion-Weighted Images in Acute Stroke Patients: A Semiautomated Technique for Structure/Function Correlation

Wang, Y.1 • Payabvash, S.2 • Souza, L. C. S.2 • Gonzalez, G. R.1 • Furie, K. L.2 • Lev, M. H.2

1University of Western Ontario, London, ON, CANADA, 2Massachusetts General Hospital, Boston, MA

PURPOSE
To develop a semiautomated tool that predicts the degree of limb paresis - as measured by NIH stroke scale score (NIHSS) - based on the percentage of infarction in brain parcellations from admission MR DWI.

MATERIALS & METHODS
We retrospectively reviewed the imaging data and clinical data of 155 patients presenting within 12 hours of unilateral ischemic stroke onset. The infarct core was segmented manually from DWI for each patient, and automatically coregistered to the MNI-152 standard brain space. Talairach and CMRM atlases were used to automatically parcellate the entire frontal lobe and deep white matter tracts into 64 distinct cortical and subcortical regions. Using the percentage of infarction in each of these regions, we constructed a multivariate model that predicts the degree of motor paresis for each extremity based on the NIHSS score at the time point closest to imaging. Ordered logistic regression was used to determine the optimal predictive brain regions.

RESULTS
The brain regions that best correlated with NIHSS score for motor function in the upper limbs were the subgyral and middle frontal gyrus white matter, and the posterior limb of the internal capsule. The best predictors of lower limb paresis were the superior and medial frontal gyrus white matter, as well as the posterior limb of the internal capsule. The multivariate model predicted motor dysfunction with a positive predictive value of 92% for the left upper extremity (LUE), 89% for the right upper extremity (RUE), 85% for the left lower extremity (LLE), and 91% for the right lower extremity (RLE). Moreover, the model correlated with the various NIHSS motor function scores to within a ± 1 point error in 76% of cases for the LUE, 81% for the RUE, 66% for the LLE, and 83% for the RLE.

CONCLUSION
The location and volume of infarction on admission DWI strongly correlates with clinical motor dysfunction in acute stroke patients, and can be modeled with high accuracy using a semiautomated technique. This approach may be especially valuable in the management of stroke patients in whom a reliable physical exam is not possible. It has the potential to be applied to other clinical components, including swallowing, aphasia, and vision, and also might be generalized - using perfusion mapping - to predict the potential for clinical recovery based on core/penumbra mismatch.

KEY WORDS: Stroke, DWI
Clinical Evaluation of iPhone Platform-Based Teleradiology System for the Diagnosis of Acute Stroke

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PURPOSE
Recent advances in the treatment of acute ischemic stroke have made rapid visualization and interpretation of relevant images a key factor in triaging and treating patients. However, availability of medical grade display monitors and laptops may be limited to experts in the field especially outside of routine hours. Most physicians carry smartphones or personal digital assistants all the time and these may function as mobile medical viewing devices. We developed a client-server system that allows visualization of medical images on the iPhone (Apple Inc., Cupertino, CA) and decided to assess its accuracy for the diagnosis of acute stroke.

MATERIALS & METHODS
We developed a system that allows visualization of medical images on the iPhone. The patient data remain on the visualization server and are not saved on the iPhone device. The server converts DICOM images to JPEG images and wirelessly streams the JPEG images to the iPhone. Images were viewed on the iPhone using locally developed client program which allowed 2D and 3D visualization of images. The server can rapidly load the imaging data on iPhone and allows interpretation to begin almost immediately. Institutional review board approval was obtained to review CT and CT angiograms on patients presenting with symptoms suggestive of acute stroke. One hundred twelve noncontrast CT and 65 CT angiogram of the head were viewed retrospectively on an iPhone-based teleradiology system by two neuroradiologists. The images were analyzed for hemorrhage, stroke mimics, and presence of early ischemic changes on noncontrast CT head and presence of thromboembolism on the CT angiogram. The results were compared against a workstation equipped with a medical-grade display.

RESULTS
Both readers detected acute parenchymal hemorrhages and stroke mimics with 100% accuracy and perfect agreement between two readers (Kappa: 1). Both readers detected acute parenchymal ischemic changes with a very high accuracy (98.99%) and low interobserver variability (kappa: 0.81). The accuracy was not very high for detection of hyperdense vessel sign as there were false positives and false negatives on the iPhone. Both readers detected arterial thromboembolism on CT angiogram with a very high accuracy (99%) and perfect agreement between both readers (kappa: 1). In no patient would the iPhone interpretation have resulted in difference in patient management.

CONCLUSION
iPhone-based teleradiology developed by our informatics lab is highly accurate in the diagnosis of acute stroke. It allows rapid visualization of large datasets such as CT angiograms and obviates concerns related to patient confidentiality.

KEY WORDS: Stroke, teleradiology, smartphone
bypass, BOLD MR imaging

modelling different temporal patterns in the analysis. The BOLD-response to apnoea could be captured best by sized that the great interindividual variability encountered in apnoea functional MR imaging (BOLD-fMRI). We hypothe-

extra or intracranial stenosis, and studied the feasibility of apnoea in recently symptomatic patients with suspected stroke. We imaged BOLD-signal changes in reaction to symptomatic stenosis is a strong predictor for disabling

anterior circulation.

A tandem stenosis. Three patients had a stenosis in the poste-

patients the negative BOLD-response was present in the anterior and posterior circulation, although a stenosis was found only in either territory. BOLD-response was normal in 47% of the patients with extracranial stenosis; intracranial or tandem stenoses led to a normal BOLD-response in only 26%. The MR angiograms in 36 patients showed a stenosis in the anterior circulation, extra and intracranial stenoses were distributed equally (n = 16 each) and four of them had a tandem stenosis. Three patients had a stenosis in the posterior circulation and four patients in both the anterior and posterior circulation.

CONCLUSION

It is promising to use different temporal models in the analys-
is of hypercapnia-induced BOLD-changes. Our method of analysis yielded more than 80% of assessable data sets. Intracranial and tandem stenoses more often caused a patho-
logic BOLD response than extracranial stenosis. Whether a brain region with abnormal BOLD response/impaired CVR represents tissue at risk has to be studied.

KEY WORDS: Cerebrovascular accident, cerebrovascular reserve, functional imaging

Poster 4

Temporal Pattern of Regional Cerebrovascular Reserve in Patients with a Cerebrovascular Accident

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PURPOSE

An impaired cerebrovascular reserve (CVR) ipsilateral to a symptomatic stenosis is a strong predictor for disabling stroke. We imaged BOLD-signal changes in reaction to apnoea in recently symptomatic patients with suspected extra or intracranial stenosis, and studied the feasibility of apnoea functional MR imaging (BOLD-fMRI). We hypothe-
thesized that the great interindividual variability encountered in the BOLD-response to apnoea could be captured best by modelling different temporal patterns in the analysis.

RESULTS

Treating each hemisphere individually, there were a total of 41 revascularization procedures which resulted in improved CVR in 37 hemispheres. Angiography demonstrated bypass patency in 35 procedures (31 STA-MCA and 4 EDAS), 2 of which did not show an improvement in CVR. In the 6 angiographically demonstrated nonpatent bypass procedures (4 STA-MCA and 2 EDAS), 4 demonstrated improvement in CVR. The mean clinical follow-up period was 14.2 months. Clinically, revascularization resulted in 1) an improvement in MRS scores after 18 procedures, 2) a stable MRS score after 20 procedures and 3) a deterioration in MRS scores after 3 procedures. In the 3 patients that deteriorated, 1 died of massive cerebral hemorrhage and in the other two, the revascularization procedure failed to improve focal brain regions based on CVR mapping. These areas were associat-
ed with the persisting clinical deficit.

CONCLUSION

The use of EC-IC revascularization in moyamoya patients with preoperatively identified hemispheric impairment in CVR improves both, hemispheric CVR and clinical outcome. Additionally, the postoperative BOLD MR CVR corre-
lates well with by-pass patency and clinical outcome. BOLD MR CVR provides information on the tissue level improve-
ment in vascular reserve. BOLD MR CVR can therefore be used to determine efficacy of graft revascularization which is not determined easily with angiographic methods.

KEY WORDS: Moyamoya disease, extracranial intracranial bypass, BOLD MR imaging

MATERIALS & METHODS

Fifty-two patients (22 females; aged 38 to 81 years, mean/median 62.5 years) with a recent history of TIA or stroke were examined with apnoea fMRI, besides routine MR imaging and MR angiography. The fMRI time series were preprocessed and analyzed using functional imaging software (SPM5). Six different temporal models were ana-
yzed. They differed by the onset of the modelled “activation block” which was shifted by multiples (0-5) of the repetition time (TR: 3.57 s). The resulting parametric images were superimposed onto the respective morphologic T2-weighted image and analyzed in a three-reader consensus reading. The readers were blinded to the vessel status.

RESULTS

The parametric maps of 10 patients were not assesseable. The remaining 42 sets were judged to be readable (20 good, 16 medium, 6 sufficient). In 23 cases the model with a time shift of twice TR (7 s) showed best results. Second best model was 4 x TR (10). In 14 patients apnoea led to the expected positive BOLD-response in the whole brain and was judged as normal; although the vessel status was normal in only six patients. The parameter maps of 28 patients showed signifi-
cant regional differences in the BOLD-response and were judged to have an impaired CVR. In 18 patients a negative BOLD-response corresponded to the site of stenosis. In three patients the negative BOLD-response was present in the anterior and posterior circulation, although a stenosis was found only in either territory. BOLD-response was normal in 47% of the patients with extracranial stenosis; intracranial or tandem stenoses led to a normal BOLD-response in only 26%. The MR angiograms in 36 patients showed a stenosis in the anterior circulation, extra and intracranial stenoses were distributed equally (n = 16 each) and four of them had a tandem stenosis. Three patients had a stenosis in the poste-
rior circulation and four patients in both the anterior and pos-
terior circulation.

CONCLUSION

It is promising to use different temporal models in the analysis of hypercapnia-induced BOLD-changes. Our method of analysis yielded more than 80% of assessable data sets. Intracranial and tandem stenoses more often caused a patho-
logic BOLD response than extracranial stenosis. Whether a brain region with abnormal BOLD response/impaired CVR represents tissue at risk has to be studied.

KEY WORDS: Cerebrovascular accident, cerebrovascular reserve, functional imaging
Poster 5
Usefulness of CT Perfusion, CT Angiography and Nonenhanced CT in the Evaluation of Acute Ischemic Stroke Patients with Unknown Onset Time

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PURPOSE
To investigate benefit of emergent CT Perfusion (CTP), CT Angiogram (CTA) and nonenhanced head CT (CT) in assessment for interventional or aggressive medical therapy in ischemic stroke patients with unknown onset time.

MATERIALS & METHODS
Our stroke center protocol for suspected ischemic stroke patients includes emergent CTP, CTA, and head CT for the assessment of brain tissue viability (i.e., penumbra). We hypothesize that a clinical outcome can be predicted based on the presence/absence of early CT stroke changes and presence/absence of markedly decreased cerebral blood volume (CBV). Patients with normal-to-minimally decreased CBV and no CT stroke changes underwent intervention using intraarterial (IA) TPA and/or mechanical embolectomy. Patients who met these parameters but were not candidates for intervention due to other factors (i.e., low NIH scale score [NIHSS]) underwent aggressive medical management (i.e., tight blood pressure control) in the intensive care unit (ICU). Postintervention nonenhanced head CT or MR imaging was performed. Clinical outcome was measured using NIHSS upon admission and discharge.

RESULTS
A preliminary analysis performed from November 2007 to October 2008 for this ongoing study demonstrated 24 patients who presented with unknown stroke onset time: 11 males and 13 females. Age ranged from 30 to 89 years (median age 68 years). Admission NIHSS ranged from 1 to 34 (median 16). Ten of 24 patients showed unfavorable CTP with decreased CBV and early stroke changes on CT. Twenty-four of 24 patients had normal or minimally decreased CBV and negative head CT. Four cases had right internal carotid artery (ICA) plus middle cerebral artery (MCA) occlusions, and 10 cases had MCA occlusions. Seven of 14 cases had further intervention: 1 IA tPA alone, 2 mechanical embolectomy alone, and 4 IA tPA and mechanical embolectomy. Admission NIHSS ranged from 9 to 34 (median 15) and discharge NIHSS ranged from 4 to 20 (median 9). Illustrated on Figure 1. One of 7 patients developed an intraparenchymal hematoma without mass effect postintervention. No further intervention was performed on 7/14 cases with negative head CT and favorable CBV based on the following clinical, imaging, or angiographic findings: collateral circulation, distal segment occlusion, low NIHSS, and vessel stenosis. ICU observation with tight BP control was recommended on these cases.

CONCLUSION
Imaging workup (CT, CTA, CTP) in patients with unknown stroke onset identifies selected cases with a positive benefit-to-risk ratio (normal to minimally decreased CBV and negative head CT) for acute intervention. This practice can have a noticeable impact in this patient group as these traditionally are not considered for intervention.

KEY WORDS: CT perfusion, stroke, with unknown onset time, acute ischemic stroke

Poster 6
Location of Vessel Occlusion and Volume of Affected Brain Predicts Clinical Outcome at 3 Months in Acute Stroke Patients Evaluated within 4 Hours of Ictus

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PURPOSE
To identify a minimum set of functional imaging parameters that predict outcome from acute stroke as measured by the modified Rankin score at 3 months.

MATERIALS & METHODS
Retrospective review was performed of patients who received iv TPA, who had presented with acute stroke symptoms to our ER within 4 hours of ictus. All patients underwent noncontrast head CT (120-140 kVp, 160-300 mAs, pitch 1/slice thickness 5.75 mm), intracranial CT angiography (120 kVp, 300 mAs, pitch 0.875/slice thickness 1.25/0.6 mm), and dynamic CT perfusion (80 kVp, 200 mAs, 50 seconds of data acquisition, 4 x 5 mm slices) through the MCA territory on an 8-slice scanner (GE Lightspeed Ultra). MIP and MPR processing was used for the CTA analysis. Perfusion analysis was performed on a GE Advantage Workstation using CTP 2 software. Maps of MTT, CBF and CBV were created and used to determine the volume of infarction. The location of occlusion was determined by assessment of the CTA. The stroke neurologist performed an NIHSS assessment at the time of presentation and a modified Rankin Scale (mRS) assessment at 3 months after ictus. The mismatch between MTT and CBV was determined by subtraction. The patients were dichotomized into groups based on the mRS. Group 1 consisted of patients with scores 0 through 3 and group 2 with scores 4 through 6. This division was chosen to reflect the degree of independence as determined by ability to walk unassisted. Nonparametric statistics were used to test the null hypothesis that there is no difference between the dichotomized groups for a given parameter. The parameters tested were the infarct volumes obtained from MTT, CBF, and CBV maps, the mismatch volume (MTT-CBV) and the NIHSS score.

RESULTS
Sixty-six patients presented within 3 hours of ictus and one within 4 hours. There were 52 patients with an mRS of 0-3 (group 1), and 14 with mRS 4-6 (group 2). In group 1 there were 14/52 (27%) large vessel occlusions (distal ICA, M1 or P1). In group 2 there were 14/15 (93%). The average time to ictus was 93 and 92 minutes for groups 1 and 2 respectively (p = 0.94). There were statistically significant differences...
between the two groups for MTT (p < 0.0002), CBF (p < 0.0001), and CBV (p < 0.0156). There was no difference in the mismatch (p > 0.06).

CONCLUSION
Volume of “tissue at risk” determined by mismatch between MTT and CBV does not predict the clinical outcome, as measured by mRS. Proximal large vessel occlusion is more likely to result in mRS of 4 or above. Infarct volume determined using MTT, CBF or CBV alone can be used to predict the mRS outcome. Of these perfusion parameters, CBV is available from CTP and CTA, while CBF and MTT are derived only from CTP. If the volume of infarction measured on the CTP maps and that measured on whole brain CTA is the same, radiation dose in acute stroke imaging could be reduced by omitting the dynamic CTP assessment without affecting clinical management.

KEY WORDS: Acute stroke, CT perfusion, clinical outcome

Poster 7
Susceptibility-Weighted MR Imaging Findings Associated with Misery Perfusion on 15O Positron Emission Tomography in Patients with Chronic Cerebrovascular Disease

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PURPOSE
Positron emission tomography (PET) with oxygen-15 (15O) is a current standard measuring oxygen extraction fraction (OEF) in cerebral ischemia. An increased OEF is known as misery perfusion. The purpose of this study was to test the hypothesis that susceptibility-weighted MR imaging (SWI) can identify misery perfusion detected by 15O PET in patients with chronic cerebrovascular steno-occlusive disease.

MATERIALS & METHODS
Consecutive 61 patients (50 men and 11 women, 43 symptomatic and 18 asymptomatic; age range of 40 to 81 years) with chronic unilateral atherosclerotic steno-occlusive lesions of internal carotid or middle cerebral artery underwent MR imaging and 15O PET. The interval between MR imaging and 15O PET was 4 to 40 hours. MR imaging also was performed in 20 healthy volunteers (12 men and 8 women; age range of 50 to 72 years). A 1.5 T superconducting MR system was used. The MR imaging sequence included SWI (TR, 56 ms; TE, 40 ms; slice thickness, 2.5 mm; matrix size, 157 x 256; FOV 230 mm, flip angle, 25 degree), T2-weighted imaging, T2*-weighted gradient-echo type echo planar imaging (GRE-EPI) and MRA. The SWI sequences were reconstructed with minimum intensity projection technique to obtain images with section thickness and position similar to those of T2-weighted imaging and GRE-EPI. PET study included a transmission scan for attenuation correction and three static emission scans with the inhalation of C15O, the inhalation of 15O2, and the injection of H218O. Oxygen extraction fractions were measured for each patient.

RESULTS
In 37 of 61 patients, OEF was increased within the hypoperfused areas on 15O PET. In 30 of the 37 patients with misery perfusion detected by 15O PET, SWI demonstrated prominently hypointense signal within the superficial and deep cerebral veins ipsilaterally in steno-occlusive lesions. None of the patients without misery perfusion on 15O PET showed prominently hypointense signal within the cerebral veins ipsilaterally in steno-occlusive lesions at SWI. There was no evidence of lateral enlargement of the cerebral veins at SWI among healthy volunteers. GRE-EPI showed markedly hypointense signal within the superficial cerebral veins in only three patients with misery perfusion on 15O PET.

CONCLUSION
Our results suggest that prominently hypointense cerebral veins ipsilaterally seen in steno-occlusive lesions at SWI are associated with misery perfusion detected by 15O PET. Susceptibility-weighted imaging is superior to GRE-EPI for visualization of the prominently hypointense cerebral veins with increased deoxyhemoglobin concentrations. Susceptibility-weighted imaging is helpful in identifying misery perfusion in chronic cerebrovascular steno-occlusive disease.

KEY WORDS: Misery perfusion, susceptibility-weighted, MR imaging

Poster 8
Effects of Ginkgo Biloba on Cerebral Blood Flow in Normal Elderly Evaluated by Quantitative MR Perfusion

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PURPOSE
The dietary supplement Extract of Ginkgo biloba (EGb) is used widely, despite the recent disclosure of its lack of effectiveness in reducing the incidence of dementia. A number of active components in EGb are found to be potent antioxidants, platelet aggregation inhibitors, and promoters of blood flow (1). The purpose of this study was to determine if changes in regional cerebral blood flow (CBF) measured by dynamic susceptibility contrast MR imaging in elderly healthy individuals could be detected following EGb administration.

MATERIALS & METHODS
Perfusion MR imaging was performed in nine healthy men (mean age 61 ± 10 years) before and after 4 weeks of daily oral intake of 120 mg EGb. Quantitative CBF maps were generated using singular value decomposition with an automated arterial input function measured at the level of the circle of Willis (2). The difference of CBF before and after EGb administration was tested using voxel-based analysis in SPM, and further analyzed by paired t-test after semiautomated segmentation into different lobar regions.
RESULTS
Paired t-test comparisons using an uncorrected voxel-level threshold of \( P < 0.001 \) in SPM yielded no statistically significant clusters, but a more liberal voxel-level threshold of \( P < 0.005 \) revealed a regional increase of blood flow localized to the left parieto-occipital region (figure). Region of interest analysis of segmented gray and white matter in the individual lobes of each cerebral hemisphere confirmed a mildly increased CBF (normalized to cerebellar white matter) in the left occipital and parietal white matter (mean pre-EGb nCBF 0.909 ± 0.087 and mean post-EGb nCBF 0.942 ± 0.082, \( P = 0.031 \)). No other regions showed any significant difference.

CONCLUSION
Dynamic perfusion MR imaging can be useful for evaluating hemodynamic changes following pharmaceutical intervention. In this small cohort of normal elderly individuals, a mild increase in CBF was found in the left parieto-occipital white matter after EGb administration. As the parieto-occipital region has been implicated in visual memory and cognition, this is an interesting finding. Whether EGb has a similar or perhaps larger effect on regional CBF in elderly subjects with cognitive impairment, and the relationship between CBF with neurocognitive function requires further investigation.

REFERENCES

KEY WORDS: MR perfusion, Ginkgo, SPM

Poster 9
Radiation-Induced FLAIR Abnormality in the Splenium: Evaluation with Diffusion Tensor Imaging
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PURPOSE
Radiation therapy is used commonly for treatment of central nervous system tumors. Normal tissue is included invariably within the radiation field and may be damaged. After brain radiation a band of T2 prolongation may appear in the anterior aspect of the splenium of the corpus callosum. This region is characterized by relatively uniform axonal orientation. The mechanism and significance of this finding remains unclear. We used diffusion tensor imaging (DTI) to evaluate whether the signal changes in the splenium are associated with loss of axonal integrity.

MATERIALS & METHODS
This retrospective study was approved by our institutional review board. Patients who had sequential imaging studies that included both 30-direction DTI and FLAIR sequences were included in the study. These sequences are performed routinely at our institution for pre and posttreatment evaluation of brain tumors. Exclusion criteria included neoplasm or signal abnormality contiguous with a neoplasm involving the splenium as well as the presence of the FLAIR signal abnormality in the splenium on the baseline examination. Regions of interest were manually identified to include the entire splenium on the three slices that showed the maximal FLAIR signal abnormality and in corresponding regions of pretreatment/unaffected brains and the fractional anisotropy (FA) values measured in these regions. Five patients were evaluated both prior to and after treatment, and results were evaluated with paired t-tests and chi square analysis.

RESULTS
Fractional anisotropy values in the splenium were significantly different (\( p = 0.001 \)) after treatment. As compared to the pretreatment scans, on posttreatment images the splenium demonstrated a shift to lower FA values (Figure 1). Comparison between pre and posttreatment scans of the same patients all with posttreatment FLAIR signal abnormalities in the anterior splenium demonstrated no statistical difference in the average volume of the splenium.
CONCLUSION
Our data suggest that FLAIR findings that may appear after radiation therapy in the splenium are associated with microstructural damage without significantly affecting the volume of the splenium. Correlation with neuropsychological testing after radiation treatment would be of interest to determine whether these subtle changes are associated with a disconnection syndrome.

KEY WORDS: Radiation change, diffusion tensor imaging

Poster 10

**31P MR Spectroscopy Characteristics of Intracranial Tuberculomas and their Resolution: A Longitudinal**

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**PURPOSE**
The aim of the study was three-fold; one was to validate the earlier study of small voxel size in vivo 31P MRS in focal lesions of the brain; second, to delineate the in vivo 31P MRS metabolic profile of histologically confirmed intracranial tuberculomas and three, to conduct longitudinal examinations at periodic intervals in order to correlate the 31P MRS characteristics of these tuberculomas and their response to treatment or resolution.

**MATERIALS & METHODS**
Patients with intracranial lesions on CT scan which were suspected to be tuberculoma were examined. Pre and post-contrast MR imaging, and proton decoupled 31P MRS were acquired using a dedicated dual-tuned head coil on a 1.5 T Siemens Vision scanner (Erlangen, Germany). 31P spectroscopic study was done. These patients were subjected to histologic confirmation of the diagnosis by stereotactic biopsy. Once the diagnosis was established, these patients were started on a standard ATT protocol. These patients were followed up prospectively with serial CT scan at approximately 3 months to look for resolution. 31P MRS features in total of 20 patients with solitary tuberculomas were studied. The following well resolved peaks were observed in all tuberculomas and normal gray matter: phosphomonosteris (PME), inorganic phosphate(Pi), phosphodiester (PDE), phosphocreatine (PCr), γ, β and α resonance of adenosine triphosphate (ATP). PCr and total ATP (γ+β+α) represented high energy phosphates (HEP) and PME, PDE and Pi constituted low energy phosphates (LEP).

**RESULTS**
Tuberculomas showed decreased PME, PDE, PCr, δ ATP and β ATP with significant decrease in PCr, γ ATP and β ATP when compared to gray matter in normal controls. They also showed decreased total phosphorus, total ATP, HEP, βATP/Pi, HEP/LEP, PME + PDE/PCr + Pi, PCr/Pi, PCr/total ATP ratios with significant decrease in total phosphorus, HEP, total ATP, PME + PDE/PCr + Pi, PCr/Pi and PCr/total ATP ratios. We found significant decrease of high energy marker PCr, γ ATP and β ATP in intracranial tuberculomas and significant decrease in total phosphorus, HEP, total ATP. This is indicative of the low energy status of the tuberculomas. The PCr/total ATP and PCr/Pi ratios also were decreased. PCr /ATP ratio is an indicator of energy state of the tissue. Decrease in PCr/Pi ratio suggests the presence of ischemia in the lesion. This further consolidates the finding of decreased energy status and decreased thermodynamic potential of the tissue. On correlation of the PMRS parameters with the duration of resolution of tuberculomas we found that tuberculomas with lower HEP/LEP and PCr/Pi ratios took longer time to resolve. This is a very significant finding in view of the prevalence of wide variability in the duration of resolution of tuberculomas.

**CONCLUSION**
de novo tuberculomas have both low membrane phospholipid turnover as well as low energy status. It is evident also that the duration of response to treatment is inversely related to the metabolic state of the lesion.

KEY WORDS: Tuberculoma, 31P MRS, MR imaging

Poster 11

**Influenza Neurotoxicity, Cerebral Vasculopathy and Posterior Reversible Encephalopathy Syndrome: Codemonstration in Two Patients**

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**PURPOSE**
Patients with influenza can develop neurologic dysfunction, best recognized during influenza epidemics. In children, encephalopathy/encephalitis can occur and in adults, an increased incidence of stroke is recognized. Posterior reversible encephalopathy syndrome (PRES), a neurotoxic condition with accompanying characteristic watershed brain edema (historically: eclampsia, cyclosporine neurotoxicity, Tacrolimus neurotoxicity), also occurs in association with severe infection. We describe two patients with influenza A who develop severe neurotoxicity. PRES vasogenic edema and Catheter/MR angiogram evidence of cerebral vasculopathy.

**MATERIALS & METHODS**
Case 1: A 65-year-old female presents with a 3-day viral prodrome with fever, projectile vomiting and altered mentation. Admission lumbar puncture revealed a few red blood cells concerning for SAH. Emergent cerebral angiogram revealed cerebral vasculopathy but no aneurysm. Admission CT and MR imaging studies revealed vasogenic edema in the occipital and parietal regions bilaterally, consistent with PRES. Nasopharyngeal swab ultimately came back positive for influenza A. Case 2: A 3-year-old child developed a 1-day history of fever, congestion and decreased mentation progressing to coma. Nasopharyngeal swab obtained emergently was positive for influenza A. Admission MR imaging demonstrated bilateral thalamic lesions consistent with influenza encephalopathy/encephalitis with bilateral occipital-parietal and frontal vasogenic edema consistent with...
PRES. MR angiogram demonstrated evidence of vasculopathy in the posterior cerebral arteries bilaterally with evidence of significant occipital-parietal flow restriction.

RESULTS
Codemonstration of influenza, PRES and cerebral vasculopathy suggest a common etiology or mechanism.

CONCLUSION
Neurologic complications seen in influenza epidemics (adults: stroke; children: encephalopathy/encephalitis) are likely due to influenza-triggered cerebral vasculopathy/vasculitis.

KEY WORDS: Influenza encephalopathy, vasculopathy, posterior reversible encephalopathy syndrome

Poster 12
Decreased Brain Glx Levels in HIV Dementia: A 3 T MR Spectroscopy Study
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PURPOSE
The current study was undertaken to investigate the utility of 3T MRS for evaluating HIV+ patients with different levels of cognitive impairment with emphasis on the measurement of Glu and Glx (the sum of Glu and Gln).

MATERIALS & METHODS
Eighty-six HIV+ subjects were stratified into three groups according to their cognitive status using the Memorial Sloan Kettering (MSK) dementia severity score. Twenty-one with normal cognitive function (NC) (MSK 0), 31 had mild cognitive impairment (MCI) without dementia (clinical MSK stage = 0.5) and 34 had dementia (HAD) (MSK≥1). Using a 3.0 T Philips scanner and SENSE head coil, brain MR imaging and single voxel MRS (TR/TE = 2000/45 msec) were acquired from the left frontal white matter (FWM) and the left basal ganglia (BG) with and without water suppression. The voxel size was 2.2 x 2.2 x 2.2 cm³. Spectra were analyzed using the LC model and quantified (in mM concentrations) relative to the unsuppressed water signal. Metabolite concentrations and ratios relative to creatine (Cr) were calculated for the 3 groups. Differences between groups were evaluated using ANOVA and post-hoc comparisons. P < 0.05 was considered significant.

RESULTS
FWM Glx (combined Glu and Gln) was lower in HAD (8.1 ± 2.1 mM) compared to both MCI (9.17 ± 2.1 mM) and NC group (10.0 ± 1.6 mM), (P = 0.006). FWM ml was higher in HAD (4.15 ± 0.75 mM) compared to both MCI (3.86 ± 0.85 mM) and NC status (3.4 ± 0.67 mM), (P = 0.006). FWM Glx/Cre (Cr) was lower and FWM myo-inositol (ml)/Cr significantly higher in the HAD compared to MCI and NC group (P = 0.001 and (P = 0.004) respectively. BG NAA was lower in the HAD group (6.79 ± 1.53 mM), compared to the MCI (7.5 ± 1.06 mM), and NC groups (7.6 ± 1.01 mM), (P = 0.036). There were significant positive correlation of FWM Glx with Digit symbol test (P = 0.02, 0.002, and 0.02 respectively). There were also significant negative correlations between Glu, Glx, and Glx/Cr with trail-making test B (P = 0.005, 0.0001, and 0.0003 respectively). FWM Glx showed negative correlation with Grooved pegboard non-dominant hand (P = 0.02).

CONCLUSION
3 T MRS with phased-array head coil reception allows more sensitivity detection of MRS metabolites (in particular compounds such as Glx), and it appears that Glx (consisting of mainly Glu) is abnormal in FWM of patients with HAD. Reduced Glu uptake has been demonstrated previously to occur in vitro in astrocytes exposed to HIV as detected by Northern blot analysis and immunoblotting, and was reported recently in a cohort of 13 HIV positive subjects using TE-averaged MRS at 3 T. In the current study, in a large cohort of HAART experienced HIV+ individuals, progressively decreasing levels of FWM Glx were found in patients with normal cognition, MCI, and HAD. Frontal white matter Glx decreases were associated also with poorer cognitive function, specifically impaired executive and fine motor functioning in HAD. 3 T MRS measurements of Glx may be a useful indicator of neuronal loss or dysfunction in patients with HIV infection.

KEY WORDS: HIV dementia, Glx, MRS

Poster 13
Clinical Utility of Ultrashort TE Proton MR Spectroscopy in Imaging Diseases of the Brain
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PURPOSE
To compare the clinical utility of ultra-short TE single voxel proton MR spectroscopy (MRS) with standard short TE single voxel proton MRS using either STEAM or PRESS in imaging diseases of the brain.

MATERIALS & METHODS
Fifteen patients underwent single voxel MR spectroscopy at 1.5 T using either STEAM or PRESS for water and fat suppression. MR spectroscopy was acquired with ultrashort STEAM (12 msec) and ultrashort PRESS (20, 25 msec) with standard short TE STEAM (20 msec) or standard short TE PRESS (30, 35 msec). The shortest default TR allowed by the scanner was utilized. MR spectroscopy was acquired after gadolinium administration, several patients were imaged pre and postgadolinium.

RESULTS
Ultrashort TE proton MRS was acquired successfully in all patients including the supratentorium and posterior fossa. Outer saturation bands prior to shimming could only be prescribed for ultrashort TE PRESS acquisitions and not STEAM acquisitions. Peak height variability was noted between ultrashort STEAM and PRESS for choline.
Metabolites in the 2.0-2.4 ppm range (Glx/Gln) tended to have sharper peak distinction utilizing ultrashort STEAM MRS.

CONCLUSION
Ultrashort TE proton MRS using STEAM or PRESS can be acquired technically at 1.5 T. Sharper peak distinction at 2.35 ppm (Glx/Gln) can be demonstrated on both STEAM and PRESS ultrashort TE MRS compared to short TE STEAM and PRESS MRS. Brain metabolites having a short T1 can have a higher peak signal on ultrashort TE STEAM PRESS than on standard short TE PRESS. Gadolinium effect on ultrashort TE PRESS does not affect diagnostic efficacy. Ultrashort TE STEAM should be considered for brain lesions with short T1 metabolites.

KEY WORDS: PRESS, STEAM, GLX

Poster 14
Relationship between Fluorodeoxyglucose Uptake and Apparent Diffusion Coefficients in Solitary Brain Tumor

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PURPOSE
The standardized uptake value (SUV) of fluorodeoxyglucose (FDG) PET is used to evaluate glucose metabolism in tumors. This value appears to be associated with tumor aggressiveness. The apparent diffusion coefficient (ADC) obtained by diffusion-weighted imaging (DWI) is thought to be associated strongly with tumor cellularity. We infer that these indices might be correlated mutually. This study evaluated the relationship between maximum SUV and minimum ADC values in solitary brain tumors, and determined the usefulness of maximum SUV and minimum ADC values in differential diagnosis of brain tumors and WHO grading of gliomas.

MATERIALS & METHODS
In this study, 30 patients with solitary brain tumor were enrolled: 22 gliomas (low grade 7, high grade 15), 5 malignant lymphomas, and 3 metastatic tumors. To assess the degree of FDG uptake, the maximum SUV within each tumor was calculated semiquantitatively. To measure the degree of FDG uptake, the maximum SUV within each tumor was chosen as the minimum ADC value. Several regions of interest (ROIs) on solid parts within tumors. The lowest ADC value among the cases with available ADC maps and rCBV maps available. The average Ki-67 labeling index is a commonly used immunohistochemical marker for tumor proliferation. High Ki-67 levels correlate with high tumor grade and have implications for treatment and prognosis. The purpose of this study was to determine whether there is correlation between Ki-67 and rCBV and Ki-67 and ADC in atypical/malignant meningiomas.

RESULTS
An inverse correlation was found between maximum SUV and minimum ADC for all cases ($p = 0.0007$) and for glioma cases ($p = 0.008$). A correlation was found between WHO glioma grading and maximum SUV ($p = 0.005$). An inverse correlation was found for WHO glioma grading and minimum ADC ($p = 0.003$). Low-grade glioma showed significantly lower maximum SUV than high-grade glioma did ($p = 0.015$). Low-grade glioma showed significantly higher minimum ADC than high-grade gliomas did ($p = 0.006$). Lymphoma showed significantly higher maximum SUV than high-grade glioma did ($p = 0.007$). In contrast, no significant difference was found for minimum ADC between high-grade glioma and lymphoma.

CONCLUSION
An inverse correlation was found between maximum SUV and minimum ADC for solitary brain tumor. Both minimum ADC and maximum SUV were useful for glioma grading. Maximum SUV was useful for differentiating lymphoma from high-grade glioma.

KEY WORDS: ADC, FDG, brain tumor

Poster 15
Correlation between Relative Cerebral Blood Volume and Apparent Diffusion Coefficient on MR Imaging with Ki-67 Labelling Index in Atypical and Malignant Meningiomas

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PURPOSE
Atypical (WHO grade II) and malignant (WHO grade III) meningiomas have a greater tendency to recur than benign meningiomas. Low apparent diffusion coefficient (ADC) values have been shown to correspond with increased tumor cellularity, while high relative cerebral blood volume (rCBV) is an indicator of tumor vascularity. The Ki-67 labeling index is a commonly used immunohistochemical marker for tumor proliferation. High Ki-67 levels correlate with high tumor grade and have implications for treatment and prognosis. The purpose of this study was to determine whether there is correlation between Ki-67 and rCBV and Ki-67 and ADC in atypical/malignant meningiomas.

MATERIALS & METHODS
An IRB approved retrospective review of consecutive patients with pathologically proved atypical/malignant meningiomas was performed. A small manually drawn round region of interest (cm) was used to measure the minimum ADC and maximum rCBV values within the whole tumors. The rCBV maps were blood-brain-barrier corrected. Areas of calcification, necrosis, and cystic change were avoided. These measurements were normalized to normal contralateral white matter (ADC ratios and rCBV ratios). The maximum Ki-67 values estimated on the surgically excised tumor specimens were utilized. Linear regression and Pearson correlation tested were used to evaluate the relationship between Ki-67 and ADC ratios and Ki-67 and rCBV ratios.

RESULTS
There were 23 cases (21 WHO II tumors, 2 WHO III tumors; 10 males, 13 females, average age: 60.0 years) with ADC maps available and 13 cases (9 WHO II tumors, 4 WHO III tumors; 7 males, 6 females; average age: 49.5 years) with rCBV maps available. The average Ki-67 labeling index among the cases with available ADC maps and rCBV maps was 17.6 (range 5 to 60) and 16.7 (range 3 to 60), respectively. The mean ADC ratio was 0.91 (standard deviation:
0.26) and the mean rCBV ratio was 24.6 (standard deviation: 10.6). There is a strong positive correlation between maximum rCBV ratios and Ki-67 labeling index, with a Pearson correlation of 0.87 (p-value: 0.00011) and linear regression coefficient of 0.76 (Figure). However, there was a weak negative correlation between minimum tumor ADC values and Ki-67 labeling index, with a Pearson correlation of -0.85 (p-value: 0.70) and a linear regression coefficient of -0.0073.

CONCLUSION
Maximum rCBV correlated strongly with Ki-67 values and may be useful for noninvasive assessment of tumor grade and prognosis. However, there does not appear to be a correlation between ADC and Ki-67 labeling index for atypical and malignant meningiomas.

KEY WORDS: Meningioma, MR Imaging, Ki-67

Poster 16
Safety of Gadobenate Dimeglumine for Contrast-Enhanced MR Imaging of the Central Nervous System in Intraindividual Crossover Studies

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PURPOSE
In a series of prospective, randomized, double-blind, intraindividual crossover comparisons studies, gadobenate dimeglumine (Gd-BOPTA) has been shown to provide consistently higher enhancement than other available gadolinium agents used for MR imaging of the central nervous system (CNS). Herein we review the safety profile of Gd-BOPTA and the other gadolinium agents in these trials.

MATERIALS & METHODS
In five prospective studies, adult patients underwent two identical MR examinations within 48 hours to 2 weeks, one with 0.1 mmol/kg bodyweight gadobenate dimeglumine (N = 378) and the other with 0.1 mmol/kg of gadopentetate dimeglumine (Gd-DTPA, N = 224), gadodiamide (Gd-DTPA-BMA, N = 125), or gadoterate meglumine (Gd-DOTA, N = 31). Safety monitoring in these studies included vital signs, lab values, and adverse events (AE). Adverse events were rated as mild, moderate, or severe, and the relationship to the contrast agent was classified as probable, possible, not related, or unknown by site investigators blinded to the contrast agent given.

RESULTS
Changes in vital signs and lab values were considered unremarkable and were similar in all contrast agent groups. The overall incidence of adverse events with a potential relationship to contrast injection was 45 AEs in 752 total examinations (6.0%). The most commonly reported AEs with all agents included nausea/vomiting, headache, dizziness, hypoesthesia, injection site reaction/pain/hemorrhage. No statistically or clinically significant differences between gadobenate dimeglumine and comparators were noted in any of the five studies. No serious AE considered related to contrast administration were reported. Most AE were mild and self-resolving, with the exception of 6 instances in which the AE with a possible relationship to CM were considered moderate (1 each of nausea, headache, pruritus, rash, epistaxis, and ear discomfort). Of these six moderate AE, five (1.3%) occurred after Gd-BOPTA and one after Gd-DTPA (0.4%).

CONCLUSION
The safety profile of the higher relaxivity gadolinium agent Gd-BOPTA in patients undergoing enhanced MR imaging of the CNS was similar to that of other commonly used gadolinium contrast agents in a series of five crossover comparison studies.

KEY WORDS: MR imaging, gadobenate, safety

Poster 17
Prediction of Glioblastoma Multiforme Progression from Diffusion Tensor Imaging Using a Constrained Random Walk Simulation

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PURPOSE
Glioblastoma multiforme (GBM) is the most common and most aggressive primary brain tumor, with extremely poor clinical outcomes. Disease progression and recurrence is all but inevitable. It has been described that at diagnosis, invasive tumor exists in surrounding white matter, undetected by conventional MR imaging (1). Furthermore, there is evidence that invasion occurs principally along white matter tracts (2). We aimed to predict tumor invasion at baseline from the underlying white matter (WM) structure as derived from diffusion tensor imaging (DTI). Defining “at-risk” regions at the time of treatment planning may permit rational changes to management, allowing better control of disease in potentially infiltrated WM (1).

MATERIALS & METHODS
Ethical approval was granted. Contrast-enhanced T1-weighted (T1-Gd) images from three patients with GBM were downsampled to match 6-direction diffusion-weighted images (b = 1000, 1.8 x 1.8 x 5 mm voxels.) A manual volume of interest (VOI) encompassing the enhancing lesion was surface-extracted, and each voxel assigned a number of
tumor "cells." Using in-house code (Matlab R2009a, The Mathworks Inc., Natick, Massachusetts) these "cells" undertook a 100-step random walk constrained by the principal eigenvector ($\varepsilon_1$) field of the diffusion tensor. The permissible step size and deviation from $\varepsilon_1$ were determined from sigmoidal functions of fractional anisotropy (FA) in each voxel, such that low FA resulted in smaller step sizes with increased angular dispersion and vice versa. By counting visits to each voxel, normalized probability maps of tumor progression/recurrence were generated. For this pilot study, the predicted progression maps were compared subjectively to T1-Gd images at 6 months.

RESULTS
The figure shows representative images in one patient with GBM. A is the T1-Gd image at diagnosis, while B shows the follow-up image. For comparison, the predicted recurrence map is overlaid in mirror image on the contralateral hemisphere in image B.

CONCLUSION
In this pilot study comprising three patients, there was good subjective correlation between the disease progression predicted by DTI-constrained random walk and the eventual lesion on follow up. This information may permit alterations to treatment planning, such as anisotropic radiotherapy fields. Substantial work is required for further development, including quantitative validation, and nonuniform tumor surface weighting.

REFERENCES

KEY WORDS: Glioblastoma, progression, prediction

Poster 18
Identifying Minimally Invasive Glioblastomas: A Multiple Cohort Study of Conventional and Diffusion Tensor MR Imaging
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PURPOSE
Invasion is a key feature of glioblastomas and a major cause of treatment failure. Autopsy studies have identified 20-25% of patients have glioma cells extending less than 1 cm from the tumor margin (1-2). If these patients could be identified they might be suitable for aggressive local therapies (e.g., carmustine wafers). Attempts to assess invasive behavior using T2-weighted MR (3) and diffusion tensor MR (DTI) (4) have failed to identify patients with minimal invasion. In this study we aim to see if T2-weighted MR and DTI can identify a group of high-grade glioma patients that demonstrate little invasion over a long follow-up period.

MATERIALS & METHODS
Role of T2-weighted MR: 32 patients with glioblastomas being treated with chemoradiotherapy (mean age 53 years, range 17 - 69 years) with a WHO performance status of 0-1 were studied at diagnosis. The maximal enhancing region on T1-weighted (CE) and area of high signal on T2-weighted (T2R) sequences were measured in 2 planes. The ratio of CE/T2R and difference between the two measures was correlated with progression free survival (PFS). DTI: Diffusion tensor was processed using MedINRIA and maps of the isotropic component (p) and the anisotropic component (q) were created (5). The abnormality in p and q maps were outlined and overlaid onto the anatomical images. Those where the two lines were within 10mm of each other were defined as minimally invasive. Two cohorts of patients were recruited: Cohort 1: unselected high-grade glioma patients studied prior to introduction of chemoradiotherapy (mean age 46 years; range 23-79 years; n = 17); Cohort 2: glioblastoma patients imaged before the start of chemoradiotherapy (mean age 56 years (range 30-68 years; WHO Performance status 0-1; n = 13). The progression-free survival (PFS) was compared to DTI appearance.

RESULTS
T2-weighted MR: Neither the ratio of CE/T2R nor difference between the two correlated with PFS. Taking a difference between CE and T2R as 10 mm, only 2/7 patients had not progressed, 2/11 patients with a difference larger than 10 mm had progressed. This was not significantly different. DTI: 4/17 (23%) in the first cohort had a limited invasion appearance on DTI. In this group the mean PFS was 940 days compared to 220 days for those with nonlimited patterns ($P = 0.01$). In the second cohort 4/13 (30%) had a minimally invasive pattern. Three have yet to progress with a mean PFS approaching 2 years. In the nine without invasive patterns only two have yet to progress. Taking the group as a whole, DTI minimal invasive patterns predict a 2-year PFS with 100% specificity and 66% sensitivity.
CONCLUSION

Although T2-weighted imaging cannot predict invasive behavior, DTI can. Studies in different cohorts suggest about a quarter are minimally invasive and these have a prolonged PFS. This method might allow selecting patients suitable for aggressive local therapies.

REFERENCES
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KEY WORDS: Glioblastoma, diffusion tensor imaging, invasion

Poster 19

Central Nervous System Lymphoma: A Review of the Imaging Appearances in both Immunocompetent and Immunocompromised Patients

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PURPOSE
To illustrate and review the spectrum of imaging characteristics and clinical presentations of CNS lymphoma in both immunocompetent and immunocompromised individuals and discuss specific radiologic and clinical features that may aid in early diagnosis.

MATERIALS & METHODS
This exhibit is based on a retrospective review of CNS lymphoma cases evaluated with MRI between the years of 1995 and 2009. A variety of imaging presentations of CNS lymphoma will be presented and distinguishing imaging features, diagnostic imaging pearls, patient demographic data, and prognoses will be discussed.

RESULTS
Central nervous system lymphoma can present in the brain, spine, head and neck and has a variety of imaging appearances that can make it difficult to diagnose. There are several common radiologic patterns in both immunocompromised and immunocompetent individuals which if recognized can help with early diagnosis.

CONCLUSION
The imaging spectrum of CNS lymphoma is quite varied which can make early diagnosis difficult. Illustrating key imaging and clinical features of CNS lymphoma including typical and atypical locations of lesions, signal characteristics, and clinical presentation can facilitate early diagnosis.

KEY WORDS: Neuroradiology, neoplasm, lymphoma

Poster 20

Utility of Peritumoral Apparent Diffusion Coefficient for Differentiation of Glioblastoma Multiforme from Solitary Metastatic Lesions

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PURPOSE
In glioblastoma, the peritumoral region may be infiltrated with malignant cells in addition to vascogenic edema, whereas in a metastatic deposit, the surrounding peritumoral areas comprise predominantly vascogenic edema. The purpose of this study was to determine whether the minimum apparent diffusion coefficient (ADC) can be used to differentiate glioblastoma and solitary metastasis on the basis of cellularity levels in the contrast-enhancing tumors and nonenhancing peritumoral edema regions.

MATERIALS & METHODS
All 73 patients (38 glioblastoma and 35 solitary metastasis; 41 men, 32 women; age 29-83 years; mean age, 57.5 ± 12.3 years) underwent pretreatment conventional MR and diffusion-weighted MRI (DWI). All patients had a previously untreated solitary enhancing brain tumor and peritumoral edema. The minimum ADC was measured in the enhancing tumor, peritumoral region, and contralateral normal white matter. To determine the statistical difference between the metastasis and glioblastoma, we analyzed the age, sex, minimum ADC value, and ADC ratio in two groups using the Wilcoxon rank sum test or χ² test. A receiver operating characteristic (ROC) analysis was used to determine the cutoff value of the minimum ADC that had the best combination of sensitivity and specificity for distinguishing glioblastoma and metastasis.

RESULTS
The mean minimum ADC values and ADC ratios in peritumoral regions of metastases were significantly higher than those in the glioblastomas (p < 0.05). However, the mean minimum ADC values and mean ADC ratios in enhancing tumors demonstrated no statistically significant difference between the two groups (p > 0.05). According to the ROC, the cutoff value of 1.302 × 10⁻³ mm²/s for the minimum peritumoral ADC generated the best combination of sensitivity (82.9%) and specificity (78.9%) for distinguishing between glioblastoma and metastasis (p < 0.05).

CONCLUSION
Although conventional MR characteristics of solitary metastasis and glioblastoma may be similar, diffusion-weighted imaging can offer diagnostic information to make a differential diagnosis between the tumors.

KEY WORDS: Glioblastoma, metastasis, diffusion-weighted image
Changes in Viscoelastic Brain Tissue Properties of Patients with Normal Pressure Hydrocephalus Measured by MR Elastography

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PURPOSE
To investigate mechanical tissue properties in patients with normal pressure hydrocephalus (NPH) by measuring viscoelastic parameters in vivo using a novel MR elastography (MRE) technique.

MATERIALS & METHODS
Six patients (mean age of 70.5 years) with the clinical diagnosis of normal pressure hydrocephalus and six age-matched healthy volunteers (mean age of 69.2 years) underwent MRE of the brain on a 1.5T scanner. Wave image acquisition was performed using a single-shot echoplanar imaging sequence that was sensitized to vibration by a sinusoidal gradient of four periods and 60 Hz frequency. Multifrequency vibrations (25 to 62.5 Hz) were applied to the brain by a custom-built vibration generator with a maximum amplitude of approximately 1 mm in parallel direction to the long axis of the magnet. Transverse image slices with through-plane motion-encoding direction were selected in a central slab through the brain. Using the rheological springpot model, a viscoelastic parameter $\mu$ [kPa] that represents both elastic (stiffness) and viscous (friction) properties of brain tissue was calculated.

RESULTS
Wave images of the brain were obtained from the multifrequency MRE experiment decomposed into four frequencies used for vibration signals. A decrease (24 %) of cerebral viscoelasticity in patients with normal pressure hydrocephalus ($\mu = 1.47$ kPa) compared to age-matched healthy volunteers ($\mu = 1.95$ kPa) could be observed.

CONCLUSION
This finding supports the theory that altered intracranial compliance occurs in the context cause of NPH. The measurement of cerebral viscoelasticity by MRE may provide a novel parameter for assessing NPH in affected patients.

KEY WORDS: NPH, MR elastography, cerebral viscoelasticity

Application of the Novel Toroidal Model Compared to Ellipsoidal Model in the Diffusion Tensor Imaging Evaluation of Demyelination in Multiple Sclerosis Patients

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PURPOSE
Diffusion tensor imaging (DTI) is capable of accessing microstructural organization of neural tissue, especially white matter (WM). Commonly DTI is based on an ellipsoidal model, characterized by indices of mean diffusivity (MD) and fractional anisotropy (FA). The toroidal-based representation is described by the modified parametric equation of an elliptical torus, offering two new quantitative indices: toroidal volume (TV) and toroidal fraction ($T_{fraction}$), which represent measures of diffusivity and anisotropy respectively. Those indices seem to provide additional information of the subtle changes in neural tissue. The purpose of this study is to evaluate the application and accuracy of this novel model of toroid-based DT analysis in detecting WM damage in the corpus callosum (CC) of multiple sclerosis (MS) patients compared with the standard parameters of MD and FA.

MATERIALS & METHODS
Brain exams of 13 MS patients (EDSS of 1.2 ± 0.8), and 11 healthy controls were obtained with a 3.0 T MR scanner (Intera Achieva, PHILIPS Healthcare). Diffusion tensor imaging protocol used a b-value of 1000 s/mm², 32 encoded directions, slice = 2 mm, FOV = 256 mm, matrix = 128 X 128. In-house software was used to generate FA, MD, TV and $T_{fraction}$. The CC was delineated manually by two radiologists on multiplanar FA maps (low anisotropy treshold = 0.2). TV maps were compared to mean diffusivity (MD) and FA maps with $T_{fraction}$ using relative operating characterisitic (ROC) curve. Analysis of variance (ANOVA) test was applied to discriminate differences between the groups within the measurements ($p < 0.05$).

RESULTS
The results are shown in the Table 1. Multiple sclerosis patients presented increased diffusivity (MD and TV) and decreased anisotropy (FA and $T_{fraction}$) ($p < 0.05$).

<table>
<thead>
<tr>
<th>Parameter</th>
<th>MS Patient</th>
<th>Healthy Controls</th>
</tr>
</thead>
<tbody>
<tr>
<td>MD (10⁻³ mm²/s)</td>
<td>0.84 ± 0.02</td>
<td>0.80 ± 0.03</td>
</tr>
<tr>
<td>TV (mm³/s³)</td>
<td>0.53 ± 0.06</td>
<td>0.42 ± 0.05</td>
</tr>
<tr>
<td>FA</td>
<td>0.65 ± 0.02</td>
<td>0.69 ± 0.02</td>
</tr>
<tr>
<td>$T_{fraction}$</td>
<td>0.52 ± 0.03</td>
<td>0.58 ± 0.03</td>
</tr>
</tbody>
</table>

The toroidal-based measurement presented greater areas under the ROC curves (0.958 and 0.916) than the ellipsoidal model (0.839 and 0.839), thus demonstrating greater efficiency of the toroidal model in detecting alterations in MS subjects.
CONCLUSION
The histopathology of MS involves myelin and neuronal damage, which is associated with a decrease in FA and MD increase. Although the WM fibers in CC follow an orientation pattern, it has been suggested that individual differences in fiber distributions can widen up the normal rates, decreasing the specificity of the anisotropy-based analysis. The novel application of the toroidal model to the study of neural tissue seems to provide greater accuracy in detecting MS alterations than the standard FA and MD parameters, introducing a promising tool to study microscopic changes in brain tissue.

KEY WORDS: Diffusion tensor imaging, multiple sclerosis

Poster 23
Evaluation of Contrast Enhancement Comparing 3 T MR Imaging T1 FLAIR and Conventional Spin Echo in an Agar Model
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PURPOSE
The comparability of contrast enhancement of T1 FLAIR to CSE sequences has been challenged at 1.5 T. This data predates commercial 3 T systems and the introduction of newer contrast agents, and thus we propose to test the previous hypothesis that contrast enhancement is superior on CSE compared to T1 FLAIR images. We developed an agar phantom to compare Multihance dose-signal curves on 3 T MR imaging.

MATERIALS & METHODS
Serially diluted concentrations of Multihance were added to 2% agar, then placed into wells within a 4% agar block. This phantom was placed in an 8-channel phased array coil and 3 T MR system (GE HDX). T1 FLAIR images were obtained, and CSE sequences were performed using the manufacturer’s protocols and TRs of 350, 700, 1400, 2800, 5600. Data Analysis: Mean ROI and SD of each well were measured. Values were entered into an Excel spreadsheet and graphs of signal vs concentration were plotted for T1 FLAIR and each TR CSE sequences. Polynomial curves were fit to graph points.

RESULTS
Second order polynomial curves fit well for T1 FLAIR and commonly used TRs (350-1400) for CSE graph points. Third order curves fit well for longer TRs (2800-5600). The T1 FLAIR graph demonstrates greater change in signal for a given change in concentration and more linear response over a wider concentration range.

CONCLUSION
Initial data indicates T1 FLAIR gives a more predictable signal response than CSE. For certain concentration ranges, T1 FLAIR contrast signal is superior to TR 350 CSE, and while contrast may be slightly better on CSE TR 700 images, this is less predictable with increasing concentration. Comparing small changes of concentration approximating physiologic values is needed. Our analysis continues, and will be further updated at ASNR.

KEY WORDS: T1 FLAIR, postcontrast, agar model

Poster 24
Sensitivity of Susceptibility-Weighted Imaging Detecting Developmental Venous Anomalies
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PURPOSE
To analyze the sensitivity of susceptibility-weighted imaging sequences in the detection of brain developmental venous anomalies (DVAs).
MATERIALS & METHODS
A prospective MR study was performed over 15 months in a cohort of 101 patients with various clinical and radiologic diagnoses (cavernous angiomas, other cerebral vascular malformations, stroke, and brain trauma or tumor) in whom we assessed the presence and radiologic characteristics of brain DVAs. Imaging analysis included number, localization and depth of DVA, associated signal alterations in surrounding parenchyma, presence of small vessels in caput medusae (microvasculature), width and distance of draining vein, and caput medusa surface. The study protocol included T2-weighted sequences (T2 turbo spin-echo, T2* gradient-echo, and FLAIR), susceptibility-weighted imaging and contrast-enhanced T1-weighted. All sequences were performed at the same section thickness and position.

RESULTS
Twenty-eight DVA were found in 23 patients (23%). Location was lobar (57.1%), basal ganglia (14.0%), brainstem (7.0%) and cerebellum (21.0%). Developmental venous anomalies drainage was superficial or deep in equal numbers (39.3%), and both superficial and deep in 21.0%. We found significantly higher sensitivity in detecting number of DVAs, increase in parenchymal signal abnormalities, identification of microvasculature, and angioarchitecture characteristics of DVAs (drainage vein and caput medusae) with susceptibility-weighted imaging sequences as compared to the other T2-weighted sequences (P < 0.005). No significant differences in sensitivity were observed between susceptibility-weighted imaging and contrast-enhanced T1-weighted imaging (reference standard).

CONCLUSION
The acquisition properties and postprocessing of susceptibility-weighted imaging sequences resulted in significantly higher sensitivity for detecting DVAs than conventional T2-weighted sequences, reaching a sensitivity at least as high as contrast-enhanced T1-weighted.

KEY WORDS: Susceptibility, developmental venous anomalies, cavernoma

Poster 25
Normal and Pathologic Brain Vasculature Assessment Using Hemodynamic Response Imaging, Perfusion and Conventional Enhancement

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PURPOSE
T1-weighted postcontrast imaging (T1Gd) is the accepted radiologic criteria for the diagnosis, therapeutic planning and response assessment in patients with brain lesions (1, 2). Dynamic susceptibility contrast (DSC) is an accepted and commonly used method to differentiate between malignant and nonmalignant lesion based on the relative cerebral blood volume (rCBV) (3). Hemodynamic response imaging (HRI) recently has been proposed to provide additional information regarding the angiogenic status of brain tumors (4). The aim of this work was to compare these three methods in order to study the advantage and contribution of each method for the characterization of the brain vascular properties in healthy subjects and in patients with primary brain tumors.

MATERIALS & METHODS
Seven healthy subjects and four patients with primary brain tumors: 2 recurrent glioblastoma (GB), 1 meningioma and 1 newly diagnosed GB, were included in this study. MR scans were performed on a 3.0 T GE scanner and included: (1) HRI protocol (4, 5) using GE-EPI sequence. Two block design paradigms were applied, during which subjects inhaled either a gas mixture of 95% O2 + 5% CO2 or 95% air + 5% CO2, with an air room as baseline; (2) DSC acquired using GE-EPI sequence along the injection of double dose Gd bolus (0.2 mmol/kg, 5 cc/sec); (3) High-resolution 3D SPGR acquired after contrast injection. Percent signal change ΔSHRI-O2 and ΔSHRI-CO2, and rCBV and rCBF maps were calculated. Data normalization was performed so that each voxel in the normalized calculated map was represented by its distance from the mean value of the entire map in standard deviation (std) units. Volumes of interest (VOIs): Healthy subjects: white (WM) and cortical gray matter (GM) VOIs were defined separately for each lobe based on EPI segmentation. Patients: lesion VOIs defined on each map at the area of hyperintense signal or high response, using threshold of +2 std above normal values.

RESULTS
Healthy subjects: WM/GM ratios were: 2.4 for rCBV; 2.6 for rCBF; 3.5 for ΔSHRI-O2 and 3.7 for ΔSHRI-CO2. Significant correlations were detected between ΔSHRI-O2/ΔSHRI-CO2 and between rCBV/rCBF (p < 0.0001) but not between HRI and DSC indices. This suggests that HRI provides additional information regarding the human brain vasculature to the commonly used DSC. The parietal lobe showed significant increase in ΔSHRI-O2 compared to the other brain lobes (p < 0.05), while no other differences were detected between the lobes for all other parameters. This might be related to the different functionality of this lobe. Patients: each one of the three methods marked a different area within and around the tumor, with some overlap between them, mainly in the center. For GB, some enhanced areas did not show any increased vascularity both with DSC and HRI, indicating a breakdown of the blood-brain barrier (BBB). Different patterns of segmentation were obtained in the different pathologies.

CONCLUSION
These vascular-sensitive methods seem to provide complimentary information regarding the vasculature profile in the healthy and pathologic brain. Together, these methods might improve the characterization of tumor vascular properties, the diagnosis and monitoring of brain lesions, especially those who receive antiangiogenic drugs.

REFERENCES

KEY WORDS: Susceptibility, developmental venous anomalies, cavernoma
Calculation of Transstenotic Pressure Gradients in Normal Subjects and Patients with Venous Outflow Obstruction

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PURPOSE
Venous outflow obstruction has been implicated as a cause of increased intracranial pressure. Frequently, patients undergo invasive transvenous measurements of pressure gradients to determine the magnitude of the flow restriction, as venous stenting commonly is considered if the pressure gradient is greater than 10 mmHg. We have developed and clinically implemented a method to noninvasively measure pressure gradients within the dural sinuses based on velocity data acquired using a highly accelerated 3D phase contrast MRA technique (PCVIPR) (1).

MATERIALS & METHODS
PCVIPR data were acquired using an 8-channel head coil on 3T clinical systems (GE Healthcare, Waukesha, WI) after obtaining informed consent according to our IRB protocol in 10 normal volunteers and one patient with venous outflow obstruction. PC MRA data were utilized for segmentation of the venous vasculature using Mimics (Materialise). Using custom in-house software, within the segmented volume relative pressures were computed directly from the 3D PC velocity field using the Navier-Stokes fluid relations (Newtonian fluid, viscosity of 4 cP) and an iterative solver (2). All resulting data were analyzed within Ensight (CEI) for relative pressure differentials. Centerline splines were calculated to allow for a continuous evaluation of relative pressures and peak velocities along the length of the cranial sinuses, and relative pressure differences between the superior sagittal sinus (SSS) and sigmoid sinus (SS) were computed.

RESULTS
Pressures and velocity distributions were measured successfully in the single patient (Figure 1) and volunteers. The average pressure differences between the SSS and SS in the volunteers and patient were 2.74 ± 0.27 and 8.24 mmHg, respectively. Much of the pressure drop in the patient was due to the transstenotic pressure gradient (TSPG) of ~5 mmHg. A stenotic jet was observed in the patient reaching velocities over 170 cm/s.

CONCLUSION
Venous outflow obstruction typically is evaluated using cerebral venography and manometry, but PCVIPR provides a noninvasive MRA technique with high spatial and temporal resolution that provides a comprehensive volumetric analysis with scan times less than 5 minutes. This technique permits a post priori flow quantification of cranial vasculature in any imaging plane and calculation of TSPGs in these vessels. Further investigation with comparisons between calculated TSPGs from PCVIPR and measured venographic pressures is warranted.

REFERENCES

KEY WORDS: Venous stenosis, relative pressure, phase contrast MRA
**Poster 27**

**Automatic Segmentation Technique to Remove Cerebrospinal Fluid Pixels on MR Perfusion Parametric Images Using Niblack’s Method**

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**PURPOSE**

Signals of cerebrospinal fluid (CSF) and vascular contents inside CSF spaces often are indistinguishable from brain parenchyma on MR perfusion, making reading and measurement of brain perfusion difficult (Figure 1). We developed an automatic image segmentation technique to remove CSF pixels and contents inside CSF spaces on MR perfusion parametric images to improve the readability of MR perfusion.

**MATERIALS & METHODS**

Usually the first few images in a brain perfusion MR study are discarded, because equilibrium signals are not reached on these images and they cannot be used to calculate the baseline signal. The CSF pixels have high proton density and they appear hyperintense on the first dynamic image, which is a truly proton-density weighted image with an equivalent TR of infinite. We use image division to generate ratio images to compensate for spatially dependent signal variation caused by B1 inhomogeneity. By applying appropriate signal threshold to ratio images using Niblack’s method, CSF pixels and contents inside can be identified and removed.

**RESULTS**

After removal of CSF pixels and contents inside CSF spaces, the brain parenchyma on MR perfusion is evaluated better. The outline of brain parenchyma is clear from CSF spaces. Choroid plexus on MR perfusion is no more confused with brain parenchyma (Figure 2).

**CONCLUSION**

We have found a simple, fast, automatic, and effective technique for identifying CSF pixels on MR perfusion images. Removal of CSF pixels in MR perfusion is helpful in clinical evaluation of brain perfusion.

**KEY WORDS:** MR perfusion, image processing, cerebrospinal fluid

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**Poster 28**

**Visualization of Cerebral Microbleeds on Non-GRE MR Sequences: Imaging Appearance, Frequency, and Clinical Correlates**

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**PURPOSE**

Cerebral microbleeds (CMBs) are round, homogenous, clinically silent lesions typically seen on T2*-weighted gradient-recalled echo (GRE) MR imaging. Cerebral microbleeds in specific locations likely is related to underlying pathology of amyloid angiopathy or hypertension. Higher numbers of CMBs have been associated with more extensive leukoaraiosis and number of lacunae. We describe the presence and appearance of CMBs on fluid-attenuated inversion recovery (FLAIR) MR imaging and time-of-flight MRA source images (SI) and assessed potential pathologic correlations.

**MATERIALS & METHODS**

We performed retrospective review of clinical and imaging data in consecutive patients admitted to the UCLA Stroke Service within a 2-year period, with GRE, FLAIR, and MRA SI acquisitions. Each CMB was described by presence on
sequence, appearance, and location. In addition, demographic and clinical variables were assessed for each patient, as well as number of lacunar infarcts and degree of white matter burden.

RESULTS
Among 165 patients meeting study entry criteria, mean age was 70 and 52% were female. Presenting events were ischemic stroke in 135, and transient ischemic attack in 30. Cerebral microbleeds on GRE were present in 22% of patients, with an average of 4.5 per patient. Among the total 175 CMBs detected on GRE, 65% also were evident on FLAIR, 70% also were evident on MRA SI, and only 15% on neither FLAIR nor MRA SI. Three patterns were noted on FLAIR: homogenous, rounded hypointense (n = 46, 40%), hypointense center with hyperintense ring (n = 38, 33%), and hyperintense (n = 30, 27%). Visibility on FLAIR or MRA SI tended to be less frequent in patients with diabetes (OR 0.45, 95%CI 0.17-1.19), hypertension (OR=0.32, 95%CI 0.09-1.14), and coronary artery disease (OR 0.52, 95%CI 0.18-1.44) and more frequent in patients currently smoking (OR 3.15, 95%CI 0.40-24.82). Number of lacunar infarcts, extent of white matter hyperintensity, and cortical location did not differ between groups.

CONCLUSION
Two-thirds of CMBs are detectable on FLAIR and MRA SI. Examination of these sequences may be clinically helpful when GRE acquisitions are unavailable or technically unsatisfactory. Visualization across multiple sequences may help distinguish true CMB from other causes of GRE hypointensity. Further investigation into the nature of CMBs should be undertaken to understand the clinical meaning behind the presence of CMBs on different imaging sequences and the potential implications for pathologic correlation.

KEY WORDS: MR imaging, microbleed

Poster 29
Variable Pitch Spiral Acquisition CT Perfusion Evaluation of Subarachnoid Hemorrhage: Comparison of Radiation Dose and Brain Coverage with Standard CT Perfusion and CT Angiogram Technique

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PURPOSE
To compare radiation dose and brain coverage of CT perfusion studies using variable pitch spiral (CTPv) acquisition technique vs standard cine CT perfusion (CTPc) technique performed to evaluate subarachnoid hemorrhage vasospasm. Radiation dose for CT angiogram of the circle of Willis (CTA) also was investigated; the CTPv technique used at our institution acquires angiographic data coincident with perfusion data. Previously, evaluation of cerebral perfusion and the cerebral vasculature required two separate acquisitions, CTPc and CTA.

MATERIALS & METHODS
We retrospectively estimated the radiation dose of CTPv for 10 consecutive patients. CTPv studies were performed using a 128-slice (Definition AS+; Siemens Medical Solutions, Munich, Germany) multidetector row CT scanner. CTPc and CTA dose were evaluated retrospectively for 10 consecutive patients who had both studies performed on the same 64-slice (Sensation 64; Siemens Medical Solutions) multidetector row scanner. For both CTPv and CTPc studies, 40 ml of nonionic contrast (Iosvue 370mg/ml) was injected through an 18-gauge IV line via power injector. For CTA, 140 ml of nonionic contrast (Iosvue 370 mg/ml) was administered.

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<th>Scan parameters for various protocols</th>
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<td>Parameter</td>
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For CTPv and CTPc, weighted volume CT dose index (CTDIIvol) and dose length product (DLP) were recorded. For CTA, CTDIvol and scan length were recorded; DLP then was calculated. CTPc+CTA DLP then was calculated for each patient; as scan length using CTA technique is variable, average CTPc+CTA DLP was calculated also.

RESULTS
For CTPv technique, estimated CTDIvol was 218.8 mGy and DLP was 2503 mgYxcm. For CTPc technique, estimated CTDIvol and DLP were 433.1 and 1247 mgYxcm, respectively. For CTA technique, estimated CTDIvol was 31.3 mGy with average DLP of 523 mgYxcm. CTPc+CTA average DLP was 1771 mgYxcm. CTPv technique compared to CTPc+CTA resulted in a 41.3% increase in DLP while yielding a 231.0% increase in perfusion brain coverage.

CONCLUSION
In our experience, CTPv technique results in a modest increase in radiation dose compared to CTPc+CTA while more than tripling the perfusion brain coverage. Even with the increase in total radiation dose, CTPv technique has significant advantages over CTAc+CTA including the aforementioned increased perfusion coverage, decreased radiation dose per area, decreased total contrast volume administration, and one fewer contrast injection.

KEY WORDS: CT perfusion, radiation dose, subarachnoid hemorrhage
CT Perfusion Unveils Subarachnoid Hemorrhage Pathophysiology: Relationship between Acute Perfusion Abnormalities, Clinical Grade and Bleeding Severity

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PURPOSE
To establish the relationship between CT brain perfusion performed as soon as SAH has been diagnosed and the severity of the bleeding determined by the clinical grade and extent of the bleeding or the outcome of the patients. Subarachnoid hemorrhage (SAH) is still related to high neurologic morbidity and mortality. The severity of the initial bleeding and its effect on the level of consciousness of the patients are the major determinants of outcome in this form of stroke. There are few studies focused on establishing the initial effects of the bleeding, although it seems to be a global reduction of cerebral blood flow. Perfusion CT has been introduced as a powerful tool to explore the cerebral blood flow and its anomalies. As it is easy and ready to use in an emergency basis, its use in the case of SAH would be ideal as it can be performed just after diagnosis has been made in order to explore the initial effects of brain circulation caused by the bleeding.

MATERIAL & METHODS
After the diagnosis of SAH by conventional CT a perfusion CT (PCT) was performed before CT angiography. All imaging studies were performed on a 6-slice spiral CT scanner. Perfusion CT consisted of two 45-second series during the intravenous administration of contrast medium. A period of 10 minutes between slides was used for contrast washout. Measurements of mean transient time (MTT), time to peak (TTP), cerebral blood volume (CBV) and cerebral blood flow (CBF) in volumes of interest corresponding to territories perfused by the major cerebral arteries were performed. Also these measurements were averaged from the different volumes, establishing mean values for each parameter and each patient. Different data regarding severity of the bleeding such as level of consciousness and amount of bleeding in conventional CT were collected. Outcome was assessed by the Glasgow Outcome scale at least 6 months after the bleeding. For statistical analysis nonparametric correlations between variables were performed (Spearman’s Rho).

RESULTS
Forty-two patients have been included in the study since January 2007. In none of them the perfomance of CT perfusion has caused any delay or complications due to increase amount of intravenous contrast necessary for the study. In SAH patients there are increasing perfusion abnormalities as the severity of the bleeding increases. The most affected perfusion parameters are TTP and MTT, as they significantly increase with the severity of the bleeding (p<0.01, Spearman’s Rho). When average MTT time is increased over 6.5 seconds there is a 3.2 (CI = 1.4-6.8) risk of poor outcome. This value has a positive predictive value of 80% for a poor outcome.

CONCLUSION
Subarachnoid hemorrhage causes cerebral blood flow abnormalities even in the acute phase of the illness, consisting mainly in an increase in circulation times (TTP and MTT), which are correlated with the severity of the bleeding. These may be produced by an increase in intracranial pressure, as has been suggested by other authors.

KEY WORDS: CT perfusion, SAH

Poster 32

Moyamoya Disease: Comparative Study between MR Angiographic and Other MR Findings of 3.0 T MR Imaging

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PURPOSE
We assessed the comparative findings between MR angiographic (MRA) and MR image by using 3.0 T MR to find the relationship among the steno-occlusive severity of intracranial arteries, amount of moyamoya vessels, “ivy sign” and cerebrovascular attack (CVA) lesions in moyamoya disease (MMD).

MATERIALS & METHODS
MR imaging and MRA (3 T) were performed on 100 MMD patients (200 sides) from 2006 to 2009 (32 males and 68 females; age range/average, 5-71/ 28 years, post/preoperative patients: 61/39) in our institution. We analyzed the severity of cerebrovascular steno-occlusion by modified Houkin’s MRA score (0 to 10); the amount of moyamoya vessels by modified moyamoya vessels score (0 to 5); “ivy sign” by modified Yoon’s ivy score (0 to 2) and the existence of small (< 1 cm), medium (1 - 3 cm), and large(> 3 cm) CVA lesions of each hemisphere. Then we compared these findings to find the relationship between each parameter.

RESULTS
MR angiographic score was significantly consistent with moyamoya vessels score (p < 0.01). Moyamoya vessels score correlated well with ivy score (p < 0.01).
CONCLUSION
Our study revealed that the amount of moyamoya vessels might reflect the severity of steno-occlusive change in MMD in some level. Collaterals might be corresponding factor of “Ivy sign” which will appear by slow-flow and disappear without flow.

KEY WORDS: Moyamoya disease, 3.0 T MR, MRA

Poster 33
Dilated Virchow-Robin Space Score Is the Most Sensitive Imaging Biomarker of Stroke Risk
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PURPOSE
Significant numbers of elderly patients undergo MR brain scanning for multiple diagnostic reasons, many of these patients subsequently will suffer strokes. Quantitative scoring of vascular disease imaging biomarkers may have a role in identifying patients on routine MR imaging who are at high risk of stroke. White matter lesion scoring has been shown previously to correlate with Framingham stroke risk scores (1). Dilated Virchow-Robin spaces (VRS) are proved biomarkers of microvascular disease (2) and are simple and rapid to score. We aim to show that VRS scores are both more sensitive and specific indicators of stroke risk compared with white matter scores.

MATERIALS & METHODS
Images from 158 subjects (aged 44-88 years) who underwent MR imaging with a 1.5 T Achieva MR scanner (Phillips, The Netherlands), from three studies investigating the imaging biomarkers of vascular depression, containing equal numbers of depressed subjects and controls were analyzed. Each subject had T1-inversion recovery 3D volume acquisition. A modified Scheltens’ scale (3), which scores: cortical deep white matter; periventricular hyperintensities; basal ganglia and infratentorial changes, was used for white matter scoring. Virchow-Robin space analysis was scored for both the centrum semiovale and basal ganglia, for each region the slice with greatest number of VRS was selected and the number of VRS counted. The VRS score in basal ganglia and centrum semiovale was combined to produce the VRS score. The subjects were stratified for stroke risk using the modified Framingham stroke risk score. This score correlates to a percentage stroke risk per year (4). The subjects were divided into high stroke risk >10% and lower risk <10% per year. Statistical analysis included ANOVA and ROC analysis.

RESULTS
Scheltens’ and VRS scores both correlated with Framingham stroke risk (P > 0.01). The presence of high VRS scores was a more sensitive and specific indicator of stroke risk compared to Shelton’s with VRS with the highest sensitive of 80%, specificity 60%. Principle component analysis revealed that only independent variable within the analysis was the VRS score.

CONCLUSION
Virchow-Robin space score is simpler and faster to implement that Scheltens’ and a more sensitive indicator of stroke risk. The scoring of VRS takes less than 1 minute per subject. Virchow-Robin space scores can provide important information on microvascular disease and stroke risk in the diagnostic setting.

REFERENCES

KEY WORDS: Stroke, biomarker, Virchow-Robin space

Poster 34
Isolated Pontine Infarction: Evaluation of Atherosclerotic Basilar Artery Disease with the Use of High-Resolution MR Imaging
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PURPOSE
To evaluate the usefulness of high-resolution MR imaging (HRMRI) for atherosclerotic basilar artery in patients with isolated pontine infarction.

MATERIALS & METHODS
High-resolution MR imaging of basilar arterial wall in 42 patients diagnosed with acute isolated pontine infarction were compared with 3D time-of-flight MR angiography (3D-TOF MRA) and transcranial Doppler sonography (TCD) in evaluation. We also evaluated the relationship between the finding of each vascular imaging and the MR pattern of stroke, which were classified as a paramedian pontine infarction (PPI), a lacunar pontine infarction (LPI).

RESULTS
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RESULTS
On TCD, 19 patients had increased peak systolic velocity measured in the basal artery and 23 patients had normal spectral wave form. Interpretation of stenosis in HRMRI by a radiologist correlated with increased PSV (p = 0.01; sensitivity, 81.3%; specificity, 61.5%; positive predictive value, 56.5%; negative predictive value, 84.2%; accuracy, 69.0%). Of 42 patients, 27 (64.3%) had PPI as depicted on DWI. MR findings of stenosis in HRMRI were correlated with PPI (p < 0.001; sensitivity, 81.3%; specificity, 92.3%; positive predictive value, 86.7%; negative predictive value, 88.9%; accuracy, 88.1%).

CONCLUSION
This study demonstrates that HRMRI is the most sensitive method to detect atherosclerosis of the basal artery in an isolated pontine infarction in comparison with the use of 3D-TOF MRA or TCD and the wall thickening of basal artery on HRMRI is the specific sign for diagnosis of atherosclerotic basal artery disease.

KEY WORDS: Stroke, MR imaging, basilar artery

Poster 35
Bloomingly Hypointense Middle Cerebral Artery on T2*-Weighted Gradient Echo Imaging: Association with the Response to Intraarterial Thrombolysis and the Residual Luminal Narrowing

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PURPOSE
To determine whether the vascular sign of acute stroke on T2*-weighted gradient-echo imaging (T2*-GRE) is related with outcomes of intraarterial thrombolysis (IAT).

MATERIALS & METHODS
The T2*-GRE and digital subtraction angiography (DSA) was evaluated retrospectively on 81 patients who underwent IAT for acute stroke. The “blooming index,” the diametric ratio between blooming hypointensity of affected middle cerebral artery (MCA) and normal MCA, was measured on T2*-GRE. The thrombolysis cerebral ischemia (TICI) grades and the presence of residual luminal narrowing (RLN) were assessed on DSA after classical IAT by using intraarterial fibrolics infusion and clot disruption. The blooming index was compared between TICI0-1 and TICI2-3 after classical IAT. The ROC curve analysis was performed on the blooming index to predict TICI2-3 after classical IAT and RLN, respectively.

RESULTS
The 72.8% (59/81) of patients resulted TICI2-3 after classical IAT. The RLN was detected in 28.3% (17/60), and blooming index ≤ 1.3 was optimal in predicting RLN (area under the curve, 0.821; sensitivity, 88.2%; specificity, 69.8%, p = 0.0001).

CONCLUSION
The favorable response to classical IAT and the presence of RLN can be predicted by the less bloomingly hypointense MCA on T2*-GRE.

KEY WORDS: Bloomingly hypointense middle cerebral artery, T2*-weighted gradient-echo imaging, response to intraarterial thrombolysis

Poster 36
Quantifying Iron Deposition in Parkinson’s Disease Using 7 T MR Imaging T2* Sequences

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PURPOSE
Excess iron deposition is a common hallmark of neurodegenerative processes. In Parkinson’s disease (PD), excess iron accumulates in the substantia nigra (SN). Prior studies at 1.5 and 3.0 T have examined this iron deposition in PD, but no studies have been performed with the increased susceptibility sensitivity provided by 7.0 T MR imaging.

MATERIALS & METHODS
Institutional Review Board approval and consent were obtained prior to imaging of three PD patients and age-matched healthy controls. Patients are evaluated routinely with standardized psychomotor video testing (Unified Parkinson’s Disease Rating Scale). 7 T imaging was performed on a Philips Achieva 7 T whole-body scanner (Philips Healthcare, Cleveland, OH) using a 16-channel head coil (Nova Medical, Wilmington, MA). T2* calculations were based on 3D full-brain fast-field-echo scan with full-brain coverage at 1 mm isotropic resolution (TR/TE/ΔTE = 17/2.7/3.0 ms, scan time = 4:40 min). T2* values were calculated on a voxel-by-voxel basis using an unconstrained nonlinear optimization algorithm in Matlab (The Mathworks, Natick, MA). Patients also had 1.5/3 T clinical scans. Two CAQ-qualified neuroradiologists (M.K.S., J.L.C.) outlined regions of interest including red nuclei, cerebral peduncles, and substantia nigra.

RESULTS
Comparison analysis (controls/PD patients) reveals increased iron (decreased T2*) in patients for all midbrain structures with the biggest difference found in the pars compacta region of the SN. Figure shows increased hypointensity of midbrain nuclei at 7 T compared to 1.5 T. The pattern of iron deposition within the SN pars compacta has been elucidated best within the pathology literature (1-3). Correlation with MR findings has been limited by the resolution of lower field MR imaging (particularly 1.5 T research) due to the complex anatomy of the SN. 7 T MR imaging should offer
improved resolution with increased sensitivity to the susceptibility effects of iron. This, in turn, may yield a better correlation between the pathologic findings in PD and the (more elusive) changes on MR imaging.

**CONCLUSION**

These preliminary 7 T data show decreased T2* values indicative of increased midbrain iron deposition within the substantia nigra in PD patients compared to controls.

**REFERENCES**


**KEY WORDS:** Parkinson, iron, substantia nigra

**Poster 37**

Wilson’s Disease $^{31}$P and $^1$H MR Spectroscopy and Clinical Correlation

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**PURPOSE**

Proton ($^1$H) MRS changes are noted in Wilson’s disease (WD). However, there are no studies regarding membrane phospholipid abnormality using $^{31}$P MRS in these patients. To analyze the striatal spectroscopic abnormalities using $^{31}$P and $^1$H MR spectroscopy (MRS) in WD.

**MATERIALS & METHODS**

Forty patients of WD (treated: 29, untreated: 11) and 30 controls underwent routine MR image sequences and in vivo 2D $^{31}$P and $^1$H MRS of basal ganglia using an image-selected technique on a 1.5 T MR scanner. Statistical analysis was done using Student t-test.

**RESULTS**

The mean durations of illness and treatment were 6.2 +/- 7.4 and 4.8 +/- 5.9 years respectively. MR images were abnormal in all the patients. $^1$H MRS revealed statistically significant reduction of N-acetyl-aspartate (NAA)/Choline (Cho), and NAA/Creatine (Cr) ratios in striatum ($^1$H MRS) of treated patients compared to controls. The mean values of phosphonoesters (PME) ($p < 0.0001$), phosphodiesters (PDE) ($p < 0.0001$) and total phosphorus (TPh) ($p < 0.0001$) were elevated in patients compared to controls. Significantly elevated levels of ratio of PME/PDE ($p = 0.05$) was observed in the striatum in untreated patients as compared to controls. The duration of illness correlated well with increased PME/PDE ($p < 0.001$), PME/TPh ($p < 0.05$) and PDE/TPh ($p < 0.05$), and decreased NAA/Cho ($p < 0.05$) ratios. There was correlation of MR score and reduced NAA/TPh ratio with disease severity. The PME/PDE ratio (right) was elevated in the treated group ($p < 0.001$) compared to untreated group.

**CONCLUSION**

There is reduced breakdown and/or increased levels of membrane phospholipids and increased neuronal damage in basal ganglia in patients with WD.

**KEY WORDS:** Wilson’s disease, MR imaging, MR spectroscopy

**Poster 38**

Clinical and Neuroimaging Profile of a Novel Neurogenetic Syndrome Caused by a Homozygous Deletion of AP4E1

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**PURPOSE**

To describe the clinical presentation, neuroimaging findings and identification of the underlying genetic cause of a previously unknown neurodegenerative disorder in an inbred sibship.

**MATERIALS & METHODS**

A 23-year-old female and her 21-year-old brother, born to healthy first cousins of Middle Eastern ancestry were referred to our genetics clinic for evaluation of an idiopathic neurodegenerative disease. They were born after full-term pregnancies and unremarkable labor and deliveries, after which they presented with microcephaly, hypotonia, severe mental retardation and developmental delay. Progressive tetraplegic spasticity with hypertonia and hyperreflexia were present by the end of the first year. Speech and sphincter control were never acquired, and deambulation was delayed and then lost. They have been experiencing generalized tonic-clonic seizures since infancy (female) and adolescence (male). 3 T MR scans of the brain were obtained including T2-weighted and fluid-attenuated inversion recovery (FLAIR) images. Genome-wide array comparative genomic hybridization (aCGH) was performed using a custom-designed 44K oligonucleotide array and fine-mapping was carried out with a gene-targeted 180K array.

**RESULTS**

T2-weighted FLAIR images revealed enlarged lateral and third ventricles, as well as abnormal and reduced volume of the hippocampus bilaterally. T2-weighted images showed
cortical atrophy, white matter loss, especially in the frontal lobes and corpus callosum, and abnormal hypointensity in the globus pallidus. Array analysis detected a 171 kilobase (kb) homozygous interstitial deletion of the long arm of chromosome 15 at band q21.2 including the \( AP4E1 \) and \( SPPL2A \) genes.

**CONCLUSION**

Here we describe the neuroradiologic findings, clinical presentation and genetic etiology of a novel nonhypoxic-ischemic cerebral palsy-like syndrome. The \( AP4E1 \) gene is a subunit of the adaptor protein complex-4, which is a heterotetramer composed of \( AP4E1, \) \( AP4B1, \) \( AP4M1 \) and \( AP4S1 \). A recent report of a family with a very similar phenotypic presentation had a mutation in the \( AP4M1 \) gene (Verkerk, et al. 2009). Together with evidence from animal models and functional studies, these results indicate that the homozygous deletion of \( AP4E1 \) gene in our patients is the cause of this syndrome. We suggest screening for this autosomal recessive condition in patients with a similar clinical and neuroimaging profile.

**KEY WORDS:** Gene deletion, epilepsy, mental retardation

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**Poster 39**

**Role of Diffusion Tensor Imaging for Better Assessment of Neurologic Disorders**

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**PURPOSE**

In some neurologic cases, traditional MR protocols do not give satisfactory explanation for the patient’s complaint or satisfy our needs regarding assessment of the patient’s overall condition and care. This motivates us to use newly introduced MR techniques, namely diffusion tensor imaging (DTI) and tractography, and to quantitatively study the structural integrity of brain changes at the microscopic level through assessment of fractional anisotropy (FA) and apparent diffusion coefficient (ADC) values (1). The aim of this study is to evaluate the effectiveness of DTI and tractography in improving the diagnostic outcome of patients with specific neurologic disorders.

**MATERIALS & METHODS**

Fifteen patients with different neurologic disorders and 15 healthy age- and gender-matched subjects were included in the study. Patients were referred with variable neurologic disorders including demyelination, dysmyelinating diseases such as multiple sclerosis (MS), vascular dementia, Alzheimer, dystonia, epilepsy, encephalitis and amyotrophic lateral sclerosis (ALS). The protocol involved comprehensive conventional MR imaging followed by DTI. All patients and their controls were assessed both qualitatively and quantitatively using fractional anisotropy (FA) and apparent diffusion coefficient (ADC) from specific designated regions of interest tailored according to the specific pathology.

**RESULTS**

There was no quantitative or qualitative significant difference in diffusivity or FA measurements between the right and left brain regions in the healthy controls. The patient group had significantly decreased FA values and increased ADC values in specific regions relevant to each individual pathology when compared to the healthy control. Additionally, in some diseases like multiple sclerosis (MS), DTI was helpful in estimating the lesions’ load quantitatively (Table 1).

<table>
<thead>
<tr>
<th>Region</th>
<th>FA</th>
<th>ADC</th>
</tr>
</thead>
<tbody>
<tr>
<td>FAWM 1</td>
<td>0.58</td>
<td>0.9</td>
</tr>
<tr>
<td>FAWM 2</td>
<td>0.58</td>
<td>0.85</td>
</tr>
<tr>
<td>NAWM</td>
<td>0.36</td>
<td>0.98</td>
</tr>
<tr>
<td>Plaque</td>
<td>0.01</td>
<td>2.1</td>
</tr>
</tbody>
</table>

**CONCLUSION**

Diffusion tensor imaging is helpful for evaluation of patients with neurologic disorders that were not evident or conclusive in the conventional MR imaging. It helped in quantitative evaluation of these patients thus putting a reference for further patient follow up.

**REFERENCES**


**KEY WORDS:** DTI

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**Poster 40**

**Role of Diffusion Tensor Imaging in Diagnosis of Medial Temporal Lobe Epilepsy**

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**PURPOSE**

Frequently, we are facing epilepsy studies which appear normal on conventional MR imaging (MRI) even after performing special MR epilepsy protocol. Modern MR techniques are helpful in assessment of patient with seizures (1). This study is aiming to assess the role of diffusion tensor imaging (DTI) in patients with medial temporal lobe epilepsy (MTLE).

**MATERIALS & METHODS**

Ten patients with MTLE and 10 healthy subjects had performed conventional MR imaging epilepsy protocol including thin cuts coronal oblique IR images for temporal lobes, FLAIR, fractional anisotrophy (FA) and apparent diffusion coefficient (ADC) of special regions specially hippocampus bilaterally using 1.5 T MR unit (Intara; Philips Medical System, Best, Netherlands) Qualitative assessments were done for the conventional MR images as well as the DTI color maps using offline workstation (extended work space “EWS”) (Release 2.5.3.0: Dell, Round Rock, Tex). MR trac-


tography then was performed for fornix, cingulum, inferior longitudinal fasciculus (ILF), inferior fronto-occipital fasciculus (IFOF), corpus callosum, middle cerebellar peduncle, and corticospinal tract. Fractional anisotropy and ADC values were measured and then compared as an assessment of pertinent regions. All data were correlated with the clinical and advanced EEG of the patient.

RESULTS
There was no significant quantitative or qualitative difference in diffusivity or FA measurements between the sides in controls. The patient group, however, had significantly decreased FA values and increased ADC values in the hippocampus as well as the basal ganglia ipsilateral to the seizure focus, and there were mild similar changes in the cingulum, ILF and to a lesser extent in other tracts ipsilateral to seizure focus as suggested by the clinical and EEG findings (Table 1).

Table 1: Decreased FA values and increased ADC values in the right hippocampus and ILF of the same patient

<table>
<thead>
<tr>
<th>Hippocampus</th>
<th>FA</th>
<th>ADC (10⁻³ mm²/s)</th>
<th>Cingulum</th>
<th>FA</th>
<th>ADC (10⁻³ mm²/s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Left</td>
<td>0.21 ± 10⁻³</td>
<td>0.87 ± 10⁻³</td>
<td>Left</td>
<td>0.471 ± 10⁻³</td>
<td>0.810 ± 10⁻³</td>
</tr>
<tr>
<td>Right</td>
<td>0.09 ± 10⁻³</td>
<td>1.05 ± 10⁻³</td>
<td>Right</td>
<td>0.432 ± 10⁻³</td>
<td>0.909 ± 10⁻³</td>
</tr>
</tbody>
</table>

CONCLUSION
Moreover, in some cases, the DTI data also revealed contralateral similar (but less impressive) abnormalities of FA and diffusivity values when compared with the controls.

REFERENCES

KEY WORDS: Epilepsy, DTI

Poster 41

Effect of Bevacizumab on Normal-Appearing White Matter Fibers: A Diffusion Tensor Imaging Study

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PURPOSE
Postoperative radiation therapy (RT) is the standard first-line treatment for glioblastoma (GB) (1). Recently, antiangiogenic drugs such as bevacizumab combined with chemotherapy have become routine second-line-therapy for patients with recurrent/progressive malignant glioma (rGB). Whereas radiation effects on the brain tissue are well characterized (2), the effect of antiangiogenic drugs such as bevacizumab combined with chemotherapy (CTr) such as Temozolomide/Irinotecan on the normal-appearing brain tissue, is less known. The aim of this study was to evaluate the effect of bevacizumab and CTr on the integrity of the normal appearing white matter (NAWM) fibers in patients with GB, using diffusion tensor imaging (DTI).

MATERIALS & METHODS
The control group included 31 healthy subjects. The study group included 16 patients: (I) seven patients with GB scanned after RT, before and during the course of antiangiogenic therapy (total of 24 MR scans); (II) one GB patient scanned during RT and during antiangiogenic therapy (total of 9 MR scans); (III) two newly diagnosed patients with GB scanned before surgery; and (IV) six patients with benign brain lesions scanned before surgery. MR scans were performed on a 3T GE scanner. Diffusion tensor imaging was performed using GE-EPI sequence with b=1000 sec/mm² and 15 diffusion directions. Mean values of fractional anisotropy (FA), mean diffusivity (MD), radial (Dr) and axial (Da) diffusivity were calculated from all major fibers of the entire brain and on the corticospinal tracts (CST). Values were calculated from both hemispheres in the control group and on the contralateral side to the lesion in tumor patients. The distance was calculated in standard deviations, between the mean values obtained in each patient and the mean normal values.

RESULTS
Post radiation effects: Increased MD, Da and Dr were detected in 7/8 patients who received RT previous to the MR scan (group I) in the major white matter fibers and in the CST. These values were correlated negatively between the time intervals from the end of the RT with MD (r = -0.83, p = 0.02) and with Dr (r = -0.80, p = 0.03). No differences were found in FA values in group I and in all diffusivity values in all other patients compared to normal values. These results support previous reports of early and late radiation effects on the brain tissue (3). Antiangiogenic therapy effects: No changes in diffusivity values were detected during bevacizumab and CTr. Improvement in MD, Da and Dr was detected in 3/7 patients in group I, presumably related to brain recovery from the RT. In the patient in group II, changes were detected following RT with increase in MD, Da and Dr parameters. While Dr and MD stabilized after 5.5 months, Da continued to increase. During bevacizumab treatment, no additional reduction in Dr and/or MD was detected.

CONCLUSION
Diffusivity changes were detected in the NAWM of the contralateral hemisphere to the lesion due to RT. There were no significant diffusivity changes during therapy with bevacizumab and CTr in relate to postradiation changes. These results have important clinical implications including the question of using bevacizumab-related therapies in the upfront setting for glioblastoma.

REFERENCES
Concurrent Positron Emission Tomography and Computed Tomography Evaluation of Ventricular Size and Cerebral Metabolism

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PURPOSE
Dementia is a relatively common diagnosis, affecting 5% of Americans over age 65 and 20% over age 80. Alzheimer disease is the most common form of dementia and must be differentiated from other etiologies of cognitive dysfunction including normal pressure hydrocephalus (NPH). Concurrent positron emission tomography (PET) and computed tomography (CT) of the head allows evaluation of cerebral atrophy, specifically ventriculomegaly, and global cerebral metabolism of glucose. This research tested the hypothesis that patients with CT evidence of NPH do not have PET evidence of cerebral hypometabolism.

MATERIALS & METHODS
A total of 54 patients with cognitive dysfunction were imaged with concurrent PET and CT scans of the brain. The mean age of patients was 74 years. A blinded retrospective review of all scans was performed to determine the average global cerebral metabolism, ventricular size, and presence or absence of NPH. The Spearman's test was conducted to determine if global cerebral glucose metabolism correlated with ventriculomegaly and NPH.

RESULTS
There was no correlation between glucose metabolism and ventriculomegaly (p = 0.2110). Furthermore, global cerebral glucose metabolism did not correlate with the clinical presence of NPH (p = 0.4883). Lastly, ventriculomegaly positively correlated with clinical NPH (Spearman's rho = 0.43, p value = 0.0012).

CONCLUSION
In this patient population, ventriculomegaly was a common finding on CT scans, seen in 91% of patients, while only 9% of patients demonstrated CT evidence of NPH. Based on our statistical analysis, patients with CT evidence of NPH do not have PET evidence of cerebral hypometabolism. However, a prospective study to better evaluate the relationship of global cerebral metabolism with ventriculomegaly and NPH is needed.

KEY WORDS: Normal pressure hydrocephalus, cerebral hypometabolism, cognitive dysfunction
GKM1 always overestimates $K_{\text{trans}}$ by a factor roughly proportional to $v_p$. For GKM2, its estimated $K_{\text{trans}}$ is always between its true value and that estimated by Model 1 (estimated $K_{\text{trans}}$ closer to the true value in low permeability or high flow states).

**CONCLUSION**
Accuracy of estimated parameters depends on model selection and is relatively independent of injection and sampling rates, whereas precision of estimated parameters depends on sampling rate and injection protocol.

**KEY WORDS:** DCE-MR imaging, kinetic model, simulation

**Poster 44**
Characterization of Imaging Features of Inflammatory Pseudotumors of the Head and Neck with Pathologic Correlation

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**PURPOSE**
The pathogenesis and significance of inflammatory pseudotumors remains controversial. On histology, inflammatory pseudotumors consist of a mixture of myofibroblastic spindle cells and inflammatory cells including both B- and T-cell lymphocytes and are classically positive for CD34. These lesions have been reported to occur in virtually any tissue or organ, although the orbit and lungs appear to be the most common sites. The goal of this study is to characterize the imaging features of inflammatory pseudotumors found in head, neck, and spine regions.

**MATERIALS & METHODS**
An IRB approved retrospective review of the pathology department database between January 2004 and January 2009 was performed. Only cases with available CT or MR studies were included for review. Based on these imaging studies, maximum lesion size, enhancement, margins, presence of calcifications, cystic/necrotic components, bone erosions, proptosis, and treatment response were noted.

**RESULTS**
Our search yielded six cases of pathology proved inflammatory pseudotumors in the head and neck region for which imaging studies were readily available. These included 3 orbital, 1 maxillary sinus, 1 brain/dura, and 1 paraspinal muscle. The average age at time of diagnosis was 39.2 years (range: 11 to 89 years). The average maximum dimension of the lesions was 3.0 cm. Overall, half ($n = 3$) of the lesions were well defined. On CT, the orbital inflammatory pseudotumors were soft tissue density and homogeneous. One of these demonstrated mild erosive change of the inferior orbital wall and the lacrimal gland lesion demonstrated associated inflammatory changes. The maxillary sinus lesion initially appeared aggressive with areas of low density centrally, bone erosion, and orbital invasion. The maxillary sinus and all of the orbital pseudotumors caused painful proptosis. Calcifications were identified in two (33%) cases (meninges/brain and paraspinal muscles). These calcifications were identified in two (33%) cases and all of the orbital pseudotumors caused painful proptosis.

**CONCLUSION**
Inflammatory pseudotumors of the head, neck and spine regions display protean imaging features that vary over time and treatment. Although benign, these lesions may demonstrate aggressive behavior that can mimic malignancy, but are responsive to steroid therapy. Awareness of this entity can help guide appropriate management, as many of these lesions are self-limited and can regress.

**KEY WORDS:** Inflammatory pseudotumor

**Poster 45**
CT Perfusion in Diagnosis of Orbital Tumors

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**PURPOSE**
CT perfusion (CTP) is a minimally invasive method for assessment of orbital tumor’s hemodynamics and differential diagnosis. Orbital tumor’s studies by MR diffusion and perfusion imaging, MR spectroscopy are a difficult task because of artifacts from bone structures. The review of literature has shown a few reports of CTP use in orbital pathology diagnosis. The aim of our work was to determine the CTP opportunities in diagnosis of various orbital tumors (or growing into area of an orbit) and evaluate the efficiency of this method in consideration of radiation dose on the eyes.

**MATERIALS & METHODS**
CT perfusion was performed in 20 patients on multispiral CT scanners (Philips, GE): 5 with intraorbital meningiomas, 3 neurinomas, 2 chondrosarcomas, 2 pilocytic astrocytomas, 3 low-grade astrocytomas, 2 neurofibromas, 3 recurrent of hemangiopericytomatos. CT perfusion at a level of orbit included 4 slices with 5 mm thickness, 160 images, acquisition time 40 s. Radiation dose 2.2 mSv. All patients have undergone enhanced MR imaging before and after surgical treatment.

**RESULTS**
Hemangiopericytomatos, meningiomas had highest values CBV, CBF as compared with white matter of brain. Neurofibromas and neurinomas distinguished from others by a higher MTT. For chondrosarcomas CBV, CBF were comparable to brain tissue values, but were marked higher MTT. By values CBV and CBF it is possible to differentiate pilocytic astrocytoma from low-grade astrocytoma.
PURPOSE
Medical Center, Duarte, CA. had multiple studies (average 2.5) with the initial scan done 1.50, 0.95-2.35 respectively). Most of the imaged patients 19 and > 54 years of age (hazard 1.94, 95% CI 1.18-3.17 and patients. Relatively more studies were ordered in patients < hospital. Brain imaging studies were ordered in 23% of these In three years (2004-2007), 578 HCTs were done at our hos-

RESULTS
portional hazard of scan was estimated also.
Cumulative incidence was calculated for competing risks of medical indication, imaging diagnosis, risk factors and outcome.

eRtrospective clinical studies have reported widely varying prevalence of neurologic complications after allogeneic hematopoietic cell transplantation (HCT). To estimate prevalence of neurologic complications in HCT patients, we have analyzed patients who underwent brain CT or MR studies in the first post-HCT year. This retrospective study provides data on clinical indications, imaging findings, the risk factors of neurologic complications, and outcome in this patient population.

MATERIALS & METHODS
 Patients who received consecutive allogeneic hematopoietic cell transplantation (HCT) were reviewed over a 1-year period for presence or absence of brain CT or MR studies, clinical indication, imaging diagnosis, risk factors and outcome. Cumulative incidence was calculated for competing risks of brain imaging and death; cumulative incidence-based proportional hazard of scan was estimated also.

RESULTS
In three years (2004-2007), 578 HCTs were done at our hospital. Brain imaging studies were ordered in 23% of these patients. Relatively more studies were ordered in patients < 19 and > 54 years of age (hazard 1.94, 95% CI 1.18-3.17 and 1.50, 0.95-2.35 respectively). Most of the imaged patients had multiple studies (average 2.5) with the initial scan done within 2 weeks of HCT in 26% of scanned patients. There was an age-related statistically significant difference of indication for brain imaging: seizures being a more common indication in patients < 19 (28%), focal signs more common in patients 19-54 (11.4%), and encephalopathy as the most common indication over age 54 (47%). Only 29 (22.5%) of first studies obtained established a neurologic diagnosis: drug toxicity/PRES in seven, stroke in six, cerebral abscess in four, subdural fluid collection in four, tumor in three. With follow-up studies, an imaging diagnosis of the neurologic complication was made in almost one third of the imaged patients. As expected, diagnostic first studies were obtained more often with MR imaging than CT (odds ratio 3.65, CI 1.41-9.43). There was an inverse association of diagnostic first studies in patients imaged in the first 2 weeks post HCT (0.23, 0.05-1.07) and in patients over age 54 (0.24, 0.06-0.96). There was no association of new diagnostic first imaging abnormality with hematologic diagnosis, type of allogeneic transplant (sibling vs unrelated donor) or whether the patient had a prior HCT. The one-year posttransplant mortality was almost two thirds in the imaged patients as compared to 18% of patients who received HCT in the same time interval but did not undergo brain imaging.

CONCLUSION
Our study provides an analysis of risk factors for neurologic complications such as age, type of HCT or whether the patient had a prior allogeneic transplant. Encephalopathy early after HCT is attributed most often by clinicians to calcineurin inhibitor neurotoxicity, but only a minority of these patients have PRES demonstrable on imaging. Transplant physicians interpret normal CT or MR brain studies as supportive of a toxic-metabolic etiology. Prognosis in the transplant patient population having one or more brain imaging study within the first transplant year is poor. The one-year mortality in the imaged patients is more than three times that of patients without brain imaging.

KEY WORDS: Neurologic complications, hematopoietic cell transplant, imaging findings

Poster 47
Neuroimaging Interpretation Pitfalls of Cerebellar and Fourth Ventricle Lesions and Pseudolesions
Sheorain, V. • Thapa, G. • Sethi, A. • Levy, L. M.
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Washington, DC

PURPOSE
Posterior fossa abnormalities can sometimes be difficult to detect on CT scan due to various factors such as artifacts, isodensity, and perceptual errors. Conversely, interpretation pitfalls may produce false-positives (pseudolesions). An organized approach to detecting these lesions accurately depends on a solid knowledge of cerebellar anatomy and of fourth ventricle morphology, as well as a comprehensive evaluation of the posterior fossa. This study examines neuroimaging signs that may help to detect different types of pathology involving the cerebellum and fourth ventricle.

KEY WORDS: Neurologic complications, hematopoietic cell transplant, imaging findings

Poster 46
Neurologic Complications as Demonstrated on Brain CT or MR Imaging in the First Year after Allogeneic Hematopoietic Cell Transplantation: Risk Factors, Clinical Indications, Imaging Findings, and Outcomes
Chen, B. T. • Parker, P. • Torricelli, C. • Openshaw, H.
City of Hope Medical Center, Duarte, CA.

PURPOSE
Retrospective clinical studies have reported widely varying prevalence of neurologic complications after allogeneic hematopoietic cell transplantation (HCT). To estimate prevalence of neurologic complications in HCT patients, we have analyzed patients who underwent brain CT or MR studies in the first post-HCT year. This retrospective study provides data on clinical indications, imaging findings, the risk factors of neurologic complications, and outcome in this patient population.

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KEY WORDS: Neurologic complications, hematopoietic cell transplant, imaging findings

Poster 47
Neuroimaging Interpretation Pitfalls of Cerebellar and Fourth Ventricle Lesions and Pseudolesions
Sheorain, V. • Thapa, G. • Sethi, A. • Levy, L. M.
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Washington, DC

PURPOSE
Posterior fossa abnormalities can sometimes be difficult to detect on CT scan due to various factors such as artifacts, isodensity, and perceptual errors. Conversely, interpretation pitfalls may produce false-positives (pseudolesions). An organized approach to detecting these lesions accurately depends on a solid knowledge of cerebellar anatomy and of fourth ventricle morphology, as well as a comprehensive evaluation of the posterior fossa. This study examines neuroimaging signs that may help to detect different types of pathology involving the cerebellum and fourth ventricle.
MATERIALS & METHODS
Patients presenting with cerebellar abnormalities were evaluated retrospectively (n = 24). The clinical presentation included symptoms such as ataxia, dizziness, nystagmus, and headaches. In addition, normal subjects with “pseudolesions” of the fourth ventricle were selected also (n = 11). Patients first had head CT scans, then brain MR scans without and with contrast, as well as complete neurologic examinations. All CT scans had subtle findings involving the cerebellum and fourth ventricle. MR images were examined for various parameters related to lesion location and regional distribution, size, mass effect, signal, and degree of enhancement. Diagnoses were confirmed with either neuropathologic examination or laboratory studies.

RESULTS
Abnormalities involving the cerebellum and fourth ventricle included neoplasms such as ependymoma, metastases to the fourth ventricle, as well as fourth ventricle cysts, epidermoids, Chiari, and strokes. Neoplastic lesions and cysts were sometimes isodense to adjacent regions, with little adjacent edema, making detection extremely difficult on the unenhanced CT scan. Important key diagnostic features included subtle deformation of fourth ventricle morphology, in particular narrowing or asymmetry of the lateral recesses of the fourth ventricle (lesions posterior to the fourth ventricle), and rounding of the lateral recesses (intraventricular lesions). Evaluation of the selected normal variants with pseudolesions of the fourth ventricle demonstrated variations in size and density of the vermis, and no evidence of changes of fourth ventricle geometry or lateral recess deformity.

CONCLUSION
Subtle cerebellar and fourth ventricular lesions can sometimes pose a diagnostic challenge. Detailed knowledge of cerebellar and fourth ventricle morphology in both normal and abnormal cases, as well as careful and comprehensive examination of the posterior fossa, can help to augment diagnostic accuracy.

KEY WORDS: Fourth ventricle lesions, cerebellar, diagnosis

Poster 48
Intermeatal Distance and Tumor Size as Predictors of Mass Effect by Acoustic Schwannomas on the Brainstem

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PURPOSE
Acoustic schwannomas are common nonmalignant tumors of the 8th cranial nerve complex. Symptoms are related to the 8th nerve complex as well as mass effect on the brainstem and adjacent neural structures. The extent of mass effect depends on the tumor size and possibly on the size of the posterior fossa. The purpose of this study is to use intermeatal distance as a measure of posterior fossa size and determine any correlation between mass effect from acoustic schwannomas with tumor size and intermeatal distance.

RESULTS
There were 53 patients with acoustic schwannomas identified. Eight were excluded because the lesions were solely intracanalicular. Of the 45 patients in the study cohort, 23 were male. Ages ranged from 34 to 94 years with a median age of 58 years. Spearman rank correlation coefficients were calculated for the measurements. Intermeatal distance (IM) and age showed poor correlation (r = 0.18, p = 0.1848). The IM of males was larger than females by a mean difference of 2.83 mm (p = 0.0129, Student's t-test). The ratio of tumor size to intermeatal distance (AS:IM) which reflect tumor burden were compared to ratios of contralateral to ipsilateral thickness of the brachium pontis (BPC:BPI) which reflect extent of mass effect.

CONCLUSION
The ratio of tumor size to intermeatal distance is highly correlated to the mass effect exerted by acoustic schwannomas on the brainstem.

KEY WORDS: Acoustic schwannoma
Poster 49

Hydrocephalus: Evaluation with Cerebrospinal Fluid Flow Measurements at Phase Contrast MR Imaging

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PURPOSE

The aim of this study is to compare the mean volume levels of the cerebrospinal fluid (CSF) per minute in the aqueducts of the patients who are suspected of normal pressure hydrocephalus (NPH) with phase-contrast (PC) cine MR imaging and the patients atrophic dilatation and normal population and to investigate the efficacy of these measurements in predicting the benefit of the surgery preoperatively and to assess the contribution of these measurements in differential diagnosis of hydrocephalus. In addition, the cerebrospinal fluid pathways, the level of obstruction and the patency of endoscopic third ventriculostomy (ETV) in the patients with obstructive hydrocephalus were assessed.

MATERIALS & METHODS

Thirty patients with suspected NPH, 20 patients with atrophic dilatation irrelevant to cerebral sulci and 30 healthy volunteers without hydrocephalus, a total of 80 patients were included in this study. Fifteen of the 30 patients who were followed for NPH had a ventriculoperitoneal shunt placed and their follow up was done in the postoperative period. MR imaging was obtained with a 1.5 T MR device. Cine PC MR sequence was used with FLASH through-plane to take phase, rephrase and magnitude images in the axial plain of all participants. By using FLASH through-plane sequence, the half-axial plain velocity encoding (Venc) was chosen as 20 cm/sn for all individuals and the FLASH in-plane sagittal plain Venc was chosen as 6 cm/sn for all individuals. Calculations of velocity and flows such as mean and maximum velocities in the level of aqueductus, mean forward and backward flows were done with the assistance of a software automatically after the contours were drawn. All of the MR scans and the values gathered were evaluated by two radiologists. Moreover, cerebrospinal fluid (CSF) pathways were visualized as cine in FLASH in-plane sagittal plain images, obstructive pathologies and the level of these pathologies was determined.

RESULTS

Fifteen of the 30 patients who had been diagnosed as NPH had VPS placement performed and improvement of the symptoms of these patients was demonstrated postoperatively. The mean output in the NPH group when compared to the mean output in the control group and the atrophic dilatation group were higher with a statistical significance (p = 0.000). Among the 17 patients who had obstructive hydrocephalus, three had Chiari type malformation and one had Dandy Walker malformation and their level of obstruction was in level of foramen magnum. The other 13 patients level of obstruction were in the level of aquaductus. Seven of the 17 patients had ETV performed and patency of ventriculostomy was evaluated in early postoperative period.

CONCLUSION

The mean levels of CSF outflow volume were gathered with quantitative CSF. Outflow study in the level of aquaductus was found to be useful in patients who were suspected of NPH in diagnosis, differential diagnosis and prediction of the benefit of surgery. Cine PC MR modality was thought to be useful in evaluating normal CSF pathways, pathologies of CSF, patency of ventriculostomy after ETV.

KEY WORDS: CSF flow, phase contrast cine MR imaging, NPH

Poster 50

Hippocampal Volume Changes in Patients with Bipolar Disorder: A Comparative Study between Manual and Automatic Segmentation Techniques

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PURPOSE

Hippocampal volume changes may be involved in the pathophysiology of patients with bipolar disorder. Various segmentation techniques using MR images, including manual and automatic protocols, have been developed to optimize the determination of the hippocampal volume. For clinical application, automated methods with high reproducibility and accuracy potentially may be more efficient than manual measurements. This study aims to compare the hippocampal volumes obtained from manual and automatic segmentation methods, as well as to compare patients with bipolar disorder and healthy controls.

MATERIALS & METHODS

Twenty-seven bipolar disorder patients (14 men, 36.7 ± 16.2 years; 13 female, 41.6 ± 10.7 years) were matched with 40 healthy controls (16 men, 36.1 ± 10.5 years; 24 women, 37.1 ± 4.8 years). Sagittal 3D-MPRAGE images were obtained (1.33 mm³ voxelsize; 128 slices; matrix 256 x 256; flip angle 7º; TR/TE/TI= 2.53 s/3.39 ms/1.1 s). Manual volumetry of the right and left hippocampus was performed by two radiologists (3 and 10 years of experience). Automatic segmentation was done with two available softwares (FreeSurfer and FSL). The agreement between the volumetric methods was tested using Cronbach’s Alpha coefficient and Pearson correlation.

RESULTS

The hippocampus for the ICV corrected volume of the right (r) and left (l) hippocampuses measured with all methods differ significantly (p < 0.05) in patients with bipolar disorder compared with the healthy controls. Just the manual method for the left hippocampus did not show significant difference between bipolar patients and controls. The Cronbach’s Alpha coefficient when comparing manual volumetry and FreeSurfer were 0.846 (r) and 0.859 (l), and comparing manual volumetry and FSL were 0.764 (r) and 0.654 (l). The Pearson correlation coefficients for manual
volumetry vs FreeSurfer were 0.698 (r) and 0.804 (l), and between manual volumetry and FSL were 0.573 (r) and 0.505 (l). The difference in the mean volumes obtained with the different segmentation techniques were tested using one-way repeated ANOVA and differed significantly (P < 0.0001), being the FreeSurfer more similar to the manual volumetry than FSL.

CONCLUSION
The ICV corrected volume of the right hippocampus differ significantly in patients with bipolar disorder when compared to healthy subjects for all segmentation methods. The left hippocampal volume differ significantly for the automatic methods, but not for the manual segmentation method. In a further study, clinical data of the bipolar patients has to be considered in more detail. The automatic segmentation method FreeSurfer showed high correlation. Applying a correction factor for the overestimation of the volume, it may be an alternative to manual segmentation.

KEY WORDS: Bipolar disorder

Poster 51
Qualitative Comparison of Brain MR Images Obtained Using a 32-Element and a 12-Element Phased-Array Head Coil at 1.5 T

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PURPOSE
A 32-element phased-array head coil provides quantitatively better brain images as compared to a head coil with lower number of elements (1). We qualitatively compare clinical brain MR images obtained using this coil and a commercially available 12-element head coil.

MATERIALS & METHODS
In this IRB-approved prospective study, T1-, T2- and diffusion-weighted (DWI), and FLAIR MR images of 21 patients (mean age 51.6 years) were acquired on 1.5 T using the 32-element coil (coil A) and the 12-element coil (coil B) in random sequential order, yielding a set of four pairs of images for every subject. For each pair, images from the two coils were compared by three neuroradiologists in terms of the image quality, lesion visibility and image artifacts. The image quality was determined in terms of differentiation of anatomical structures from various brain regions (Table). Each pair was assigned a rating according to the following criteria: 0 (no difference), +1/-1 (apparently better) and +2/-2 (markedly better) quality of the image from coil A/B. The ratings from all the parameters for a pair were combined together to determine the overall rating for the pair. Each set was assigned rating for visibility of the lesion in images from the two coils by the following criteria: 0 (same quality), +1/-1 (better quality, same diagnostic value), and +2/-2 (better quality, higher diagnostic value) of the image from coil A/B. The scores assigned to each set by the three neuroradiologists were combined to obtain the average scores for the set. The two sets also were rated from 0 (no artifact) to 2 (severe artifact) for artifacts (motion, pulsation or susceptibility artifact). T-test (95% confidence interval) was used to analyze significance of difference in scores from the two coils.

RESULTS
Scores for image quality parameters and the preferred coil for those parameters are shown in the Table. The image quality rating of coil A is higher for 20 parameters and similar for the two coils for the remaining 10. Lesion visibility rating of coil A is higher for cortical and subcortical white matter (25 lesions, score 0.65 ± 0.28), and deep brain structures (six lesions, score 0.67 ± 0.30) and similar for the two coils for extraaxial space (seven lesions), cerebellum and brainstem (three lesions). There is no difference in the two coils for image artifacts.

CONCLUSION
Higher image quality (particularly for FLAIR, T2- and diffusion-weighted images) and lesion visibility scores in the cortical, subcortical white matter and deep brain structures for the 32-element coil at 1.5 T without increasing artifacts confirm improved clinical images, potentially at less incremental cost than use of 3 T.

REFERENCES

KEY WORDS: Phased-array head coils, image quality, brain MR images

Poster 52
Reduced Radiation Protocol for Unenhanced Head CT Preserves Subjective Imaging Quality

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PURPOSE
The FDA’s October 2009 initial communication expressing concern over excess radiation in CT perfusion imaging has focused national attention on adjusting CT protocols to reduce patient dose. However, dose reduction should be balanced against image quality to ensure diagnostic accuracy. We sought to determine whether a protocol designed to
deliver lower patient dose for unenhanced head CT studies resulted in a detectable subjective change in imaging quality.

MATERIALS & METHODS
Following the FDA October 2009 bulletin, our radiology department changed the unenhanced head CT protocol for a hospital 64-slice scanner from its vendor-established default of 120 kV, 500 mAs to 120 kV, 350 mAs. For this study, we searched our hospital PACS for all patients who had unenhanced head CT studies on this scanner with both dose levels. A staff neuroradiologist, blinded to study dose, then was shown both cases for each patient simultaneously and was asked to pair each study with its dose. Study findings which could indicate chronology (for example, a hemorrhage at different stages of resolution) were excluded from the field of view. Correct and incorrect answers were tallied and analyzed with a one-tailed sign test.

RESULTS
A total of 49 paired studies were found. The neuroradiologist correctly matched study and dose for 24 of these pairs (49%, \( p = 0.5 \)).

CONCLUSION
A reduced radiation protocol for unenhanced head CT studies does not create a detectable decrease in image quality. This result warrants further investigation to establish a threshold dose for unenhanced head CT studies at which image quality is impaired. Scanner settings then should be set closer to this threshold for patient safety.

KEY WORDS: Dose reduction, image quality, radiation

Poster 54
Imaging of Dural Venous Sinus Thrombosis with Diffusion Tensor and Diffusion-Weighted Sequences
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PURPOSE
Dural venous sinus thrombosis is an infrequent cause of stroke and can be difficult to diagnose and treat. Studies suggest that venous clot with high signal on diffusion-weighted imaging (DWI) portends a low recanalization rate after treatment (1). Ex vivo analysis of thrombus has demonstrated poor lysability in regions with a low apparent diffusion coefficient (ADC) (2). In a recent diffusion tensor imaging (DTI) study characterizing hemorrhagic brain lesions, areas of low fractional anisotropy (FA) corresponded to intact red blood cells entangled in a fibrin mesh (3). The purpose of this study was to determine the diffusion tensor imaging (DTI) and DWI characteristics of venous sinus thrombosis.

MATERIALS & METHODS
This study involved a retrospective review of patients diagnosed and treated for dural venous sinus thrombosis. Routine MR imaging on these patients included T1, T2, FLAIR, GRE, DWI and DTI sequences. Thrombosis was confirmed by contrast-enhanced MR imaging or CT. A subset of the patients had follow-up imaging which included MR imaging and CT scans of the head with and/or without contrast.

RESULTS
In a total of six patients with dural venous sinus thrombosis, five patients had areas of increased signal on DWI and DTI trace images ranging from mild to very high (Figure). A subset of the entire clot burden in each patient showed high signal on these sequences. In other areas, DWI and DTI trace signal was low or absent.
CONCLUSION
These results suggest that dural venous sinus thrombus can demonstrate high signal on DWI and DTI trace imaging. Interestingly, clot signal ranges from high to low on these sequences, consistent with a combination of underlying T2 signal (T2-shine through and T2-blackout) of aging blood products and underlying structure of the clot itself. This relatively unexplored imaging technique may be a useful adjunct in the characterization and treatment of venous sinus thrombosis.

REFERENCES

KEY WORDS: DTI, thrombosis, venous

Poster 55

Dural Sinus Thrombosis in Spontaneous Intracranial Hypotension: A Case Report

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PURPOSE
To present and discuss the imaging and clinical features in a case of venous sinus thrombosis (VST) associated with spontaneous intracranial hypotension (SIH).

MATERIALS & METHODS
A 45-year-old woman with unremarkable medical history presented with acute nuchal pain prevalent on the right side, accompanied by nausea and vomiting; in the last 2 days she had suffered from diffuse headache improved by bed rest. An initial CT scan showed an ill-defined hyperdense lesion in the right temporobasal region. On MR imaging a subtle enhancement of the meninges of the right temporal region and tentorium was noted; MR venography excluded evident sinus thrombosis. In the hypothesis of infectious disease, a lumbar puncture was performed: a null pressure was found at the insertion of the needle requiring active aspiration. All laboratory tests were negative. Few days later the patient developed right sixth nerve palsy.

RESULTS
A second MR examination then was performed showing diffuse dural enhancement, caudal displacement of brainstem and tonsils and prominent cervical epidural venous plexus. Thrombosis of the right transverse and sigmoid sinuses also was documented. MR evaluation of the spine failed to document a possible site of leakage. No risk factor for venous thrombosis was found.

CONCLUSION
Venous sinus thrombosis rarely can be associated with SIH: only about 20 cases have been reported so far in the literature. A causative effect of SIH can be hypothesized and explained by changes in diameter and blood velocity in dural sinuses. In our case clinical symptoms of SIH preceded venous thrombosis, as reported in most of the published cases. A change in headache pattern with loss of postural characteristic can be a predictor of the development of venous thrombosis. The initial radiologic signs of SIH, often subtle, may be missed; when VST occurs, MR findings, such as venous congestion, can partially overlap, making the diagnosis of both entities difficult.

KEY WORDS: Cerebral venous thrombosis, spontaneous intracranial hypotension

Poster 56

Proposed Modification of the Saltzman Classification System for Persistent Trigeminal Artery Variants

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PURPOSE
The persistent trigeminal artery (PTA) is the most frequently encountered carotid-basilar anastomoses with an incidence around 0.1-0.6% in larger studies. The currently used Saltzman classification system is incomplete, as many of these anastomoses have historically been referred to rather loosely as PTA variants, which does not account for the complex PTA anatomy. The purpose of this study is to propose a modification of this system with subcategories for the Saltzman type 3 variants to include types 3a, 3b and 3c depending on their terminal arterial territory.

MATERIALS & METHODS
In addition to a retrospective analysis of seven cases from three institutions, a literature review of PTA variations in relationship to the Saltzman classification was undertaken. A PTA in which the posterior communicating arteries (PCOMs) are absent and the PTA supplies the vertebrobasilar system distal to the anastomosis is still categorized as a Saltzman type 1. A Saltzman type 2 exists when the PTA supplies the superior cerebellar arteries but the posterior cerebral arteries are supplied via the PCOMs. Based on our
literature review of the variable PTA anatomy, the Saltzman type 3 variants were subdivided into three categories that were designated as subtypes 3a, 3b and 3c. The main embryologic defect in these subtypes is focal nonfusion of the longitudinal neural arteries (LNA). In subtype 3a, the PTA continues as an isolated superior cerebellar artery (SCA). In subtype 3b, the PTA persists as an isolated anterior inferior cerebellar artery (AICA). In subtype 3c, the PTA continues as an isolated posterior inferior cerebellar artery (PICA). Several examples depicting the variable Saltzman subtypes are included from our institution in various modalities including CTA, MRA and conventional angiography, which best depicted the precise anatomical termination of the PTA as it relates to the vertebrobasilar circulation.

RESULTS
Based on our own material and the existing literature, it was found that the vast majority of the PTA variants terminate as SCA, AICA or PICA. These Saltzman variants readily could be categorized further as Saltzman type 3a, 3b and 3c, respectively. Saltzman type 3b was the most common variant encountered. When considered one separate group, the Saltzman types 3a-c may have the same or higher prevalence than the initially described Saltzman 1 and 2 categories.

CONCLUSION
With the higher resolution capabilities of today’s MRAs and CTAs, and the more widespread familiarity of the PTA variants, it appears likely that the Saltzman subtypes 3a-c as described here will be encountered more frequently than initially assumed. Based on our understanding of the embryology of the vertebrobasilar system and the cases we studied, categorizing the PTA variants as Saltzman type 3a, 3b and 3c as it relates to the terminal arterial territory would be a useful practical modification. Although the existence of a PTA is not necessarily of clinical relevance, understanding the different anatomical variations during neurosurgical procedures in the cavernous sinus area is important.

KEY WORDS: Trigeminal, Saltzman, persistent

Temporal Artery Calcification: A CT Marker for Diabetes and Predictor of Future Stroke Risk

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PURPOSE
Carotid artery calcification has been investigated recently using a modified coronary artery calcification scoring system on unenhanced CT. It has been shown that there is no significant association between carotid calcification and white matter ischemia and future stroke risk. However, it is well described in the literature that white matter ischemia is caused by small vessel ischemic disease. We assess the hypothesis that by using the same calcification scoring method applied to the superficial temporal artery (STA), there is a direct correlation between STA calcification, white matter ischemia and future stroke risk. Furthermore, we postulate that there is a direct correlation between calcification of the STA and the presence of diabetes in those patients.

MATERIALS & METHODS
A retrospective analysis of 7000 consecutive patients undergoing an unenhanced head CT at two tertiary care hospitals between January 2005 and June 2006 was undertaken. A total of 61 patients were identified for the presence of temporal artery calcification. The calcification was scored using an adapted method based on the coronary artery calcification scoring method developed by Agastston, et al. Severity of white matter ischemia was assessed using the European Task Force for Age-Related White Matter Change scale. Both scores were blinded to each other as well as to other covariates such as age and sex. Bivariate and descriptive analyses were used to analyze these scores. All scoring was performed by a board certified neuroradiologist. A patient chart review was conducted in those patients demonstrating temporal artery calcification to establish whether the patient had diabetes.

RESULTS
Temporal artery calcification is an uncommon finding (59/7000 or 0.8%). There is a strong correlation between calculation of the STA and the presence of diabetes. Diabetes was present in the vast majority of patients with STA calcification (47/59 or 77%) with a relative equal incidence in both men (81.4%) and women (75%). Superior temporal artery calcification was present bilaterally in 47/59 (or 80%) of patients with left STA calcification being more severe than on the right. The degree of STA calcification had no independent effect on white matter scores in either patients with diabetes or those without diabetes.

CONCLUSION
Like carotid artery calcification, there is no direct correlation between superficial temporal artery calcification and white matter ischemic change on CT. Therefore, STA calcification is not an independent predictor of future stroke risk. However, the presence of STA calcification should be reported when reviewing cranial CT studies. Even though it is an uncommon finding, it is a very sensitive marker of diabetes, which is a well documented predictor of future stroke risk.

KEY WORDS: Temporal artery calcification, future stroke risk, diabetes
MECHANISM OF VISUAL FIELD DEFECT IN PATIENTS WITH ANTERIOR CIRCULATION STROKE: A DIFFUSION-WEIGHTED IMAGING AND CT PERFUSION-BASED STUDY

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PURPOSE
Functional defect following ischemic stroke could be due to either permanent loss of brain tissue (infarction) or reversible loss of neural function (benign oligemia/penumbra). In this study, we examined the cerebral infarction and perfusion characteristics of patients who present with visual field deficit following acute ischemic stroke of anterior circulation territory.

MATERIALS & METHODS
We included 71 consecutive patients with first-time unilateral ischemic stroke who underwent both CTP and DWI within 12 hours of symptom onset. Presence of visual field defect at the time of admission was determined based on patients’ clinical records. Infarcted brain tissues were outlined manually on DWI scans and, along with CTP maps, were coregistered automatically to MNI-152 brain space and parcellated to 146 pairs of mirrored cortical and subcortical areas. The percentage of infarcted tissue (based on DWI images) and relative CTP parameter were calculated for all brain segments in each patient. Multiple binary logistic regression was used to determine the independent imaging variables correlated with presence of visual defect at the time of admission.

RESULTS
A total of 71 patients were included in this study: 30 (41%) male, 48 (68%) left-hemispheric stroke, and mean age of 68 ± 15 years. Of these, 34 (48%) patients presented with some degree of visual field defect. The only independent CTP variable correlated with the presence of visual field defect at the time of admission was the relative cerebral blood flow (rCBF) of the lower third of the middle occipital gyrus white matter. Based on receiver operating characteristics (ROC) test, > 12% reduction in rCBF of this subcortical area was associated with presence of visual field defect in stroke patients (accuracy = 71%, sensitivity = 66%, specificity = 75%). However, there was no significant difference in mean infarction percentage of this area between those patients who presented with visual defect and those without (5.75 ± 3.11 vs 0.78 ± 0.41, p = 0.12). The only independent DWI-based variables correlated with presence of vision defect were the percentage of infarction in posterior limb of the internal capsule as well as the superior longitudinal fasciculus. Receiver operating characteristics analysis showed that if the sum of infarcted tissue percentage in these two regions was > 28%, the patient most likely would present with visual field deficit (accuracy = 70%, sensitivity = 61%, specificity = 78%). However, mean rCBF values of these two regions were not significantly different between the study groups.

CONCLUSION
There are many patients who present with visual field deficit following anterior circulation stroke; our results suggest that a > 12% blood flow reduction in subcortical occipital areas (without any significant brain tissue infarction) would contribute partially to vision loss in these patients. In addition, the infarction of deep white matter tracts may play a role in loss of vision.

KEY WORDS: Vision, stroke, perfusion

PREDICTING CLINICAL OUTCOME IN STROKE PATIENTS WITH LIMB PARESIS: A LOCATION-WEIGHTED ATLAS-BASED ANALYSIS OF ADMISSION CT PERFUSION

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PURPOSE
To develop multivariate models to predict the clinical outcome of motor function in stroke patients with limb paresis using admission imaging and clinical parameters. We determined the best anatomical regions/CTP parameters predicting clinically-detectable improvement of each limb motor paresis by the time of discharge.

MATERIALS & METHODS
We included 80 patients who were admitted to our center with motor deficit of either upper or lower limb due to first-time unilateral ischemic stroke and underwent CTP within 9 hours of symptoms onset. Limb paresis was assessed based on clinical records and admission/discharge NIHSS exam. All CTP scans were coregistered automatically to standard MNI-152 brain space and subsegmented to 146 pairs of cortical and subcortical regions based on preset atlases (Talairach atlas of cortical brain areas and JHU DTI-based white matter tracts atlas). For each region, relative CTP values (rCBF, rCBV, and rMTT) were calculated by dividing the mean CTP value of the stroke-side region by the contralateral mirror region mean CTP value. Multiple binary logistic regression was performed to determine independent clinical and imaging variables predicting improvement of motor deficit in patients.

RESULTS
A total of 52 patients presented with left hemispheric ischemic stroke and paresis of upper (n = 49) and/or lower (n = 42) right limb. By the time of discharge, 18 (37%) patients with right upper extremity paresis and 15 (36%) with right lower limb motor deficit had improvement of motor function in corresponding limbs. Among 28 patients who had right hemispheric stroke, eight (32%) out of 25 patients with admission left upper extremity paresis, and seven (30%) out of 23 with admission left lower limb motor deficit were discharged with improvement of corresponding extremity motor function. Independent imaging and clinical variables predicting improvement of upper and lower limb paresis are listed in the Table. Using logistic regression formulae, we
developed multivariate models that predict motor function recovery in each limb with 83%-96% accuracy (79%-100% positive predictive value and 89%-94% negative predictive value), 85%-88% sensitivity, and 80%-100% specificity.

**CONCLUSION**
Integrating clinical and imaging findings collected within 9 hours of admission, we developed multivariate model to predict motor recovery in patients with limb paresis following ischemic stroke. A location-weighted analysis of admission CTP parameters can help predict clinical outcome in stroke patients. The automated image analysis method used in this study can be generalized for evaluation of other clinical outcomes in stroke patients.

**KEY WORDS:** Stroke, CT perfusion, paralysis

**Poster 60**
**ASPECTS in Noncontrast Head CT in Early Stroke: An Interobserver Reliability Study**
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**PURPOSE**
The Alberta Stroke Program Early CT Score (ASPECTS) is a method for evaluating the extent of middle cerebral artery (MCA) stroke. It is an important parameter to determine the course of the treatment and the future complications. Our aim was to retrospectively study the interobserver variability of ASPECTS between the two experienced neuroradiologists on noncontrast head CT during the first 4 hours of middle cerebral artery (MCA) stroke.

**MATERIALS & METHODS**
Fifty two patients with MCA stroke within 4 hours from the onset of symptoms, and who had noncontrast CT of the head, were included in the study. All had confirmed acute MCA infarct on the follow-up CT or diffusion-weighted MR imaging (DWI) within 7 days. Two neuroradiologists with more than 5 years of experience each interpreted the studies on diagnostic quality monitors. The readers were permitted to change the windows to their liking. The studies were anonymized using vendor-provided functionality. The areas of hypodensity were evaluated using ASPECTS and the scores were entered for individual scans.

**RESULTS**
There was a consensus reading in 31 patients (7 positives and 24 negatives). In seven positive scans with hypodensity, there was agreement on the side and the anatomical zones. In 18 patients, the difference was only in one zone. In three patients, the difference was in two zones or more. The data were analyzed using Cohen’s kappa coefficient statistical method. The kappa coefficient was 0.145, signifying only slight agreement between the reviewers. However, if the data were reanalyzed considering difference of one zone between the observers as acceptable, the kappa value was 0.85, signifying almost perfect agreement.

**CONCLUSION**
There is only slight interobserver agreement in evaluating ASPECTS on noncontrast head CT in early stroke. However, if the data are reanalyzed with difference of one point on ASPECTS as being within acceptable range, there is almost perfect agreement between the two raters.

**KEY WORDS:** Early stroke, ASPECTS

**Poster 61**
**Whole-Brain CT Perfusion and CT Angiography for Evaluation of Aneurysm-Related Vasospasm**
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**PURPOSE**
Vasospasm is a major cause of morbidity in aneurysm-related SAH (ASAH). CT perfusion (CTP) has been used in acute stroke. However, its utility has been limited in the evaluation of vasospasm because of limited brain coverage and radiation. With 320-slice CT, it is now possible to obtain whole brain CTA/CTP with a reasonable radiation dose (DLP). Current methods to detect vasospasm include clinical exam, transcranial Doppler and more recently CTA/MRA. Clinical exam is limited in patients with a Hunt & Hess grade > 3. Transcranial Doppler is variable in interpretation and availability. Therefore, a noninvasive test which could evaluate arterial diameter (ART) and whole-brain perfusion simultaneously is desirable. In our center, patients presenting with ASAH are scanned for diagnosis and treatment planning with whole-brain volumetric CTA/CTP obtained with a single contrast bolus. Thus, baseline CTP values are available for comparison if patients develop vasospasm. The purpose of our study was to evaluate if there is a change in whole-brain perfusion parameters from baseline in patients with ASAH being monitored for vasospasm. We investigated whether interventions for vasospasm had an effect in improving CTP parameters.

**MATERIALS & METHODS**
Baseline CTA/CTP exams were performed on a 320-slice scanner. Follow-up CTA/CTP exams were performed at days 4-7 or if there was a clinical suspicion of vasospasm. Additional CTA/CTP exams were performed only in patients treated for vasospasm. Region of interest templates on CBF, CBV, MTT and TTP maps were placed for six predefined levels through the whole brain. Changes in perfusion param-
Healthy volunteers were compared between baseline, time of suspected vasospasm and posttreatment maps. ARTs were measured by two experienced interventional neuroradiologists and correlated with change in perfusion parameters. The DLP for each study was calculated.

RESULTS
Ten patients (3 with treated vasospasm) totalling 26 CTA/CTPs were evaluated. There was good correlation between ARTs and change in perfusion for MTT>TTP>CBF i.e., a decrease in caliber = decreased perfusion and vice versa (p < 0.0001). The correlation was better for the MCA, ACA vs BA, PCA territories. Patients without clinical vasospasm tended to have stable or improved perfusion. Patients with vasospasm had impairment in CBF and TTP (p < 0.0001) compared to baseline. When target vasospasm territories were treated with IA-milrinone, there was improvement in target CBF compared to nontarget territories (p < 0.0001). There was good to excellent correlation (Pearson coefficient = 0.79) between readers for all ARTs and for the BA, M1 and M2 (0.56-0.79) segments. The DLP for whole brain CTA/CTP exam was 1900 vs 1500 for NECT.

CONCLUSION
Our study demonstrates CTP changes occur in patients with ASAH. The expanded brain coverage permits classification of parameters in the various arterial territories: MCA, ACA, PCA, BA. There is good correlation between changes in arterial diameter and perfusion in the corresponding arterial territories. Patients treated with interventions for vasospasm demonstrate greater improvement in perfusion in the target compared to nontarget territories. Judicious use of whole-brain CTA/CTP may be helpful in monitoring for vasospasm and treatment in grade 3 and higher ASAH patients.

KEY WORDS: Vasospasm, subarachnoid hemorrhage, CT perfusion

Poster 62

Infarct Core Size Greater than 58 cc on CT Cerebral Blood Flow Maps Is Highly Correlated with Poor Outcome

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PURPOSE
In order to select acute stroke patients who will benefit most from thrombolytic therapy without taking unnecessary risk, it is important to identify initial infarct core lesion size above which patients have poor outcome. Our purpose was to determine initial thresholded CT CBF and CT CBV lesion volumes above which acute ischemic stroke (AIS) patients have poor clinical outcome.

MATERIALS & METHODS
Thirty-one consecutive patients with acute anterior circulation stroke who underwent CT perfusion (CTP) within 9 hours of symptom onset and who had clinical outcome data available were evaluated. CTP maps were acquired with a 66-second biphasic acquisition, covering 8 cm and were processed with delay-corrected deconvolution software (GE CTP 5). CT CBV volumes were automatically calculated with a relative threshold of 60% of the contralateral normal side and CT CBF volumes were calculated with a relative threshold of 30% of the contralateral normal side. These thresholds were chosen to identify infarct core based on previous work comparing CTP to diffusion-weighted imaging (DWI) lesion volumes. Clinical outcomes were considered good if the modified Rankin scale (mRS) was 0-2. Receiver operating characteristic (ROC) curves were calculated.

RESULTS
Twelve of 31 (39%) patients had a good clinical outcome (mRS 0-2) and had significantly smaller initial CT CBV lesion volumes (mean 42.0 cc) vs patients with mRS 3-6 (84.7 cc) (p < 0.05). Patients with good outcomes also had significantly smaller CT CBF lesion volumes (26.9 cc) vs patients with poor outcomes (73.3 cc) (p < 0.05). Receiver operating characteristic curves for CT CBV and CT CBF relative to poor outcome, had areas under the curve of 0.782 and 0.788, respectively. For CT CBV lesion volume, we chose a cut-off point of 77 cc with 100% specificity and 37% sensitivity for poor outcome. Seven of 7 (100%) patients with CT CBV lesion size > 77 cc had a poor outcome. For CT CBF lesion volume, we chose a cut-off point of 58 cc with 100% specificity and 52.6% sensitivity for poor outcome. Ten of 10 patients with CT CBF lesion volume > 58 cc had poor outcome.

CONCLUSION
Patients with good clinical outcome had smaller CT CBV and CT CBF infarct core lesion size on admission CTP. Thresholded CT CBV infarct core lesion size > 77 cc and thresholded CT CBF infarct core lesion size > 58 cc are highly specific for poor outcome. These findings may be important for therapeutic decision making.

KEY WORDS: Stroke

Poster 63

Hemodynamic Changes following Extracranial-to-Intracranial Bypass in Moyamoya Disease Measured Using Combined Arterial Spin Labeling and Dynamic Susceptibility Contrast MR Imaging Perfusion

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PURPOSE
Recently, an MRI-based CBF method has been developed that integrates information from arterial spin labeling (ASL) to apply a scaling factor to dynamic susceptibility contrast (DSC) relative CBF and CBV maps (1). This approach overcomes ASL CBF errors in long arrival time regions, and capitalizes on the excellent relative properties of DSC CBF maps. We have applied this method to determine the CBF changes following extracranial-to-intracranial (EC-IC) bypass surgery for moyamoya disease.
MATERIALS & METHODS
Eight newly-diagnosed moyamoya patients (M/F) were identified retrospectively who had preoperative and 6-month postoperative MR imaging that included both ASL and DSC imaging. Unilateral (n = 4) and bilateral (n = 4) STA-to-MCA bypasses were performed, resulting in 12 bypassed hemispheres. Arterial spin labeling was performed using pseudocontinuous ASL (2). Dynamic susceptibility contrast was performed using single-dose MR contrast; relative CBF and Tmax maps were created using automated deconvolution software (3). Combined ASL and DSC CBF (CAD CBF) maps were created by scaling the DSC rCBF maps using ASL CBF measurements in regions with Tmax < 3 s. Images were normalized to MNI space and measurements were performed in 10 ROIs at two levels corresponding to ASPECTS methodology.

RESULTS
There were no significant changes in CBF or CBV before and after bypass in any of the regions (p > 0.05). A slight decrease in Tmax was noted in the bypassed hemispheres. Images pre and postbypass for a patient s/p L-sided bypass are shown in the Figure.

CONCLUSION
Using an improved MR-based CBF technique, we found no significant CBF changes following successful EC-IC bypass. This is consistent with prior reports that suggest that there is no improvement in baseline CBF, but instead are improvements in cerebrovascular reactivity (4-5).

REFERENCES

KEY WORDS: Perfusion, moyamoya disease, arterial spin labeling

Poster 64
Quantitative Magnetization Transfer Imaging in Acute Stroke: A Follow-Up Study Correlating Quantitative MR Imaging with Respect of Severity of Stroke

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PURPOSE
Magnetization transfer (MT) imaging can potentially serve as a marker for loss of tissue integrity. Increased pathologic specificity is expected from quantitative MT imaging (qMTI) as compared to assessment of the semiquantitative MT ratio (MTR). However, limited resolution or long acquisition times have so far impeded qMTI in severe acute stroke. Quantitative MTI applying balanced steady state free precession (bSSFP) sequences has overcome these problems and yields the bound pool fraction F, the exchange rate kf, relaxation times of the free pool T1 and T2 in addition to the MTR. We present the results of two patients suffering from middle cerebral artery stroke with different progression of symptoms over three consecutive MRIs within the first 10 days.

MATERIALS & METHODS
Imaging was performed on a clinical 1.5 T Siemens Avanto scanner. Patient 1 (female, age 88 years) and patient 2 (male, age 60 years) underwent three consecutive cranial MR imaging (MRI) exams: First MRI (MRI1) 6 hours, second MRI (MRI2) 3-4 days and third MRI (MRI3) 9-10 days after symptoms’ onset. The clinical protocol included diffusion-weighted imaging, T2-weighted, FLAIR, T2*-weighted and TOF MRA. Quantitative MTI included a B1 map, two RF spoiled gradient-echo sequences with variable flip angles for T1 determination, 2 bSSFP sequences with variable flip angles for T2 determination and 7 bSSFP sequences using different RF pulse durations (TRF = 230 µs - 2100 µs) to yield F and kf. Data acquisition time for the whole qMTI protocol was 10 minutes. Images were registered spatially prior to data analysis using FSL. A region of interest (ROI) of the diffusion restricted area and another ROI in the contralateral normal-appearing parenchyma (ROI1) were drawn manually in MRI1 of each patient. Mean values and standard deviations within the ROIs were calculated for each of the five quantitative parameters. To illustrate progression of qMTI, values from ROI2 were scaled relative to values from ROI1 (100%) on the corresponding day.

RESULTS
In MRI1 both patients showed a pathologic increase in T1 and T2, a pathologic decrease in F and kf and a minimal decrease in MTR. For patient 1, who presented with worsening symptoms, an aggravation of qMTI values in MRI2 and MRI3 were observable (extended decrease of kf and F; extended increase of T1 and T2), while in patient 2, who was recovering, qMTI values showed a normalization. In contrast to the quantitative parameters, the MTR changed only slightly (80-100% relative to the contralateral hemisphere) and did not suggest different progressions in the two patients. Results in healthy-appearing tissue remained constant over time.
CONCLUSION
Characterization of acute cerebral ischemia with respect to severity is of major clinical relevance. We present first qMTI results in cerebral ischemia based on a bSSFP protocol. Quantitative MT parameters might deliver advanced information about tissue integrity. They seem to be superior to simple MTR measurements and possibly allow for early statement of prognosis and efficacy of therapeutic methods.

KEY WORDS: Magnetization transfer imaging, stroke, Quantitative MR imaging

Poster 65
Quantitative MR Perfusion in Moyamoya Disease: Improved Assessment of Cerebral Blood Flow Requirements

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PURPOSE
A method for quantification of cerebral perfusion using post-Gd T1 changes has been developed. Moyamoya disease is a relatively rare vascular disease resulting in internal carotid stenosis and altered intracranial hemodynamics. Revascularization is often the treatment but the amount of cerebral blood flow necessary is often unknown. Quantitative MR perfusion (qMRP) may allow for objective quantification of the magnitude of revascularization after bypass as well as confirmation of bypass conduit patency. Furthermore, factors predictive of ischemic and hemorrhagic stroke in affected individuals have been poorly elucidated, and at-risk areas may be detected with qMRP.

MATERIALS & METHODS
Six patients with moyamoya disease underwent quantitative perfusion imaging before and after cerebral revascularization (bypass) using a 1.5 T MR scanner (Avanto, Siemens AG Healthcare Sector, Erlangen, Germany) with GRE-EPI perfusion sequences. Images were acquired using a single-dose injection of Gd-DTPA (0.1 mmol/kg b.w.), each time at a rate of 4 ml/s. Quantitative MR perfusion using the “Bookend” technique and post-Gd T1 changes were utilized.

RESULTS
Normalization of perfusion parameters was noted on the side ipsilateral to the revascularization procedure with persistent perfusion abnormalities on the contralateral side. The changes in mean transit time (MTT) were most pronounced, with the time decreasing by 1.5 seconds on average after revascularization. Furthermore, in one case where the patient experienced new neurologic symptoms in the postoperative period the qMRP showed decrease in cerebral blood volume (CBV) and flow (CBF) with corresponding increase in (MTT) consistent with the clinical symptoms.

CONCLUSION
Quantitative MR perfusion imaging using post-Gd T1 changes in the setting of moyamoya disease may be useful in assessing the cerebral blood flow requirements as well as the efficacy of revascularization both in the immediate postoperative period as well as in long-term follow up. Furthermore, the use of acetazolamide (Diamox), although not addressed here, may further contribute to this understanding by providing quantitative data regarding cerebral vascular reserve. Finally, future applications of qMRP include the possible identification of markers for ischemic as well as hemorrhagic stroke, allowing for more timely intervention.

KEY WORDS: Moyamoya, quantitative MR perfusion, bookend technique

Poster 66
Vertebrobasilar Calcification on CT and Its Association with Posterior Circulation Infarction

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PURPOSE
Posterior circulation infarction is difficult to diagnose because symptoms and signs are often vague and nonspecific, and noncontrast head CT has limited sensitivity for posterior fossa ischemia. MR imaging (MRI) is the gold standard for acute posterior fossa stroke; however, urgent MRI is difficult to obtain. Nearly 70% of posterior circulation infarcts are due to thromboemboli arising from atherosclerotic lesions in the vertebrobasilar arterial system. Automated calcium scoring of atherosclerotic coronary arterial wall calcification has been validated as a surrogate marker for coronary artery disease and a predictor of future coronary events, as well as cerebrovascular accidents. The goal of this study was to determine whether calcium scoring of the vertebrobasilar artery arterial wall calcification is associated with positive MRI findings for acute posterior circulation infarction.
MATERIALS & METHODS
In a retrospective population of consecutive patients having undergone stroke protocol CT/CTA followed by an MRI within 72 hours, we identified 53 "cases" (patients with evidence of acute posterior circulation infarct on diffusion-weighted MRI) and 110 "controls" (patients with no evidence of acute posterior circulation infarct on MRI). Patients with cardioembolic disease, age < 40, intracranial hemorrhage or mass, prior craniotomy, or final diagnosis of TIA were excluded from the study. Vertebral and basilar artery calcification on noncontrast head CT and head and neck CTA was estimated qualitatively (none/0, mild/1, moderate/2, severe/3), and quantified using Agatston calcium scoring methods on a FDA-approved, commercial workstation. Mann-Whitney tests were used to detect differences in calcification between patients and control subjects. In addition, to determine whether ipsilateral vertebral artery calcification was associated with ipsilateral posterior circulation infarction, a mixed-effect logistic model analysis with a fixed effect for patient was performed on the "cases".

RESULTS
Vertebral and basilar artery calcification was significantly higher in the cases than in the controls on both noncontrast head CT and CTA of the head and neck (Table). Significant differences between cases and controls were found using both qualitative and quantitative (Agatston) calcium measurements. On the contrary, differences in the amount of calcification from right and left vertebral arteries were not found to be associated with stroke laterality, both for noncontrast CT (p = 0.21) and CTA (p = 0.21).

Table. Differences in vertebrobasilar artery calcification on CT between patients with posterior circulation infarct and normal controls

<table>
<thead>
<tr>
<th>Dimensions</th>
<th>Qualitative</th>
<th>Median</th>
<th>25th-75th Percentile range</th>
<th>Min</th>
<th>Max</th>
<th>p-value</th>
</tr>
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<tbody>
<tr>
<td>Stroke</td>
<td>0</td>
<td>0.2</td>
<td>0</td>
<td>0</td>
<td>8</td>
<td>0.0054</td>
</tr>
<tr>
<td>Control</td>
<td>0</td>
<td>0.9</td>
<td>6</td>
<td>0</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>Quantitative</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stroke</td>
<td>0</td>
<td>0.5</td>
<td>0</td>
<td>0.3</td>
<td>13</td>
<td>0.0019</td>
</tr>
<tr>
<td>Control</td>
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<td>0.6</td>
<td>6</td>
<td>4.3</td>
<td>11</td>
<td></td>
</tr>
</tbody>
</table>
| CTA
| Qualitative |           |        |                            |     |     |         |
| Stroke     | 0           | 0.4    | 0                          | 0.2 | 9.4 | 0.0005  |
| Control    | 0           | 0.1    | 9                          | 0   | 9   |         |
| Quantitative |           |        |                            |     |     |         |
| Stroke     | 0           | 0.81   | 0                          | 0.78| 3.43| 0.0006  |
| Control    | 0           | 0.41   | 0                          | 0   | 4.9 |         |

CONCLUSION
Vertebral basilar atherosclerotic calcification, assessed on noncontrast CT or CTA either qualitatively or quantitatively, is higher in patients with acute posterior circulation infarct compared to normal controls. Using calcium as a surrogate marker for estimation of atherosclerotic burden, CT may play an important role in risk and resource stratification of patients with suspected posterior circulation stroke and in triaging those patients with nonspecific posterior fossa symptoms that require an MRI.

KEY WORDS: Stroke, calcification, posterior

Poster 67
Withdrawn
Comparison of Final ASPECTS with Final Infarct Volume on Diffusion-Weighted Imaging for Predicting Functional Outcome in Acute MCA Stroke

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PURPOSE
Final infarct volume is a known predictor of functional outcome. The Alberta Stroke Program Early CT Score (ASPECTS) recently has been applied to diffusion-weighted imaging (DWI) as a potential surrogate marker of infarct extent. The ASPECTS methodology also has the added benefit of functional weighting within its template. We aimed to compare the utility of final DWI-ASPECTS with absolute DWI-volume in predicting functional outcome.

MATERIALS & METHODS
This is a retrospective study of acute nonlacunar MCA stroke patients who were imaged with DWI >/ = 24 hours but < 7 days from ictus. Two observers assigned DWI-ASPECTS while blinded to clinical and treatment data at baseline and on follow up. One blinded observer measured DWI lesion volume using a semiautomated thresholding technique that segments the lesion using pixel intensities > 3 standard deviations from the mean intensity of the normal contralateral hemisphere. Patients with frank hemorrhagic transformation that prevented reliable segmentation were excluded. Follow-up 3-month modified Rankin scale (mRS) scores were collected and dichotomized at /= 2 or > 2. Baseline clinical metrics including age, comorbidities, and NIH stroke scale (NIHSS) score as well as acute treatments were reviewed. Additional imaging variables evaluated for this study included proximal arterial occlusion (terminal ICA and/or MCA stem) at time of stroke presentation. Univariate logistic regression analysis of clinical and imaging variables was performed. Those with a significant p-value < 0.05 were entered into a multivariate analysis (model constructed by backward elimination) to determine independent predictors of functional outcome. Receiver operating characteristics (ROC) curve analysis was performed to obtain optimal threshold and detection rates.

RESULTS
Seventy-one patients were included in this analysis, with median (interquartile range) age of 73 years (range 63-83 years) and initial NIHSS score of 10 (5-15). Thirty-seven (52.1%) patients had a proximal arterial occlusion, 12 (16.9%) received intravenous tPA, 2 (2.8%) received intraarterial therapy, and 4 (5.6%) received combination iv tPA + IA therapy. The median final DWI-ASPECTS was 8 (6-9) and the median DWI-lesion volume was 19.2 (7.8-48.4) mL. Twenty-eight (39.4%) patients had mRS > 2 at 3-month follow up. On univariate analysis, NIHSS score OR = 1.21 (1.09 -1.34), p = 0.0003, proximal occlusion OR = 4.54 (1.58 - 13.0), p = 0.0049, DWI-lesion volume OR = 1.04 (1.02 -1.07), p = 0.0004, and DWI-ASPECTS OR = 0.32 (0.19 - 0.55), p < 0.0001 were associated with poor outcome (mRS >2). On multivariate analysis, when excluding DWI-

Poster 70

Brain MR Imaging Differences between Wake-Up Strokes and Patients Presented within the Four Hours of Stroke Onset

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PURPOSE
One quarter of ischemic strokes occur during sleep. In many patients the stroke may occur shortly before or after awakening. Current FDA approval for the use of intravenous thrombolysis excludes these patients unless they were last proved normal within 3 hours. Brain MR imaging (MRI) with negative fluid attenuated inversion recovery (FLAIR) and positive diffusion-weighted imaging (DWI) lesion may be a surrogate for brain ischemia of 3 hours or less.

MATERIALS & METHODS
A prospectively collected acute stroke database from UCLA was used and included patients from 2004 to 2009 who have brain MRI as initial imaging screening. Wake-up stroke: All ischemic stroke patients who were “last seen normal” more than 6 hours ago, arrived between 4 to 10 hours and had a brain MRI within 3 hours from ED arrival. Controls: Patients who were awake during stroke onset, with known time from stroke onset less than 4 hours and an initial brain MRI within 6 hours after stroke onset. One single examiner, blinded to patient group and time of onset, rated the DWI and FLAIR as positive or negative for early ischemic changes (dichotomized analysis). Additionally, volumes of the lesions on FLAIR and DWI were obtained using automatic maximal entropy thresholding (Image J v1.42). FLAIR/DWI lesion ratio was calculated after acquiring volumes in milliliters (FLAIR/DWI ratio analysis). Possible confounders were identified. Associations were assessed using the Fisher exact test for binary data and the Wilcoxon rank sum test for continuous data. Multivariable logistic regression analysis and analysis of variance models were conducted to adjust for confounders, if any.
RESULTS
We identified 21 wake-up patients and 22 controls. The mean age was 69.6 (±14.5) years in wake-up and 66.41(±14.5) years in the control patients. The baseline NIHSS was higher in controls (17.1 ± 9.4 vs 11.2 ± 9.4) p = 0.03. Baseline demographics of gender, hypertension, diabetes, coronary artery disease, peripheral artery disease, previous stroke, hyperlipidemia and tobacco use were similar in both groups. We found no significant difference between groups using a dichotomized FLAIR (p = 0.74) and DWI analysis (p = 0.35), nor using the DWI volume (p = 0.79 adjusted for the baseline NIHSS) nor a FLAIR/DWI ratio analysis (p = 0.84).

CONCLUSION
Initial FLAIR/DWI ratio was similar between patients with wake-up strokes and patients with known acute onset time who received MR imaging within 6 hours. This may suggest that a subset of patients who awaken with stroke could be suitable for thrombolytic therapies. Further studies are needed to prove the safety and efficacy of such approach.

KEY WORDS: Stroke, wake-up stroke, MR imaging

Poster 71
CT Angiography Source Image Are Flow Weighted

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PURPOSE
To compare CT angiography source image (CTA SI) and postcontrast CT (PCCT) with cerebral blood volume (CBV) and cerebral blood flow (CBF) map defects in patients with early ischemic changes in middle cerebral artery (MCA) territory and attempt to determine if the hypodensities seen on CTA SI and PCCT are more blood flow or blood volume weighted.

MATERIALS & METHODS
A total of 64 patients presenting within 6 hours of ictus were evaluated by one experienced reviewer. The reviewer, blinded to any other clinical or radiologic information, reviewed random order of CTA SI and PCCT images of these patients, mapped out the hypodense lesions and calculated the volume of lesion for each. These volumes were compared statistically to volumes calculated from defects seen on actual CBF and CBV perfusion studies.

RESULTS
The mean lesion volume on CTA SI was 88.61 ml as compared to 96.05 ml on perfusion CBF study, while for PCCT it was 36.80 ml vs 35.47 ml on perfusion CBV. Definite better statistical correlation (Pearson correlation coefficient) was found between CTA SI and CBF volumes (r = 0.87), while it was less between CTA SI vs CBV (r = 0.66). Again there was good correlation between PCCT and CBV (r = 0.91) while PCCT and CBF were less correlated (r = 0.56). CTA SI lesion volumes were more comparable to the volumes of CBF defects on perfusion studies while the PCCT lesion volumes were more closely comparable to the blood volume defects.

CONCLUSION
CTA SI, an increasingly recognized important adjunct to acute stroke assessment, are more flow weighted in the present day scanning protocols vs PCCT which are volume weighted, negating the conventional belief that CTA SI reflect the blood volume defect. Thus, CTA SI are more flow weighted, quickly acquired, need no postprocessing and cover the whole brain as opposed to postprocessed perfusion maps, and thereby may help make a quicker and better treatment decision.

KEY WORDS: CTA SI, stroke, flow weighted

Poster 72
Prediction of Malignant Middle Cerebral Artery Infarction by a Rater Independent Model Based on Normalized Stroke Edema and Subarachnoid Space

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PURPOSE
Surgical decompression reduces mortality and improves outcome in patients with malignant middle cerebral artery (MCA) infarction when performed within 48 hours after stroke onset. Early identification of patients likely to develop a malignant course of MCA infarction is crucial. However, objective parameters that reliably predict life-threatening herniation due to infarction edema have not been determined so far. The purpose of this study was to develop an automated method based on anatomical intracranial volume measurements that quantifies the risk of malignant MCA infarction.

MATERIALS & METHODS
In a pilot series of 15 cases with malignant middle cerebral artery infarction after 48 hours, CT imaging at admission was used to determine volume of space occupied by cerebrospinal fluid (CSF) in the healthy hemisphere normalized to intracranial volume: after automated skull stripping and thresholding (HU range -10 to 20) of 5 mm native CT images, CSF volume was calculated from the resulting binary mask. Intracranial volume (IV) was derived from the boundary of the skull stripped native CT scans. Normalized CSF volume (nCSF) was defined as (volume of CSF)/IV. Stroke volumes (SV) at 48 hours (maximum infarction edema prior to decompression or death) were outlined slice by slice with smart edge tracing, and normalized stroke volume (nSV) was defined as SV/IV (Analyze 9.0). As a direct indicator for herniation, the total volume of midline shift (MSV) outlined slice-by-slice was normalized to IV (nMSV = MSV/IV). The ratio of nSV/nCSF was correlated with nMSV. The mean nMSV of patients with high nSV/nCSF was compared to the mean nMSV of patients with low nSV/nCSF (Student t-test). A voxel-wise probability map of midline shift, stroke volume, and CSF for a normalized MNI-152 brain was created.
RESULTS
The ratio of nSV/nCSF was significantly correlated with nMSV (correlation coefficient 0.70, \( p = 0.016 \)). Above a cutoff value of 3.0 for nSV/nCSF, the mean nMSV of patients was 17 fold higher than the mean nMSV of patients with nSV/nCSF below 3.0 (\( p < 0.001 \)). The voxel-wise probability map in the standardized MNI-152 brain allows direct visual estimation of nMSV with a priori knowledge of nCSF and nSV (Figure).

CONCLUSION
In this pilot study, we present a model that rater independently predicts severity of herniation based on the assumption that volume of infarction edema and prestroke subarachnoid space is directly related to volume of midline shift. The nMSV that is associated with a malignant course remains to be determined in a further analysis.

KEY WORDS: Malignant stroke, edema, herniation

Poster 73
Tissue Compromise Distal to Middle Cerebral Artery Stenosis Is Better Assessed with fMRI Activation Patterns than MR Imaging Perfusion with Acetazolamide Challenge in the Setting of Collateral Circulation

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PURPOSE
Lack of hemodynamic reserve due to intracranial cerebrovascular disease appears to be predictive of ischemic events. Loss of hemodynamic reserve can be defined as increasing asymmetry in cerebral perfusion following vasodilation in the vascular territory distal to a stenosis. Such asymmetries in dynamic susceptibility contrast MR perfusion studies were investigated in patients with single vessel stenosis with quantitative phase-contrast (qPC) MRA and blood oxygenation level dependent fMRI to see if redistribution reflected compromised tissue metabolic demands and lack of collateral distribution.

MATERIALS & METHODS
Right-handed patients with single unilateral middle cerebral artery (MCA) disease (\( N = 10 \)) who had received clinical workups with fMRI and qPC MRA and MR perfusion, before and after vasodilation with acetozolamide, were examined in this IRB-approved retrospective study. MR perfusion studies were performed at 3.0 T using dynamic bolus tracking of intravenous gadolinium-based contrast (0.1 mmole/kg) before and 10 minutes after intravenous administration of acetazolamide (1g, Diamox). The MCA laterality ratio (LR) for right-handed healthy adults (\( N = 7 \)) was computed as \( LR = [A_{R} - A_{L}]/[A_{R} + A_{L}] \) for the activation volumes (A) in the left and right MCA cortex produced by the audiovisual bilateral hand motor paradigm (4.5 minutes, block design, 30 s rest, 30 s motion) used for fMRI. The MCA LR for patients was defined as \( [A_{Normal} - A_{Stenosis}]/[A_{Normal} + A_{Stenosis}] \). Visual activation in the posterior cerebral artery (PCA) territory was characterized by the PCA LR. Regions with worsening asymmetry of tissue perfusion times, calculated from voxel-wise gamma variate fitting of the time courses, after vasodilation were considered hemodynamically compromised. Those regions then were examined for collateral circulation by increased flow through the anterior and posterior cerebral arteries by qPC MRA and by changes in MCA LR compared to the PCA LR with fMRI.

RESULTS
The mean MCA LR and PCA LR for right-handed healthy adults were 0.14 ± 0.15 and -0.02 ± 0.10, respectively. Of the patients that showed MCA redistribution by MR perfusion (7/10), a significant number (4/7) showed residual activation with near normal LR (0.25 ± 0.03) in the poststenotic vascular territory while all cases (10/10) showed increased flow in anterior and/or posterior cerebral arteries adjacent to the ipsilateral stenotic MCA. The remaining cases (3/7) showed redistribution and significantly abnormal LR (0.57 ± 0.10, \( p < 0.005 \)) reflecting decreased activation in the compromised territory. Cases with no redistribution in perfusion asymmetry (3/10) showed near normal LR values (mean 0.35 ± 0.25, \( p > 0.1 \)) but still showed collateral flow by qPC MRA. The PCA LR did not change significantly across patients.

CONCLUSION
Perfusion redistribution after vasodilation may not define clinically significant hemodynamic compromise but may be a consequence of increasing collateral circulation that violates the assumption of a single input function for the perfusion analysis. Such collateral circulation was demonstrated for all patients by quantitative qPC MRA, suggesting that this is a common compensatory response to single vessel stenosis. Disturbances in fMRI activation patterns suggest inadequate vascular responses to meet tissue metabolic demands. Just as with oxygen extraction measured by PET, activation patterns from fMRI may be a better assessment of tissue metabolic compromise than hemodynamic reserve assessed by perfusion redistribution.

KEY WORDS: MR perfusion, fMRI activation, hemodynamic reserve
How Much Are We Missing? Comparison of Whole Brain and Limited Coverage CT Perfusion Parameters in Acute Stroke

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PURPOSE
CT perfusion has been established as an important tool for evaluation of the acute stroke patients. Quick and objective evaluation of different perfusion parameters is essential to make timely clinical decisions and to assess the volume of brain tissue at risk. With the advent of 320-slice whole-brain CT scanner we are able to obtain whole-brain perfusion data compared to limited perfusion coverage in older scanners. We compared the volume of the perfusion abnormality between the whole-brain vs limited coverage data, based upon quick visual assessment using a simple method of measurement.

MATERIALS & METHODS
Twenty-three consecutive patients presenting with acute stroke in less than 6 hours from onset of symptoms are included. Whole-brain perfusion scans were acquired on a Toshiba 320 detector scanner and perfusion maps were generated using Vitrea 4D brain perfusion analysis software. We measured the volumes of perfusion abnormality seen on the admission CT perfusion color maps, including cerebral blood flow, cerebral blood volume, mean transit time and time to peak maps of the whole brain. This is based upon visual assessment of 3-colored perfusion maps using formula A+B+C/2. Following that a limited coverage data covering 4 cm of brain centering on the basal ganglia were generated from the same datasets and the volume of abnormality on perfusion maps was recalculated within that range. The differences in volume were calculated and expressed as a percentage of total volume of perfusion abnormality seen in the whole-brain maps.

RESULTS
Based on the perfusion maps, three acute strokes were missed completely in the limited coverage data. A significant difference in volume was noted when comparing the whole brain coverage acquired with the 320 Toshiba scanner with the extrapolated limited coverage data, similar to that which traditionally has been available from older scanners. The average difference was most pronounced in the MTT maps (59%). Time to peak maps were most sensitive for detecting areas of ischemia. The average volume difference in TTP maps was 53%. The difference in CBF and the CBV volumes were 52% and 48% respectively.

CONCLUSION
The 4 cm limited coverage perfusion maps exclude on average ~50% of perfusion abnormality seen in whole-brain perfusion maps. In our small series three peripheral infarcts were missed in the limited coverage maps.

KEY WORDS: Stroke, perfusion, 320 Toshiba

Low-Contrast Visual Stimuli Demonstrate Differential Volumes of Functional MR Imaging Activation in Affected and Unaffected Eyes in MS Subjects following Recovery from Optic Neuritis

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PURPOSE
Optic neuritis (ON) is inflammatory demyelination in the optic nerve and is a common early manifestation of multiple sclerosis (MS). It presents as monocular blurred vision or blindness progressing over days and recovering over months. Degree of ultimate recovery from ON is variable, and residual deficits become more apparent when testing affected eyes with low-contrast (gray-on-white) eye charts. Factors contributing to differential recovery from ON are unknown but may include cortical reorganization in addition to local remyelination. Functional MRI (fMRI) may be useful to investigate cortical reorganization following ON.

MATERIALS & METHODS
Six patients with relapsing-remitting multiple sclerosis who experienced a single remote episode of unilateral optic neuritis underwent fMRI with visual stimulation. At least 6 months were required to have passed since onset of symptoms, allowing time for recovery to have reached a plateau. Visual stimuli consisted of a radial checkerboard pattern inverting at a frequency of 15Hz, with a green fixation dot in the center of the stimulus. The pattern was presented at three different contrast levels (100%, 2.5%, 1.25%) individually displayed in sequence by video screen to fill the monocular visual field. Affected and unaffected eyes were stimulated independently. Activation maps were created based on the differences in activation between 100% stimulus and each of the low-contrast stimuli. Volumes of cortical activation were measured at the T > 3.5 level using AFNI software. Clinical measures of visual acuity on a low-contrast letter chart and optical coherence tomography (OCT) were collected as part of the same study visit.

RESULTS
Differences in volume of activation were more apparent between affected and unaffected eyes when using the lowest contrast (1.25%) stimulus (mean difference unaffected-affected eyes = 3543.8 mm3; 95% CI = -574.8 - inf, p = 0.065) compared to the 2.5% stimulus (mean difference unaffected-affected eyes = 1037.8 mm3; 95% CI = 3543.8 - inf, p = 0.126) (Figure). Volume of activation using 1.25% stimulus may be related to both low-contrast letter acuity (r = 0.20, p = 0.350) and retinal nerve fiber layer thickness (r = 0.49, p = 0.178). Enrollment of additional patients is ongoing.
Conclusion
Use of low-contrast visual fMRI may augment clinical and anatomical measures for testing treatment and rehabilitation strategies following ON.

Keywords: Multiple sclerosis, optic neuritis, functional MR imaging

Poster 76
Withdrawn

Poster 77
Comparison of Visual Neuroradiologist Ratings and Volumetric Measurements of Hippocampal Atrophy in the Diagnosis of Alzheimer Disease in Homebound Elderly Population

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Purpose
Volumetric measurements of hippocampus have been shown to differentiate between subjects with and without Alzheimer disease (AD). However, given the difficulty of using volumetric measurements in routine clinical use, various visual rating systems have been developed. The purpose of this study was to assess the value of a recently developed computer-based visual rating system in differentiating between subjects with no cognitive impairment (NCI), mild cognitive impairment (MCI) and AD in comparison to volumetric measurements of hippocampus.

Materials & Methods
One hundred nine subjects of Nutrition, Aging, and Memory in Elderly (NAME) study were included. The subjects underwent structural MRI which included coronal 3D-MPRAGE images. Volumetric measurements were performed by manually outlining both hippocampi on consecutive coronal images. A computer-based visual rating system described previously (1) was utilized. The system grades both hippocampal heads on a coronal slice at the level of mamillary bodies with grade 0 being normal and grade 4 being severe atrophy. The consensus diagnosis of NCI, MCI and AD available in the study database was utilized. The raters were blinded to the diagnosis. Spearman correlations between hippocampal volumes and visual rating were assessed. One way analysis of variance was used with Tukey posthoc analyses to assess the ability of volumetric and visual system in differentiating between NCI, MCI and AD.

Results
The consensus NAME study diagnosis provided by a group of clinical experts classified the 109 subjects as NCI = 40, MCI = 46, and AD = 23. A significant correlation was seen between volumetric measurement and visual rating of hippocampi (r = 0.35, < 0.001). The volumetric measurements differentiated NCI from AD and MCI from AD (p = 0.02) but did not differentiate NCI from MCI. The ability to differentiate between the groups for the visual ratings for both hippocampi was: NCI from AD (P = 0.002) and MCI from AD (P < 0.001). The visual ratings also could not differentiate NCI from MCI.

Conclusion
The visual ratings for hippocampal atrophy were as good as volumetric measurements in differentiating between NCI and AD, and MCI and AD. Neither method was effective in differentiating NCI from MCI.

References

Keywords: Alzheimer disease, MR imaging

Poster 78
Relationship between Gadolinium Enhancement on MR Imaging and Disease Exacerbation in Multiple Sclerosis

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Purpose
Gadolinium-enhanced (Gd) MR imaging MRI is used widely for evaluation of multiple sclerosis (MS) and improves detection of demyelinating lesions compared to clinical criteria alone. Enhancing lesions on MRI commonly are considered a marker for active disease exacerbation. However, as conventional Gd enhancement reveals breakdown in blood-brain barrier (BBB) rather than active inflammation, and lesions may enhance for weeks to months after the acute inflammatory event, its precise role in assessing acute disease exacerbation remains indeterminate. In this retrospective study, we examined the relationship between the presence of Gd-enhanced lesions and recent clinical exacerbation in patients with known MS.
MATERIALS & METHODS
The study was approved by the institutional review board. All brain MRIs from January 2007 to November 2009 containing the keywords “multiple sclerosis” in the report were identified. The electronic medical record was reviewed for each case and only studies performed in patients with clinically definite MS or high probability MS necessitating treatment were included. Studies from patients over 50 years of age, patients with alternative or nonspecific diagnoses, or those performed without Gd were excluded. The studies were analyzed for the presence and number of enhancing lesions and the presence or absence of clinical disease exacerbation within 14 weeks of the MRI. Imaging of the spinal cord was included if it occurred within 1 week of the brain MRI. The Mann-Whitney test was used to compare Gd-enhancing lesions with and without clinical disease exacerbation. P < 0.05 was considered to be statistically significant.

RESULTS
A total of 429 MRIs were analyzed in 196 patients. One hundred and forty-eight MRIs (34%) in 98 patients had enhancing lesions: 72 MRIs (49%) demonstrated concordant Gd-enhancing lesions with clinical disease exacerbation, but 76 MRIs (51%) had discordant Gd-enhancing lesions without clinical disease exacerbation. The mean number of enhancing lesions was higher in concordant cases vs those with isolated enhancement (5.3 vs 2.2, p = 0.014). Furthermore, 61 MRIs (46% of total exacerbations) demonstrated no evidence of Gd enhancement despite the presence of acute clinical disease exacerbation; of these, a small number (14 MRIs, 22%) demonstrated evidence of new T2 lesions. The sensitivity of Gd-enhancing lesions for detection of disease exacerbation was 0.54, specificity 0.74, positive predictive value 0.49, and negative predictive value 0.78.

CONCLUSION
Although Gd enhancement is used extensively as a marker of active disease in MS, our study revealed as many concordant as discordant cases with only moderate specificity and low sensitivity. Increased number of Gd-enhancing lesions was associated with more clinically evident disease activity. While the discordant cases may represent either subclinical disease or chronic disease with persistent leaky BBB, Gd does not possess molecular information to distinguish between them. Low detection sensitivity whereby not enough Gd has leaked across the BBB is likely a key contributor to the cases where patients experience acute exacerbations without evidence of Gd enhancement. Therefore, while Gd enhancement is a useful tool, more specific and sensitive imaging techniques/agents need to be developed to better correlate pathophysiologic mechanisms with clinical manifestations.

KEY WORDS: Multiple sclerosis, exacerbation

Poster 80
fMRI Paradigm Development: Language Paradigms in Arabic Language
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PURPOSE
To develop clinical fMRI language paradigms in Arabic language.

MATERIALS & METHODS
Three language paradigms were developed in Arabic language: rhyming, word-generation and listening. Rhyming paradigm used rhyme-word-pairs and nonrhyme-word-pairs in the active phases. Matching stick figures served as controls similar to the English version. Rhyming and nonrhyming pairs were selected from traditional Arabic literatures and scripts. The paradigm was programmed similar to the English version. Word-generation used common Arabic letters in the active phases and nonsense symbols in the control phases. For the listening a short story was programmed in the forward/backward play. The new paradigm was tested on a bilingual patient.

RESULTS
Successful language mapping was obtained from the new Arabic paradigm. Similar, but overall relatively higher activation was obtained from the Arabic version in a bilingual patient who preformed fMRI tasks in both English and Arabic languages.
**Conclusion**

Compared to approximately 375 million people whose first language is English, there are approximately 280 million people whose first language is Arabic. Arabic language is a central Semitic language and is related to other Semitic languages such as Hebrew and Neo-Aramaic languages. We developed a successful fMRI Paradigm in Arabic Language to serve international Arabic-speaking patients and overseas.

**Key Words:** fMRI language lateralization, arabic language, fMRI paradigms

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**Poster 81**

Noninvasive Characterization of the Tumor Hot Spot: Is It Possible by MR Spectroscopy and Arterial Spin Labeling?

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**Purpose**

The "hot spot" of a brain tumor is characterized by the highest degree of malignancy. This is reflected by metabolic activity on the one hand and high perfusion on the other hand. The purpose of our study was to determine whether there is an accordance between the region of the highest tumor perfusion using arterial spin labeling (ASL) and the region of the most malignant part of the tumor related to metabolic changes as demonstrated by MR spectroscopy (MRS).

**Materials & Methods**

Fifteen patients with tumorous brain lesions were included. A 3 T MR scanner was used to perform the pulsed ASL sequences (TE: 11 ms, TR: 2750 ms, voxel size: 3 x 3 x 6 mm, FOV: 192 x 100) and the multivoxel MR spectroscopy (TE: 135 ms, TR: 1510 ms, voxel size: 10 x 10 x 10 mm, FOV: 160 x 160). The different sequences were coregistered and the cerebral lesions were assessed for location of the highest Cho/Naa ratio on MR spectroscopy maps and highest signal intensity on the ASL sequence.

**Results**

All 15 tumorous brain lesions showed an accordance of the region of highest signal intensity in the ASL sequence and the highest Cho/Naa ratio in multivoxel MR spectroscopy.

**Conclusion**

These results indicate that in tumorous brain lesions there is an accordance between tumor perfusion and tumor-related metabolic changes, showing the most malignant part of the tumor without any kind of extrinsic tracer or contrast media. The results of this study hopefully will make a contribution to target stereotactic biopsy toward the most malignant part of the tumor and moreover reduce sampling errors for histopathology.

**Key Words:** Arterial spin labeling, MR spectroscopy, tumorous brain lesion

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**Poster 82**

Role of Diffusion Tensor Imaging - Fiber Tractography in Accurately Depicting Optic Nerves for Neurosurgical Planning of Anterior Skull Base and Suprasellar Neoplasms

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**Purpose**

Accurate localization of the optic nerve fiber tracts in relation to anterior skull base and suprasellar neoplasms is of critical importance during neurosurgical excision of these tumors. Preoperative diffusion tensor imaging (DTI) fiber tracking (DTI-FT) reconstruction of optic nerves is potentially useful to better define the surgical approach and improve surgical outcome. The purpose of this study was to describe the role of DTI-FT in anterior skull base and suprasellar masses, as a guide for surgical planning, to assess the relationship between optic nerve fiber tracts and the tumor and to define different patterns of involvement of the fiber tracts.

**Materials & Methods**

Diffusion tensor imaging-FT was acquired by a 3 T MR scanner with a single-shot EPI sequence (TR/TE 8986/80 ms, b = 1000 s/mm) with gradients applied along 32 non-collinear directions. Standard imaging also was obtained for anatomical guidance. Fractional anisotropic (FA) color-coded maps and tractography were generated from the DTI data on a separate workstation. The optic nerves were seed-
ed at multiple locations. Nerve fiber involvement by the tumors was arranged into four different categories, as follows: displaced, edematous, infiltrated and disrupted.

RESULTS
Close relationship of the optic nerves and optic chiasm with the intracranial masses was demonstrated on FT images which was not predictable on conventional MR images. Displacement of nerve fibers was the most common pattern identified in all patients (n = 10), followed by edematous pattern in (n = 4). Infiltration was seen in (n = 2), and frank disruption in (n =1).

CONCLUSION
The combination of DTI-FT helped in accurate identification of optic nerve fiber tracts, enhancing safe neurosurgical planning, optimizing the surgical performance, potentially reducing duration and improving surgical outcome.

KEY WORDS: Diffusion tensor imaging - fiber tractography, neurosurgical planning, anterior skull base and suprasellar neoplasms

Poster 83
Standard and Probabilistic Models of Diffusion Tensor Imaging and Tractography in Patients with Brain Tumors

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PURPOSE
To determine whether probabilistic tractography will perform better than standard deterministic tractography in reconstructing the arcuate fasciculus tract in patients with brain tumors.

MATERIALS & METHODS
We retrospectively identified 10 patients with brain tumors in the left hemisphere < 2 cm from the expected course of the arcuate fasciculus. All patients were left dominant for language by fMRI and had language deficits on Boston Diagnostic Aphasia Examination. fMRI was performed using phonemic fluency, semantic fluency and verb generation paradigms. The arcuate fasciculus was reconstructed using DTI&FiberTools implementing a deterministic algorithm based on Fiber Assignment by Continuous Tracking (FACT) and a probabilistic algorithm based on an extended Monte Carlo simulation of Random Walks using the Probabilistic Index of Connectivity (PiCo) method. Tracking was controlled by using two regions-of-interest corresponding to fMRI localization of Broca’s and Wernicke’s areas and fractional anisotropy threshold of > 0.15. The tracts were examined for their extension between Broca’s and Wernicke’s areas and their configuration near tumors and/or areas of edema. The fibers were scored in a similar way to Bernal 2009 for their rostral extent to the fMRI-defined Broca’s area: 0 - none; 1 - few; 2 - some; or 3 - all.

RESULTS
In 8 out of 10 cases, both probabilistic and FACT methods reconstructed tracts consistent with the arcuate fasciculus. Probabilistic tracts spanned the entire expected course of the arcuate fasciculus to the fMRI-defined Broca’s area, while FACT tracts did not show the anterior most fibers. In one case, neither probabilistic nor FACT tracking generated a tract through a region of extensive edema. In another case, probabilistic tracking generated a tract adjacent to a tumor whereas FACT tracking did not. The average score for the rostral termination of the probabilistic tracts was 2.1, and for the FACT tracts was 0.1.

CONCLUSION
Probabilistic tractography reconstructs more complete courses of the arcuate fasciculus than deterministic tractography, and may perform better through areas of tumor and/or edema. The FACT algorithm tends to underestimate the anterior-most fibers of the arcuate fasciculus, where the fibers are crossed by primary motor fibers. The multiple pathways calculated by the probabilistic algorithm appear to distinguish crossing fibers and true connecting fibers, and also may help compensate for decreased fractional anisotropy near the tumor. Additional work is necessary to validate the reconstructed tracts with direct intraoperative stimulation to confirm the location and functional status of the arcuate fasciculus.

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KEY WORDS: DTI, probabilistic tractography
Poster 84

**Diffusion Kurtosis Imaging of Hydrocephalus**

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**PURPOSE**

In a prior report we found significant diffusion tensor imaging (DTI) changes in the internal capsule of patients with normal pressure hydrocephalus (NPH) when compared to normal as well as Alzheimer (AD) control groups. Diffusion tensor imaging assumes that water diffusion is Gaussian; diffusion kurtosis imaging (DKI) estimates kurtosis, a dimensionless measure for the deviation from Gaussian distribution of water diffusion and thereby offers a more sensitive detection of tissue microstructural changes. We are currently deriving DKI as well as DTI measures in NPH patients in order to help identify measures that can identify shunt responders among NPH patients who do not respond to high volume spinal tap.

**MATERIALS & METHODS**

We are obtaining DKI as well as DTI scans as part of the NPH MR protocol. In this initial DKI report we report the first longitudinal study of a patient with NPH who is showing rapid clinical deterioration. An elderly female with NPH and dementia was studied 5/20/08 and subsequently on 6/23/09 using a 3 T scanner; during the 1 year 1 month interval the patient experienced increasing severity of gait impairment and increased severity of dementia. MR imaging performed included standard sequences and additional DTI and DKI using 3 b values and 30 directions. Mean kurtosis (MK) and radial kurtosis (RK) measures were derived from the paraventricular region, the internal capsule and the frontal white matter anterior to the ventricular system. Quantification of ventricular size and severity of NPH was obtained using the Freesurfer software.

**RESULTS**

Hydrocephalus severity showed 12% increase in ventricular size between time one and two. All DKI measures showed decreased values between time one and time two. Internal capsule: MK measures: 28% decrease; RK measures: decreased by 25%; Paraventricular: MK measures: 2% decrease; RK measures: 26% decrease; Frontal white: MK measures: 2% decrease; RK measures: 9% decrease. The findings show reduction in mean kurtosis and radial kurtosis measures correlating with increasing severity of hydrocephalus and increasing dementia.

**CONCLUSION**

Diffusion kurtosis imaging is a new tool for the assessment of biological tissues that shows strong promise for the evaluation of a multitude of pathologic conditions and shows particular promise in the evaluation of hydrocephalus.

**KEY WORDS:** Kurtosis, MR imaging, NPH

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Poster 85

**Intraoperative MR Imaging and Functional Neuronavigation for Resection of Lesions Involving Language Cortex or Arcuate Fasciculus**

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**PURPOSE**

Preservation of language function while maximizing resection is the main aim of surgery for the surgical treatment of intracranial lesions involving language cortex or fiber tracts. The purpose of this study was to evaluate the feasibility and efficacy of intraoperative MR imaging (iMRI) and functional neuronavigation for resection of lesions involving language cortex or arcuate fasciculus.

**MATERIALS & METHODS**

From March to August 2009, 29 cases of intracranial lesions (26 gliomas and 3 arteriovenous malformations, 13 male, 16 female) involving language cortex (Broca or Wernicke area) or arcuate fasciculus were operated at the Chinese PLA General Hospital in a 1.5 T iMRI suite with functional neuronavigation. Preoperatively, the language cortex was depicted with blood oxygenation level dependent (BOLD) functional MRI (fMRI). The arcuate fasciculus was delineated with diffusion-tensor based fiber tracking, while Broca and Wernicke areas working as regions of interest (ROI) for fiber tracking. These images then were integrated into a neuronavigation system for surgery.

**RESULTS**

With intraoperative MRI, complete lesion removal could be achieved in 26 (90%) cases. In three patients only subtotal tumor removal was performed in order to avoid new postoperative neurologic deficits. Postoperatively, language status was unchanged in 20 patients (69%) and improved in six patients (21%). Two cases (7%) got short-term (within 1 month) language deficits after surgery. One case (3%) got prolonged language deficit at 3-month followup.

**CONCLUSION**

Intraoperative MRI and functional neuronavigation are helpful for a maximized and safe resection for intracranial lesions involving language cortex or arcuate fasciculus. Complications related to the surgical procedure are reduced and the risk of postoperative language deficit is minimized.

**KEY WORDS:** Intraoperative MR imaging, language cortex, arcuate fasciculus
Poster 86
Development of an Improved Diffusion Tensor Template of the Human Brain

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PURPOSE
The purpose of this study was to develop a diffusion tensor (DT) template that is more representative of single-subject brain DT data, and more accurately matches ICBM space than the existing state-of-the-art IIT template (1).

MATERIALS & METHODS
Existing Turboprop DT data from 67 healthy human subjects, acquired on a 3 T MR scanner, were used in this study (1). The b = 0 s/mm² volume from each subject was registered to the ICBM-152 template. The subject with the lowest total deformation was identified, and the corresponding deformation was applied to the diffusion-weighted data of that subject to estimate tensors. The resulting DT dataset functioned as a temporary template. All datasets were registered to the temporary template using DTIGUI (2) (SBIA, U Penn, PA, USA), which performs high-dimensional nonlinear registration based on FA and trace information. The normalization accuracy achieved for the 67 DT datasets using the high-dimensional nonlinear registration method described above was compared to that achieved with the registration method used in the development of the previously published IIT DT template (1). The average cross-correlation of FA and trace maps over all pairs of subjects was compared between methods. The average Euclidean distance of diffusion tensors, Euclidean distance of deviatoric tensors (3), overlap of eigenvalues-eigenvectors, over all pairs of subjects, as well as the coherence of primary eigenvectors (4), also were compared between registration techniques. Two-tailed Student’s t-tests were used to assess the significance of any differences. Only differences with p < 0.01, corrected for multiple comparisons with the Bonferroni approach, were considered significant. Both mean and median tensors were used to generate DT templates. The new templates were compared to the previously published mean and median DT IIT templates (1) in terms of level of artifacts, FA values, sharpness of FA maps, and accuracy in matching the anatomy of the ICBM-152 template.

RESULTS
Based on all similarity metrics, the normalization accuracy achieved in this study for the 67 datasets was increased significantly compared to that achieved for the development of the previously published IIT DT templates. Also, in several white matter regions, the template-derived FA values were significantly higher, and more similar to single-subject values, than those of the existing IIT templates. In addition, the new templates did not contain any visible artifacts. Furthermore, the template-derived FA maps were significantly sharper in the new compared to the existing IIT DT templates. Finally, the new templates more accurately matched the anatomy of the ICBM-152 template than the existing IIT templates, especially in the corpus callosum.

CONCLUSION
A new template that is more representative of single-subject human brain diffusion properties, and more accurately matches ICBM-152 space than the previously published IIT template, was produced. The new template may significantly increase the accuracy of subject-to-template registration, and may play an important role in facilitating accurate comparisons of neuronal structural integrity across populations.

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KEY WORDS: Diffusion tensor, brain template, registration

Poster 87
Administration of Gadolinium Prior to DSC MR Imaging Does Not Alter Perfusion Measurements in Patients with Newly Diagnosed WHO Grade 1 Meningioma

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PURPOSE
Dynamic susceptibility-weighted contrast-enhanced (DSC) MR imaging utilizes the susceptibility effects induced by gadolinium contrast agents to quantify three cerebral hemodynamic measurements: relative cerebral blood volume (rCBV), peak height (rPH), and percentage of signal intensity recovery (rPSR). Dynamic susceptibility-weighted contrast-enhanced imaging has been reported previously to differentiate benign from malignant meningiomas. The administration of a loading gadolinium dose prior to DSC imaging attempts to more accurately estimate rCBV by reducing T1 shortening artifact; however, the effects of this loading dose on rPH and rPSR measurements has yet to be adjudicated. The purpose of this study was to determine if predosing with gadolinium alters DSC MR imaging hemodynamic measurements obtained from patients with meningioma.

MATERIALS & METHODS
As part of their preoperative imaging protocol, 10 patients with newly diagnosed treatment naïve WHO Grade 1 meningioma underwent DSC MR imaging. Ten minutes prior to DSC sequence acquisition 5 of 10 patients were predosed with gadolinium contrast agent (0.1 mmol/kg). Image processing was performed in a blinded retrospective manner. GE Functool was used to produce regions of interest around the entire contrast-enhancing region. The resulting T2* signal intensity-time curves were interrogated to produce rPH and rPSR. rCBV was calculated using the negative enhancement integral of the T2* signal intensity-time curve. Welch T or Chi squared tests compared mean, maximum, and minimum imaging and patient characteristics between groups.
Utility of Serial "Lesion Quotient" Measurement in Differentiation of Recurrent Metastatic Tumor from Radiation Necrosis in Gamma-Knife-Treated Metastasis

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RESULTS

All MR examinations were of sufficient quality, without degradative susceptibility artifact, to be included for study. Patients from the predosed group were found to be matched appropriately in age (mean; 52.8 years vs 58.4 years), gender (1/1 vs 4/4; Male/Female), and volume of enhancement (14.2 ml vs 27.4 ml) compared to the nonpredosed group (P > 0.05). No statistically significant difference in the mean (mean ± standard deviation; 35% ± 11% vs 35% ± 12%; P = 0.63), minimum (46% ± 11% vs 35% ± 15%; P = 0.23), and maximum (66% ± 12% vs 69% ± 20%; P = 0.93) rPSR measurements was found between the predosed group compared to the nonpredosed group. Additionally, mean (3.46 ± 2.22 vs 2.26 ± 1.01; P = 0.32), minimum (2.47 ± 1.25 vs 1.16 ± 0.71; P = 0.08), and maximum (4.68 ± 3.24 vs 3.49 ± 1.67; P = 0.49) rPH values were observed not to be statistically different. rCBV values tended to be higher within the predosed group compared to the nonpredosed group (mean, 3.15 ± 1.39 vs 2.83 ± 1.27; minimum 2.35 ± 0.97 vs 1.93 ± 1.31; maximum 3.75 ± 2.10 vs 3.44 ± 0.85), however, this difference was found not to be statistically significant (P > 0.57).

CONCLUSION

The administration of a gadolinium loading dose prior to MR imaging of WHO Grade 1 meningioma does not significantly alter DSC perfusion measurements. Although the relatively small sample size of this retrospective study cautions against over interpretation, the results of this preliminary study call into question whether the clinical utility of gadolinium administration prior to DSC MR imaging is out weighted by the potential adverse effects in patients with meningioma.

KEY WORDS: DSC MR imaging, meningioma, predosing gadolinium

Poster 88

Utility of Serial "Lesion Quotient" Measurement in Differentiation of Recurrent Metastatic Tumor from Radiation Necrosis in Gamma-Knife-Treated Metastasis

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PURPOSE

Enlargement of metastatic lesions following gamma-knife therapy can be due to recurrent tumor or radiation necrosis, and differentiation can be challenging. Dequesada et al. recently reported that the ratio of nodule area on T2 imaging to the total enhancing area on T1 imaging can be helpful in differentiating recurrent tumor and radiation necrosis. This index, termed as the "lesion quotient," was noted to be ≤ 0.3 in radiation necrosis, ≥ 0.6 in recurrent tumors, and > 0.3 in combination pathology. We preformed this study to determine if these findings could be reproduced in our patient population and whether serial measurements of lesion quotients on scans pre and postgamma-knife therapy offered any additional diagnostic benefit.

MATERIALS & METHODS

Fifty-three gamma-knife-treated metastatic lesions that showed enlargement on follow-up MRIs were identified from PACS archives. Definitive diagnosis was available in 24 of these lesions based on histopathology (n = 20) or from follow up (n = 4). We used a polygon ROI tool on PACS (GE centricity) to measure the nodule area on axial T2 and the area of enhancement on corresponding axial postcontrast T1. Lesion quotients were computed as above. When pregamma-knife MRI was available and lesion was visible on both T2 and enhanced T1 images (20 lesions), pregamma-knife lesion quotients also were measured. Lesions were categorized into three groups: recurrent tumors (n = 6), metastases with radiation-induced changes (n = 9), and pure/predominant radiation necrosis (n = 9); groups were compared by nonparametric statistics.

RESULTS

Lesion quotients in recurrent tumors, metastases with radiation-induced changes, and pure/predominant radiation necrosis were (means ± standard error) 0.86 ± 0.15, 0.79 ± 0.10, and 0.57 ± 0.33, respectively; the three groups were not significantly different (p = 0.1). Only 2/9 lesions with pure/predominant radiation necrosis showed lesion quotients < 0.3. All recurrent tumors and metastases with radiation-induced changes showed lesion quotients > 0.6. To investigate whether serial measurements of lesion quotients on scans pre and postgamma-knife therapy offered diagnostic benefit, we compared the interval change in lesion quotients after treatment in the three groups (ΔLQ). The ΔLQ values in recurrent tumors, metastases with radiation-induced changes, and pure/predominant radiation necrosis were 0.42 ± 0.13, -0.12 ± 0.04, and -0.23 ± 0.15, respectively. These differences were statistically significant between the three groups (p = 0.006).

CONCLUSION

Serial measurements of lesion quotients of gamma-knife-treated metastases on MR scans pre and postgamma-knife therapy are useful in distinguishing recurrent tumors from radiation necrosis.

REFERENCES


KEY WORDS: Radiation necrosis, gamma knife, metastasis
**Poster 89**

**CT Perfusion in Diagnosis of Recurrent Brain Gliomas and Radiation Necrosis**

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**PURPOSE**

The low CT, MR imaging (MRI) and clinical specificity of radiation necrosis (RN) diagnosis with its high rate of incidence after radiosurgery, raises the importance of differential diagnosis between tumor recurrent brain gliomas (RBG) and RN. The estimation CT perfusion (pCT) capabilities in differential diagnosis between RBG and RN.

**MATERIALS & METHODS**

Twenty-six patients with previously treated brain gliomas (astrocytomas I-II -3, anaplastic astrocytomas -12, glioblastomas- 11), who showed the appearance of progressive enhancing zones in periphery of surgery and enlargement of this zones in time on follow-up MR scans, were arranged in the first group. Verification in this group was made using histology (biopsy) and positron emission imaging (with methionine). There were two control groups: nine patients with “pure” necrosis (PN) in nontumor lesions after radiotherapy/radiosurgery (Novalis, Primus, Gamma-knife), and 30 patients with primary malignant gliomas (GB). Perfusion maps of cerebral brain volume (CBV), cerebral brain flow (CBF), mean transit time (MTT) were generated at Advantage Windows workstation (CT perfusion III). Normalized ratio (divided by normal white matter values): nCBV, nCBF, nMTT were used for analysis.

**RESULTS**

Box plot (Mean; Box: Mean-SE, Mean+SE; Whiskers: Mean-SD, Mean+SD) of normalized to WM perfusion parameters nCBV, nCBF, nMTT are presented in the Figure. Control groups: patients with “pure” necrosis (PN) had low perfusion parameters nCBV and nCBF, (1.63 +/- 0.60, 1.40 +/- 0.63) and nMTT = 1.2 +/- 0.4. Patients with GB (GB-III) had high values of perfusion parameters nCBV, nCBF, (4.32 +/- 2.44, 4.32 +/- 2.38) and nMTT = 1.1 +/- 0.4. Group I: 9 patients with RBG had high normalized perfusion parameters nCBV, nCBF (5.11 +/- 4.3, 4.71 +/- 0.7) and nMTT=1.2 +/- 0.7. The differences between mean nCBV, nCBF and nMTT in these cases and control GB group were nonsignificant (p > 0.2). Eight patients with radiation necrosis (RN) had low perfusion parameters (1.69 +/- 0.78, 1.34 +/- 0.46) with no significant differences of parameters in PN control group and nMTT = 1.5 +/- 0.4). Nine patients with mixed RN+RBG (biopsy proved) had intermediate values of perfusion parameters. Normal CBV, nCBF differed significantly from that one in the GB control group (p < 0.01), and nMTT values were similar to that one in RN control group. So RGB, GB and RN+RBG demonstrated significantly higher nCBV, nCBF than RN and PN. The difference between mean nMTT were nonsignificant. We suppose that the low 95% confidence levels of nCBV and nCBF (1.91 and 1.66) may be taken as a cutoff point to diagnose recurrent tumor and radionecrosis.

**CONCLUSION**

CT perfusion parameters nCBV, nCBF are informative in distinguishing malignant glioma recurrence from radiation necrosis.

**KEY WORDS:** CT perfusion, recurrent brain glioma, radiation necrosis

**Poster 90**

**Does MR Perfusion Imaging Affect Treatment Decisions for Brain Tumor Patients? A Prospective Study**

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**PURPOSE**

To determine the effect of MR perfusion imaging on the intermediate outcome of management decision in patients with brain tumors.

**MATERIALS & METHODS**

Consecutive adult brain tumor patients who had MR imaging (MRI) at our institution were identified retrospectively (all brain tumor patients have routinely had MR perfusion imaging at our institution since 2007). Patients with known oligodendrogial tumor were excluded. The MRIs were interpreted prospectively in consensus by three neuroradiologists, first based on conventional MR imaging protocol (T1-weighted, T2 FLAIR, T2-weighted with fat saturation, diffusion-weighted, postcontrast T1-weighted, and postcontrast SPGR sequences) and then based on perfusion MR imaging protocol (the conventional sequences plus pulsed arterial spin label and/or dynamic susceptibility contrast sequences, with qualitative analysis). Hypothetical management plans then were created prospectively by a team of brain tumor treatment subspecialists, including at least one each hematologist/oncologist, neurosurgeon, and radiation oncologist. Effects of MR protocol (conventional vs perfusion) on diagnosis, tumor status, and treatment plan were evaluated, as were effects on levels of confidence in status and plan. Clinical follow up was obtained by chart review.
RESULTS
Twenty-five patients have been evaluated to date (planned sample size is 55). Twenty of the 25 cases were patients with known pathologic diagnoses (ranging from WHO grade I to IV), whereas five patients were presenting de novo. Compared with conventional MR imaging, perfusion MR imaging protocol led to changes in treatment plan in 2/25 (8%) patients, and referring physician (RP) confidence in their proposed treatment plan increased in 13/25 (52%). For the 20 established patients, RP confidence in tumor status (i.e., improved, stable, or progressed) increased in 10/20 (50%), was unchanged in 6 (30%), and decreased in 4 (20%) with the addition of perfusion imaging. Of the four cases where confidence in tumor status decreased, two showed decreases of ≥ 1 point on a ten-point scale: in one case there was stable disease at the primary site but concern for a possible new remote lesion (this patient later developed multiple remote lesions), and in the other case the neuroradiologists thought there was progression but the RPs thought the disease was stable (this patient died 10 days later with acute renal failure). For the five patients presenting de novo, the primary preoperative diagnosis changed in 1/5 (20%) with perfusion imaging, changing from probable low-grade to probable high-grade glial tumor (this patient’s subsequent stereotactic brainstem biopsy was most consistent with grade II astrocytoma, but he developed a new second lesion at 6.5 months and was treated with 54 Gy). Neuroradiologists and RPs each thought perfusion sequences were useful in 12/25 (48%) patients and indicated a preference for obtaining perfusion sequences in the future for 24/25 (96%) and 18/25 (72%) patients, respectively.

CONCLUSION
In a study design simulating clinical practice, MR perfusion imaging appeared to have clinically significant effect on management decisions for patients with brain tumors. Neuroradiologists and RPs found it useful in about half of cases and very often expressed a preference to include it for future imaging in these patients.

KEY WORDS: Perfusion, brain tumor, intermediate outcome

Poster 91
Differentiation of High-Grade Glioma and Central Nervous System Lymphoma Based upon Relative Cerebral Blood Volume and Permeability Index Parameters of MR Perfusion

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PURPOSE
MR imaging (MRI) is primary modality for the evaluation of brain tumors. However, based upon the conventional MRI sequences alone, it is not always possible to differentiate between high-grade glioma (HGG) and primary central nervous system (CNS) lymphoma (PCNL). The early differentiation is important as the management of two conditions is different. Despite their similar appearance on MRI, both of these tumors have different cellular morphology and tumor angiogenesis. The florid angiogenesis is not a typical feature of CNS lymphoma. High-grade glioma on the other hand, frequently contain vascular hyperplasia that can be morphologically quite heterogeneous. Both of these tumors have different degree of disruption of blood-brain barrier (BBB) as well. Therefore, PCNL would have different perfusion and vascular permeability patterns on imaging perfusion studies in comparison to HGG. Dynamic susceptibility-weighted contrast-enhanced MRI EPI (DSE) sequence is a well established technique for evaluation of tumor perfusion and vessel permeability. Relative cerebral blood volume (rCBV), has been shown to correlate well with the histologic quantification of tumor vascular hyperplasia. However, the rCBV does not give any information about the capillary permeability of the tumor. The extent of vascular permeability or leakage of BBB has been shown to correlate with other variables of DSE MRI called as permeability index (K trans) and percentage of signal intensity recovery. We tested the hypothesis that the rCBV and permeability index are different in lymphoma and GBM.

MATERIALS & METHODS
1. Twenty-eight patients with histopathologic diagnosis of high-grade glioma (n = 14) or lymphoma (n = 14) and MR brain perfusion studies performed were reviewed retrospectively. 2. The routine protocol for brain tumor imaging includes T2-weighted, T1-weighted and FLAIR axial, GRE EPI axial, DWI/ADC axial, postcontrast T1-weighted axial and coronal. Perfusion studies are performed used dynamic contrast-enhanced GRE T2 EPI sequences (TR = 1800, TE = 47, slice thickness = 5 mm, FOV = 230 mm). 0.1mmol/kg body weight of gadolinium-diethylene-triamine-pentaacetic acid (Gd-DTPA) was injected at 4 cc/s. These images processed using nordicICE software developed by Nordic Neuro Lab. The relative blood volume, and permeability index (K trans) were calculated from tumor, perilesional edema and corresponding similar region of contralateral hemisphere using a standard size region of interest (ROI). 3. The Wilcoxon rank sum test was used to compare HGG and lymphoma. A P < .05 was considered to indicate a statistically significant difference.

RESULTS
Total 31 lesions (14 HGG and 17 primary CNS lymphoma) were evaluated. Cerebral blood volumes were significantly larger in HGG as compared to PCNL (mean, 145.78 +/- 64.68 vs 78.325 +/- 62.13; p = value 0.003). There was tendency for permeability indices to be higher in PCNL as compared to HGG (mean 3.69 +/- 2.71 v s 2.8 +/- 0.89) but this difference was not statistically significant (p = value 0.691). There was no significant difference in perilesional rCBV values in both groups (23.54 +/- 24.68 v s 23.30 +/- 24.05).

CONCLUSION
Based upon significantly high rCBV values in HGG, we conclude that DSE T2 MR perfusion improves the diagnostic accuracy of MRI to differentiate HGG from PCNL. The trend of higher permeability indices in PCNL was not statistically significant, but it likely is related to small sample size.

KEY WORDS: High-grade glioma, CNS lymphoma, MR perfusion
Poster 92

Results from a a Multicenter, Open-Label, Phase 3 Study to Determine the Safety and Efficacy of Gadobutrol, a Macroyclic 1.0 Molar GBCA, in Patients Referred for Contrast-Enhanced MR Imaging of the Central Nervous System

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PURPOSE
To determine the efficacy and safety of gadobutrol 1.0 molar (Gadovist®) in patients with known or suspected CNS lesions.

MATERIALS & METHODS
This clinical study was a multicenter, open-label Phase III study to evaluate the efficacy and safety of gadobutrol 1.0 molar. Primary efficacy variables were degree of contrast enhancement, border delineation, internal morphology, and number of lesions. A set of two MR images (MRI) were obtained for each patient: Clinical study investigators and three independent blinded readers evaluated two sets of images, unenhanced and the combination of unenhanced and gadobutrol enhanced MRI, giving assessment on each of the efficacy variables and a radiologic diagnosis. All available patient-related clinical information was collected up to 3 months after the MR scans, and an independent truth panel gave the assessment of the final clinical diagnosis.

RESULTS
Three hundred twenty-one patients were included in the study and underwent two sets of MR scans. All efficacy analyses performed for the full analysis set (FAS) also were provided for the per-protocol set (PPS). As there was only a difference of seven subjects between the FAS (N = 321) and the PPS (N = 314), the results for the PPS are extremely similar to the results from the FAS. The protocol-specified objectives for all four primary efficacy variables (superiority for degree of contrast enhancement, noninferiority for number of lesions, border delineation, and internal morphology) were achieved in the PPS as well as in the FAS. Results for the secondary efficacy variables were also very similar to the results for the same variables in the FAS. Statistically significant superiority of gadobutrol to unenhanced was demonstrated for the degree of contrast enhancement, border delineation, and internal morphology, and noninferiority was demonstrated for number of lesions detected. The protocol-specified objectives were achieved for all four primary endpoints. Therefore, this study has met all the prespecified primary efficacy objectives and has demonstrated the effectiveness of gadobutrol in CNS imaging. The mean change in diagnostic confidence from precontrast to postcontrast for the clinical investigators was also statistically significant (P < 0.0001), with a mean improvement of 0.84. Sixty-eight (19.8%) subjects reported at least 1 AE during the study. No deaths were reported during the study period, and none of the subjects discontinued from the study due to an AE. One subject experienced an SAE, which was not considered related to study drug.

CONCLUSION
This study has met all the prespecified primary efficacy objectives and has demonstrated the effectiveness of gadobutrol in contrast-enhanced MRI of the central nervous system (CNS). Gadobutrol-enhanced MRI also led to a significant improvement of the diagnostic confidence.

KEY WORDS: CNS lesions, contrast media

Poster 93

Cystic Meningiomas Have Greater Peritumoral Edema than Noncystic Meningiomas

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PURPOSE
The mechanisms of edema formation adjacent to meningiomas are not completely understood. One possible mechanism is alteration of CSF flow dynamics by the tumor. The alteration in CSF flow could force CSF into the brain parenchyma or interfere with fluid reabsorption. The same process may be responsible for development of cysts in, or adjacent to, meningiomas. The purpose of this study is to determine if cystic meningiomas have greater peritumoral edema than noncystic meningiomas.

MATERIALS & METHODS
This was a retrospective review of 262 consecutive patients who underwent brain MR scans at Georgetown University Hospital from 1/1/06 through 11/4/09 and whose reports contained the word "meningioma". A total of 329 lesions were evaluated. Meningiomas were excluded from the study if they previously had been partially resected, or if pathology was not available and they did not display classic MR imaging characteristics. Two hundred forty meningiomas were included in the study. For each meningioma, the size of the tumor was measured in long and short axis dimensions on the axial postcontrast image on which it was largest. Peritumoral edema was measured in a similar fashion using a fluid attenuated inversion recovery (FLAIR) sequence. We defined the "Meningioma Product" as the product of the long and short axis measurements of the meningioma and the "Edema Product" as the product of the long and short axis measurements of the edema. For each meningioma, an "Edema Index" was calculated by dividing the Edema Product by the Meningioma Product to correct for meningioma size. A meningioma was considered cystic if it contained at least one peritumoral or intratumoral cyst. Multiple logistic regression was used to identify significant predictors of Edema Product and Edema Index.

RESULTS
Of the 240 meningiomas, 14 (6%) were cystic. Both cystic type (p-value < 0.0001) and Meningioma Product (p-value < 0.0001) were significant predictors of the Edema Product. Cystic type (p-value < 0.0001) was a significant predictor of Edema Index.
CONCLUSION
Cystic meningiomas have greater peritumoral edema than noncystic meningiomas. Cyst formation and peritumoral edema may both be caused by alterations in CSF flow and reabsorption.

REFERENCES

KEY WORDS: Meningioma, cystic, edema

Poster 94

MR Imaging Features of Meningiomas and their Mimickers: A Retrospective Comparison

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PURPOSE
Meningiomas are common, benign, extraaxial neoplasms that usually can be distinguished from other lesions based on their classic imaging appearance on both CT and MR. However, there are a number of other entities, both benign and malignant, that can mimic the characteristic imaging findings of meningiomas, resulting in misdiagnosis. The aim of this study is to determine the incidence of the mimickers of meningioma, compare the classic MR imaging features of meningiomas with their mimickers, and to determine if there are additional clues that may reliably differentiate the two groups.

MATERIALS & METHODS
A retrospective review was performed of all brain lesions identified on MR imaging over a 5-year period (from June 2004 to June 2009), in which meningioma was the favored diagnosis or included in the differential diagnoses based on preoperative imaging findings. One hundred and fifty surgically proved cases were identified, including 123 meningioma cases and 27 cases of other entities. The preoperative brain MRI of each lesion was reviewed by a neuroradiologist and resident. Lesion characteristics evaluated in each case included lesion size, location, enhancement pattern, the presence of a dural tail, the presence of susceptibility artifact or calcifications, T2 signal characteristics, adjacent bone involvement, and the presence of underlying brain edema. Diffusion-weighted imaging characteristics of each lesion also were reviewed, including signal intensity relative to gray matter and apparent diffusion coefficient (ADC) values.

Comparison of the imaging features then was made between the meningioma and nonmeningioma groups, and preliminary data analysis performed using SPSS version 17.

RESULTS
A total of 150 surgically proved cases were identified, of which 123 (82%) were meningiomas, while 27 (18%) were other entities. The nonmeningioma group included a variety of extraaxial lesions such as hemangiopericytomas, dural metastases, lymphoma, granulomatous diseases, and pituitary macroadenomas, as well as intraaxial, exophytic lesions such as glial neoplasms and hemangioblastomas. The mimicking lesions were less likely to enhance homogeneously (p = 0.006) compared to the meningiomas, less likely to have a dural tail (p = 0.003), and less likely to contain calcifications or susceptibility artifact (p = 0.022). The nonmeningioma entities also were more likely to contain cystic components (p = 0.00), and more likely to have faster diffusion properties relative to gray matter (p = 0.044). The overall T2 signal characteristics, the presence of subjacent brain edema and bony invasion were not reliable factors in distinguishing between meningiomas and the other disease processes. The mean ADC value of the meningiomas was lower compared to that of the nonmeningioma group (92 mm3 compared to 124 mm3, SD ± 17, p = 0.00).

CONCLUSION
Multiple disease processes can mimic the MR appearance of meningiomas. Homogeneous enhancement of the lesion, the presence of a dural tail, the presence of calcifications/susceptibility artifact, the lack of cystic components, and an apparent diffusion coefficient value close to that of gray matter are all imaging clues that favor the diagnosis of a meningioma, and may be useful in separating this common neoplasm from other, rarer, mimicking entities.

KEY WORDS: Meningioma, extraaxial lesions, neoplasms

Poster 95

Volumetric Analysis of Meningiomas to Calculate Annual Growth Rate/Doubling Time and Its Correlation with Associated Imaging Features

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PURPOSE
Meningiomas are extra-axial, meningial-based tumors that are usually histologically benign. Some meningiomas grow very slowly or seemingly not at all, whereas others grow faster. Three-dimensional (3D) volumetric measurements may be more accurate as compared to 2-dimensional measurements because tumors may grow in different directions. The purpose of the study was calculate the annualized growth rate and doubling time of meningiomas and to correlate this with associated imaging features like presence or absence of vasogenic edema as well as with irregular or smooth margins.
MATERIALS & METHODS
For this retrospective study, 295 patients with meningiomas who underwent imaging from 2000 to 2008 were identified. Thirty-one patients (all females, 36-62 years, mean age 62.7 years) who had at least 2 follow-up studies, were included in this analysis. Twenty-seven patients had three follow-up studies, whereas four patients had two follow-up studies. Median follow-up time was 4.1 years (2.5 -7 years). Two patients had two meningiomas and one patient had three meningiomas. Serial images of these patients were used to perform volumetric analysis. The volumes were calculated using Vital Images (Vitrea® medical imaging) software. It utilizes a semiautomated algorithm based on perimetric analysis method. Tumor doubling times were calculated using the formula: Doubling time = t x log2 / log ( Vt / V0). Where t is time between initial and final volume, V0 is the initial volume of the tumor, and Vt is the final volume of the tumor. Spearman’s correlation coefficients and Kruskal-Wallis tests were done to assess the relationship of doubling time to associated imaging findings.

RESULTS
Twenty-six out of 31 patients had growing and five had non-growing meningiomas. Overall annualized growth rate for growing meningiomas was 14.37% and average doubling time was 13.72 years. Annualized growth rate and doubling time of the growing meningiomas was correlated with associated imaging findings of presence or absence of peritumoral edema and irregular or smooth margins. Out of the 26 growing meningiomas, nine (35%) had irregular margins and 17 (65%) had smooth margins. Associated peritumoral edema was seen in six (23%) whereas 20 (77%) did not have edema. All the five nongrowing meningiomas had smooth margins and no associated peritumoral edema. Meningiomas with irregular margins had faster growth rate and shorter doubling times (22.84% and 7.82 years) as compared to meningiomas with smooth margins (9.88% and 16.85 years) with p values of 0.05 and 0.03 respectively. Meningiomas with associated peritumoral edema also showed faster growth rate and shorter doubling times (17.79% and 12.32 years) as compared to meningiomas without edema (13.34% and 14.14 years), however, was not statistically significant (p values of 0.32 and 0.37 respectively).

CONCLUSION
Serial volumetric analysis suggests that meningiomas with irregular margins and associated peritumoral edema have a faster annualized growth rate and shorter doubling time. This information can be used in deciding prognosis and making a decision for conservative management vs surgery in patients with incidentally detected meningiomas or patients with associated comorbidities and higher risk for surgery.

KEY WORDS: Meningioma, volumetric analysis, doubling time

Poster 96
Intracranial Nonjugular Venous Pathways: A Possible Compensatory Drainage Mechanism
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PURPOSE
To quantify and compare the cross-sectional area (CSA) of the internal jugular veins (IJVs) vs the nonjugular veins (NJVs) in the intracranial compartment. The IJVs are considered to be the main pathway draining the intracranial venous system. However, there is increasing evidence for the existence of alternative venous pathways. Studies utilizing extracranial ultrasound techniques have demonstrated a nonjugular venous system. The main components of this system are the vertebral plexus and the pterygopalatine plexus. In the current study we used MR images to investigate the NJVs drainage system and its components. The exact visualization and measurement of the intracranial NJVs could be of diagnostic and therapeutic importance.

MATERIALS & METHODS
Sixty-four subjects with no history of neurologic disease were included in the study. All subjects were scanned with a phase-contrast MR sequence in the supine position. Image processing software developed in our institution was used to identify and quantify the size of the IJVs and NJVs in the plane of the internal jugular foramen. All images pre and postprocessing were reviewed by a neuroradiologist experienced in neurovascular imaging.

RESULTS
We were able to visualize and quantitate the surface size of the IJVs and the NJVs. The cumulative CSA of the NJVs was correlated inversely with that of the IJVs (p < 0.0001, r² = 0.25). Correlation was also significant when comparing IJVs to NJVs components (vertebral plexus: r² = 0.19, p = 0.0004; pterygopalatine plexus: r² = 0.11, p = 0.0069). Furthermore, NJVs cumulative CSA was inversely correlated with subject’s age (p = 0.0002, r² = 0.2).

CONCLUSION
Our study indicates that NJVs might serve as a compensatory drainage mechanism in the intracranial compartment. This mechanism appears less significant as age progresses.

KEY WORDS: Internal jugular vein
Poster 97

**Postoperative Evaluation of Superficial Temporal Artery-Middle Cerebral Artery Bypass by a New MR Angiography Technique Developed by Combining White-Blood and Black-Blood Sequences**

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**PURPOSE**

We have developed a new MR angiography (MRA) method by subtracting signals of a black-blood sequence from those of the 3D TOF MRA, which has been named “hybrid of opposite-contrast MRA” (HOP MRA), assuming that such a combination would be further capable of depicting small peripheral vessels. We assessed the value of this technique in the postoperative evaluation of superficial temporal artery (STA)-middle cerebral artery (MCA) bypass.

**MATERIALS & METHODS**

Our study group comprised 19 patients (12 men and 7 women; mean age, 62.4 years; range, 11 to 80 years) who had undergone STA-MCA bypass surgery. Their period from surgery to MR examination ranged from 3 days to 11 years. We performed both HOP MRA and conventional 3D TOF MRA in the identical scan area at 1.5 T. Hybrid of opposite-contrast MRA was performed using a double-echo 3D field-echo sequence with the following settings: TR/TE1/TE2/FA = 31.2/6.4/23.8/20. We generated source images by subtracting second-echo signals (black blood) from first-echo signals (white blood). We then performed maximum intensity projection for signals obtained after subtraction. In the image assessment, we visually compared overall visualization of distal MCA branches as well as the length of depicted recipient MCA branches between HOP MRA and conventional 3D TOF MRA. Additionally, we counted the number of MCA branches demonstrated continuously to the donor STA on the two methods of MRA.

**RESULTS**

There was one patient whose surgery had failed and four patients without improvement in demonstration of distal MCA branches including anastomosed ones. Among remaining 14 patients, HOP MRA provided better visualization of MCA branches distal to anastomosis in ten patients and longer depiction of recipient MCA branches than 3D TOF MRA in nine patients. The average number of depicted recipient MCA branches was 2.16 on HOP MRA and 1.79 on 3D TOF MRA.

**CONCLUSION**

HOP MRA enables more detailed postoperative evaluation of STA-MCA bypass than conventional 3D TOF MRA.

**KEY WORDS:** MR angiography, black-blood technique, time-of-flight MR angiography

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Poster 98

**“Giant” Arachnoid Granulations Do NOT Follow CSF Signal on All MR Sequences**

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**PURPOSE**

Arachnoid granulations (AG) are CSF-filled protrusions that extend through openings in the dura into venous sinuses and lakes. “Giant” AGs (> 1 cm) are uncommon and can be misdiagnosed as other venous sinus pathology. Reported distinguishing features of AG are that they parallel CSF on all MR sequences. We present 17 cases demonstrating a total of 19 “giant” venous sinus AGs and analyze their imaging characteristics.

**MATERIALS & METHODS**

Seventeen cases containing a total of 19 AGs >1 cm were collected. MR imaging was available for all AG, CT was available in five, and DSA was available in seven. Available MR sequences included precontrast T1-weighted images for 10/19 AGs, contrast-enhanced T1-weighted images for 13/19 AGs, T2-weighted images for 19/19 AGs, FLAIR for 8/19 AGs, inversion recovery for 1/19 AGs, diffusion-weighted images for 1/19 AGs, and MR venography for 3/19 AGs. Intra AG fluid was compared to CSF in the ventricles and adjacent subarachnoid spaces. Nonfluid tissue contents within the AGs were compared to gray matter.

**RESULTS**

Fluid within “giant” AGs did not follow CSF signal on at least one MR sequence in 15/19 AGs. Nine of these 15 cases had CSF-incongruent signal on two or more imaging sequences. CSF-incongruent signal was seen in 8/8 AGs on FLAIR sequences, 7/10 AGs on precontrast T1-weighted imaging, 13/19 AGs on T2-weighted imaging, and 8/14 AGs on contrast-enhanced T1-weighted imaging. Nonfluid tissue was identified in all but one AG. Signal intensity varied from absent/hypointense (“flow voids” in intra-AG veins) to isointense with gray matter (septations, stromal tissue, herniated cortex). Veins and septations showed strong, uniform contrast enhancement.
**Poster 99**

**Quantitative and Qualitative Comparison of 0.5 M Gadoterate Meglumine and 1 M Gadobutrol in Contrast-Enhanced MR Angiography of Carotid Arteries**

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**PURPOSE**

We aim to provide a prospective comparison, both quantitative and qualitative, of gadobutrol and gadoterate in contrast-enhanced MR angiography (CE MRA) of carotid arteries.

**MATERIALS & METHODS**

Forty patients who are likely to have carotid artery disease underwent MRA scanning receiving either 0.5 m gadoterate meglumine (Dotarem, Guerbet, France) at a dosage of 0.2 mmol/kg or 1m gadobutrol (Gadovist, Bayer-Schering Pharma, Germany) at a dosage of 0.1 mmol/kg in a standardized administration. Imaging was performed on a 1.5 T MR system (Philips, Achieva,The Nederlands ). Acquisition parameters were TR:500 msec, TE: 50 msec, flip angle: 40 degrees, FOV: 300 x 280 mm, matrix 400 x 232, scan time 18 sec. Four hundred twenty-six arteries out of 440 were evaluated, since 14 arteries were occluded. A total of 1198 vessel segments were evaluated. While signal-to-noise ratio and contrast-to-noise ratio are calculated for quantitative analysis, two readers performed the qualitative analysis on a 3-point scale (1:good; 2: intermediate; 3: poor image quality).

**RESULTS**

In quantitative analysis both mean ± standard deviation SNR (96.68 ± 43.03, p < 0.0001) and CNR (90.77 ± 41.33, p < 0.0001) values of 1.0 m gadobutrol are statistically higher than those of 0.5 m gadoterate meglumine (69.58 ± 24.49 and 64.36 ± 24.12, respectively, p < 0.0001). The average qualitative ranking (1.89 for gadoterate meglumine and 1.35 for gadobutrol, p < 0.0001 for both readers) of all vessel segments represents a significant difference between the two contrast agents. The overall interobserver agreement is rated as good (Cohen’s κ 0.717).

**CONCLUSION**

1.0 m gadobutrol, with higher gadolinium concentrations, allows a better image quality in carotid arteries by generating higher and more homogeneous vessel contrast than a 0.5 m Gd agent. Quantitative comparison of two agents with SNR and CNR calculations reinforces the result.

**KEY WORDS:** Arachnoid granulation, normal variant

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**Poster 100**

**Superficial Temporal Artery Calcification in Patients with End-Stage Renal Disease: Association with Vascular Risk Factors and Ischemic Cerebrovascular Disease**

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**PURPOSE**

Extracranial superficial temporal artery (STA) calcification is an unusual finding seen in patients with chronic renal failure that has unknown ramifications with respect to intracranial ischemic disease and etiology. We sought to determine the risk factors associated with this rare phenomenon and to assess the coexistence of white matter and cortical ischemic changes in the brain.

**MATERIALS & METHODS**

Medical records and laboratory data on risk factors for vascular calcification were retrieved retrospectively for a total of 454 patients with a discharge diagnosis of end-stage renal disease. Further, CT head examinations were reviewed to identify and associate STA calcification with 1) those risk factors for the vascular calcification, 2) intracranial artery calcification, and 3) cerebral ischemia.

**RESULTS**

Diabetes and renal insufficiency were found to be significantly associated to risk of STA calcification, with corresponding odds ratios of 4.79 [95% CI: (2.41, 9.51)] and 3.11 [95% CI: (1.27, 7.67)], respectively. The odds of STA calcification were 13.0 [95% CI: (4.57, 36.9)] times greater in patients with carotid and/or vertebrobasilar calcification. The prevalence of white matter and/or cortical changes of ischemia in patients with STA calcification was 24.4% [95% CI: (13.4, 39.9)] as opposed to 9.3% [38/408, 95% CI: (6.8, 12.7)] in patients without STA calcification; these classifications were found to be significantly dependent (p = 0.008 for null hypothesis of independence between factors).

**CONCLUSION**

The risk of white matter and/or cortical changes of ischemia is highest amongst diabetics and patients with STA calcification. Carotid and/or vertebrobasilar calcification is very strongly associated to STA calcification. The presence of diabetes and renal insufficiency are important in describing the risk of STA calcification, whereas age, gender, hypertension, serum calcium, phosphorus, or hemoglobin levels are not.

**KEY WORDS:** Superficial temporal artery calcification, end-stage renal disease, DM
Poster 101
Evolution of Subarachnoid Hemorrhage in Cerebral Amyloid Angiopathy
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PURPOSE
MR imaging study of initial features and evolution of cortical subarachnoid hemorrhage in cerebral amyloid angiopathy.

MATERIALS & METHODS
Study of 13 patients with acute symptomatic cortical subarachnoid hemorrhage (cSAH) and probable or possible cerebral amyloid angiopathy, according to Boston criteria. All patients were explored initially by CT (9 cases) and MR imaging (13 cases), and 10 patients were controlled by MR imaging, between 1 and 12 months. The abnormality intensity, contrast enhancement, and distribution were noted.

RESULTS
In all cases explored by CT, cSAH was suspected as a sulcal hyperdensity. In 11 patients, cSAH appeared as a sulcal perirolandic FLAIR hyperintensity and as a gradient-echo (GRE) T2 hypointensity, filling the entire sulcus. In all patients, other hemorrhagic sequelae, such as microbleeds, hematomas, superficial hemosiderosis, were seen on GRE T2. Local contrast enhancement was associated to the cSAH in all 10 patients evaluated initially by T1 with gadolinium. This contrast enhancement disappeared on control MR imaging, after the first month. In nine cases, the sulcal GRE T2 hypo intensity became a linear image in the superficial layers of the cortex, suggesting superficial hemosiderosis. In two cases, the FLAIR and GRE T2 control sequences revealed new, infraclinical cSAH. In two other patients, a parenchymal hematoma appeared in the proximity of cSAH, in the following days.

CONCLUSION
In the context of probable or possible cerebral amyloid angiopathy, the cSAH is associated initially with contrast enhancement, evolves into superficial hemosiderosis and might complicate with parenchymal hematoma.

KEY WORDS: Subarachnoid hemorrhage, cerebral amyloid angiopathy, superficial hemosiderosis

Poster 102
Correlation between CT Angiogram Measurements of the Circle of Willis and the Cerebral Collateral Circulation
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PURPOSE
Carotid back or stump pressure (CSP) is an established surrogate measure of cerebral collateral circulation during endarterectomy and neurointerventional procedures involving temporary internal carotid artery (ICA) occlusion. We sought to determine whether detailed anatomical measurements of the calibre of Circle of Willis vessels on computed tomography (CT) angiography could help predict the cerebral collateral circulation.

MATERIALS & METHODS
Over a 4-year period, 90 patients underwent CSP measurement either during endarterectomy or balloon test occlusion. Using corresponding CT angiographic studies, diameter measurements of 16 vascular segments of the Circle of Willis and neck were reviewed and recorded by an experienced neuroradiologist. These 16 variables then were correlated individually with CSP using the Spearman rank order correlation test. Mean systemic pressure also was correlated with CSP.

RESULTS
The diameter of the contralateral anterior cerebral artery A1 segment was the strongest predictor of CSP (p < 0.001), followed by the contralateral distal cervical ICA and intracranial ICA (p < 0.001 and p = 0.0016 respectively). Systemic pressure was not an important factor, although it did contribute in those patients in whom CSP was above 35 mmHg. With severe contralateral ICA stenosis, the calibre of the ipsilateral posterior cerebral artery P1 segment became significant (p = 0.0183), suggesting a greater role for the posterior collateral pathway in this situation.

CONCLUSION
The dominant predictor of CSP during endarterectomy or temporary balloon test occlusion is the size of the contralateral A1 segment. To a lesser degree the contralateral distal cervical ICA and intracranial ICA are also important. The anterior collateral pathway is consistently more important than the posterior collateral pathway. However if there is severe contralateral ICA stenosis, the posterior collateral pathway may become important.

KEY WORDS: Collateral circulation, Circle of Willis anatomy, carotid stump pressure
Purpose

Time of flight (TOF) MR angiography (MRA) is a noninvasive imaging technique that does not require the injection of contrast agents. MR angiography is used in the clinical routine for evaluation of cerebrovascular diseases, for example, aneurysms and arteriovenous malformations. However, more subtle microvascular disease usually cannot be seen with the resolution of standard field strength MRA. The purpose of this study was to evaluate the possibility of 7 T ultra-high field TOF MRA to depict the brain vasculature of patients with microaneurysms.

Materials & Methods

In this on-going study, four patients diagnosed with intracranial microaneurysm by digital subtraction angiography (DSA) were scanned in a 7 T MR scanner with a transmit/receive head coil. A 5-slab 3D-spoiled gradient-echo sequence was used with TR/TE/flip angle 15 ms/3.5 ms/20 degree and tilt-optimized nonsaturated excitation variable flip angles across the slab. Data were acquired with FoV = 220 x 165, matrix = 512 x 384, and acquired slice thickness = 1.2 mm such that the acquired voxel size was 0.43 x 0.43 x 1.2 mm³ interpolated to 0.22 x 0.22 x 0.6 mm³. Image data were acquired in approximately 10 minutes.

Results

In this prospective ultra-high field MRA trial the preliminary results indicate the potential of ultrahigh field TOF MRA to visualize small vessels. All four microaneurysms which were identified during a DSA scan also could be seen on the 7 T gradient-echo images and the calculated maximum intensity projections (MIPs). In all patients, we could successfully delineate the parent artery, the size and orientation of the aneurysm dome and neck, and correlate the results to DSA.

Conclusion

Time of flight MRA at 7 T has an enhanced potential to depict small vessels in comparison to lower field strengths and may become an important tool in future neuroradiology research and clinical care.

Key words: Time of flight, MR angiography, 7 T

Poster 104

Changes in Perfusion-Weighted Imaging Parameters in Regions of the Brain Drained by Developmental Venous Anomalies

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Purpose

To determine changes in magnetic resonance (MR) perfusion-weighted imaging (PWI) parameters in regions of the brain drained by developmental venous anomalies (DVA).

Materials & Methods

We retrospectively identified MR PWI examinations performed in patients with DVAs at our institution over a period of 3 years. The PWI data were analyzed to generate mean transit time (MTT), cerebral blood volume (CBV) and cerebral blood flow (CBF) maps. Mean transit time, CBV and CBF values were obtained by drawing two regions of interest (ROIs) within the brain parenchyma drained by the DVA. The first ROI was placed over the brain parenchyma closest to the confluence of the DVA’s venous tributaries, and the second ROI was placed in the adjacent brain parenchyma. Perfusion-weighted imaging values within “mirror image” locations in the contralateral cerebral or cerebellar hemisphere also were obtained in order to calculate relative MTT (rMTT), CBV (rCBV) and CBF (rCBF) values. The perfusion characteristics of brainstem DVAs were assessed rela-
tive to the arithmetic mean of the PWI parameters in the cerebellar hemispheres. Control relative PWI parameters were calculated within regions of the brain unaffected by the DVA or other pathologic process. We used the Student’s t-test to determine p-values for the difference between the mean rMTT, rCBV and rCBF values in the regions of the brain drained by the DVAs and corresponding controls.

RESULTS
A total of 13 DVAs in 11 patients were included in our study. Mean patient age was 51.1 years (range 15-77 years, median 59 years). Six patients were male (54.5%) and five female (45.5%). The MR PWI examinations were obtained for evaluation of brain tumors in five patients (45.4%), Developmental venous anomalies in three patients (27.3%), and stroke, encephalopathy and papilledema in one patient each (27.3%). Eight DVAs drained portions of the supratentorial brain (61.5%) and five drained portions of the infratentorial brain (38.5%). Three DVAs were associated with cavernous malformations (23.1%). We found significantly increased rMTT (1.47, p-value 0.0087), rCBV (2.76, p-value 0.0001) and rCBF (2.26, p-value 0.0036) values in the regions of the brain drained by the DVAs compared to control regions (Table). The increase in the relative brain perfusion parameters was most pronounced in the brain parenchyma closest to the confluence of the DVAs’s venous tributaries: rMTT 1.66 (p-value 0.0069), rCBV 3.62 (p-value < 0.0001) and rCBF 2.67 (p-value 0.001).

Table 1. Changes in PWI Parameters in Regions of the Brain Drained by DVAs

<table>
<thead>
<tr>
<th>PWI Parameter</th>
<th>ROI 1</th>
<th>ROI 2</th>
<th>Mean (ROIs 1 &amp; 2)</th>
<th>Control</th>
<th>p-value*</th>
</tr>
</thead>
<tbody>
<tr>
<td>rMTT</td>
<td>1.66</td>
<td>1.3</td>
<td>1.47</td>
<td>1.14</td>
<td>0.0087</td>
</tr>
<tr>
<td>rCBV</td>
<td>3.62</td>
<td>2.09</td>
<td>2.76</td>
<td>0.9</td>
<td>0.0001</td>
</tr>
<tr>
<td>rCBF</td>
<td>2.67</td>
<td>1.95</td>
<td>2.26</td>
<td>0.91</td>
<td>0.0036</td>
</tr>
</tbody>
</table>

*ROI 1 is within the brain parenchyma closest to the confluence of the DVAs’s venous tributaries; ROI 2 is within the adjacent brain parenchyma. #p-value applies to the difference between the mean ROI and control ROI PWI parameters.

PWI: perfusion-weighted imaging; DVA: developmental venous anomaly; ROI: region of interest; rMTT: relative mean transit time; rCBV: relative cerebral blood volume; rCBF: relative cerebral blood flow. All values are relative to the “mirror image” location within the contralateral cerebral or cerebellar hemisphere. For brainstem DVAs, the PWI parameters are relative to the arithmetic mean of the cerebellar hemispheres.

CONCLUSION
Regions of the brain drained by DVAs demonstrate significantly increased rMTT, rCBV and rCBF values compared to brain parenchyma with normal venous drainage. Future studies are needed to determine the clinical significance of these findings.

KEY WORDS: Perfusion, developmental venous anomaly

Poster 105
Intraoperative MR Imaging and Functional Neuronavigation for the Surgical Treatment of Intracranial Vascular Lesions

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PURPOSE
Prior studies have suggested that intraoperative MR imaging (MRI) can enhance preoperative planning and intraoperative imaging for brain tumor surgery. However, the usefulness of intraoperative MRI and functional neuronavigation for the removal of intracranial vascular lesions rarely has been reported. Our purpose was to evaluate the feasibility and efficacy of intra-operative MRI and functional neuronavigation for the resection of intracranial vascular lesions.

MATERIALS & METHODS
From March to September 2009, 15 cases of intracranial vascular lesions [12 cavernomas and 3 arteriovenous malformations (AVMs)] were operated with 1.5 T intraoperative MRI and functional neuro navigation. All the 12 cavernomas were small (diameter less than 2 cm) and subcortically deep located, while the three AVMs involved language cortex and language fiber tracts (arcuate fasciculus). Intraoperative MRI images were obtained for intraoperative “brain shift” correction and navigation update.

RESULTS
In 10 (83.3%) of 12 cases with cavernomas, intraoperative “brain shift” severely interfered with the location of the lesions. Intraoperative MRI helped to relocate the lesion precisely and total resections finally were achieved. Complete removal of the three AVMs was achieved. Functional neuronavigation helped to locate and protect the language cortex and arcuate fasciculus intraoperatively. Intraoperative MRI and MRA excluded the presence of intracranial hemorrhage and the obliteration of major cerebral vessels. Postoperatively, only one case with giant AVM involving language cortex got short-term (within 1 month) language deterioration. The other 14 cases improved or maintained their neurologic status.

CONCLUSION
Intraoperative MRI and functional neuronavigation are helpful for safe and maximized resection for selected intracranial vascular lesions, such as deep located small cavernomas and AVMs involving eloquent structures.

KEY WORDS: Cerebral vascular disease, intraoperative MR imaging, functional neuronavigation
Intracranial Arterial Fenestration and Association with Aneurysm

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Purpose
The purpose of this study is to confirm the incidence of intracranial fenestration and its association with aneurysms by using MR and CT angiography (MRA and CTA) in addition to conventional angiography.

Materials & Methods
We retrospectively reviewed 6,848 consecutive reports of MRA, CTA, and conventional angiography performed over 5.5 years. Each fenestration case was reviewed by two board certified neuroradiologists to confirm the location and coexistence of aneurysm. Odds ratios were calculated.

Results
Five hundred eighty-three intracranial aneurysms were detected. There were 46 cases with fenestration, almost half of which were present in the basilar artery (22 cases), followed by anterior communicating artery (8), verteobasilar junction (6), anterior cerebral artery (6), middle cerebral artery (3) and posterior cerebral artery (1). Of the 46 patients with cerebral fenestration, 12 had an aneurysm (26%; incidence, 0.20%). Only three aneurysms occurred at the fenestration site: in the basilar, anterior cerebral, and anterior communicating artery. Therefore, the odds ratio that a patient with cerebral fenestration also has an aneurysm is 3.3 (95% CI, 1.72-6.49).

Conclusion
We confirmed that intracranial fenestration carries higher risk for intracranial aneurysm, the latter frequently not occurring in the proximity of the fenestration. Therefore, if fenestration is detected, a detailed analysis of entire intracranial circulation is strongly recommended. For this purpose, we advocate to use more modern angiographic techniques including CTA and MRA.

Key words: CT angiography, MR angiography, aneurysms

Preliminary Data on Correlation between Contrastoma and Relative Cerebral Blood Volume in Postthrombolysis Stroke Patients

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Purpose
To determine relationship between contrast extravasation (contrastoma) on the postthrombolysis noncontrast CT (NCCT) of the head and the relative cerebral blood volume (rCBV) on the preprocedural CT perfusion (CTP). Contrast extravasation during the angiographic procedure is suspected to result from breakdown in the blood-brain barrier.

Materials & Methods
This retrospective study comprised of nine NCCT of the heads showing contrastoma. These scans were performed within 4 hours following intraarterial thrombolysis with tissue plasminogen activator (tPA) or mechanical clot retrieval. Preprocedural CTP were performed within 1 hour before the neurovascular intervention. The CTP were done using the first pass contrast bolus multiphase dynamic technique on a 64-row detector scanner with 40 cc of Isovue 370. There were four slices of 10 mm thickness covering a slab of 40 mm approximately 2 cm above the sella. The data were processed on the workstation using deconvolution method. Relative cerebral blood volume (rCBV) values were measured on the CTP in the approximate region of contrastoma on the NCCT head by drawing region of interest.

Results
The absolute rCBV values in the contrastomas varied from 0.36 ml/100 g to 4.82 ml/100 g. Five patients had rCBV values less than 2.0 ml/100 gm tissue, a generally accepted cutoff point for infarcts on CTP. Two patients had values of 2.2 and 2.33 respectively. Remaining two patients had rCBV higher than 4 ml/100 ml. In one patient, contrastoma surrounded hemorrhage in the basal ganglia. In all the patients, the contrastomas were located in the basal ganglia; however in two patients there was involvement of cortex as well. Contrastomas located in the basal ganglia had well defined margins and usually conformed to the anatomical shape of the structure. Contrastoma formation in patients with rCBV more than 2.0 ml/100 ml is perplexing. Possible explanations include erroneous CTP values or progression of infarct in the interval between CTP study and the thrombolysis.

Conclusion
There is a close relationship between rCBV values less than 2.0 ml/100 g and formation of contrastoma; however, larger study with statistical analysis is needed to prove more consistent relationship.

Key words: Contrast extravasation, thrombolysis

Optimized Phase-Contrast MR Venography Technique Outperforms Time-of-Flight in the Diagnosis of Cerebral Venous Thrombosis

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New York, NY

Purpose
To compare and contrast 2D time-of-flight (TOF) vs optimized 3D phase contrast (PC) MR venography (MRV) in patients referred for suspected cerebral venous thrombosis.

Materials & Methods
A retrospective review of 38 examinations in 36 patients between 1/09 and 12/09 was performed evaluating 2D TOF
Radiologists preferred the overall quality of PC to TOF in 92% of studies, and in the remaining cases, the techniques were equivalent. All phase-contrast studies were diagnostic and demonstrated no significant degradation and were rated as best quality. In contrast, TOF studies were considered best quality in 12 cases (33%) by reviewer 1 and in 16 cases (42%) by reviewer 2. There was mild saturation effect in 20 cases (53%) (reviewer 1) and in 18 cases (47%) (reviewer 2).

In eight TOF cases, the saturation effects were thought to potentially interfere with accurate interpretation (6 cases by reviewer 1 and 4 cases by reviewer 2 with agreement in 2 cases). No studies were deemed nondiagnostic. The depiction of anatomy and identification of pathology, PC was considered superior in 45% of cases, with the remainder of cases being equal between PC and TOF. Reviewer 1 selected PC at better depicting anatomy/pathology in 24 (63%) cases while reviewer 2 only selected PC as superior in 10 cases (26%). Reviewer 2 rated the majority of studies equal at demonstrating anatomy/pathology in 29 cases (76%) in contrast to reviewer 1 who rated the techniques as equal in 14 cases (37%).

**RESULTS**
Radiologists preferred the overall quality of PC to TOF in 92% of studies, and in the remaining cases, the techniques were equivalent. All phase-contrast studies were diagnostic and demonstrated no significant degradation and were rated as best quality. In contrast, TOF studies were considered best quality in 12 cases (33%) by reviewer 1 and in 16 cases (42%) by reviewer 2. There was mild saturation effect in 20 cases (53%) (reviewer 1) and in 18 cases (47%) (reviewer 2).

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**CONCLUSION**
Optimized 3DPC was superior to 2D TOF MRV in depicting anatomy and pathology and resistant to saturation effects.

**KEY WORDS:** MR venography, phase contrast, time of flight
CONCLUSION
This study demonstrates that WSS maps can be created from whole-brain highly accelerated 3D PC VIPR scans. Wall shear stress values derived from PC VIPR velocity data are consistent with values from the literature. While it is well known that MR underestimates WSS compared to computational fluid dynamics because of lower spatial resolution (3), directly measured in vivo values can be used as a surrogate parameter and relative WSS maps of the whole brain can have prognostic value in finding areas predisposed to aneurysm and plaque formation. We are currently creating WSS maps of patients with stenoses and aneurysms and using these normal values as a baseline for comparison with patients.

REFERENCES

KEY WORDS: PC VIPR, wall shear stress, basilar artery

Poster 110

Intraindividual Comparison between Multislice CT and 4D TWIST MR Angiography in the Assessment of Residual Cerebral Arteriovenous Malformations: A Prospective Study Protocol

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PURPOSE
Cerebral arteriovenous malformations (AVMs) are a rare developmental abnormality of the intracranial vasculature in which the diagnosis can be made using the standard of reference DSA or using modern noninvasive neuroimaging methods like CT and MR angiography, respectively. One of the challenges of noninvasive MR angiographic imaging is the visualization of residual pathologic vessels thus presenting a clear nidus or arteriovenous shunting. This is of importance for treatment decision in residual AVMs after bleeding or incomplete interventional therapy and in the assessment of radiotherapeutically treated AVMs. Conventional MRA techniques like TOF MRA or contrast-enhanced techniques are not able to visualize small and slow-flowing vessel segments because of the lack of hemodynamic information. The aim of the presented study protocol was to assess the validity of a 4D contrast-enhanced MRA technique for small AVM vessel detection using CTA as the standard of reference.

MATERIALS & METHODS
In an ongoing prospective study protocol we used a combination of high temporal resolution (250 ms) and high spatial resolution (1 x 1 x 1 mm) CE MRA (0.1 mmol of Gadobutrol, Gadovist®, Bayer, Berlin) using the TWIST (Time-Resolved Imaging with Stochastic Trajectories) technique to assess the visibility of an arteriovenous shunting and residual small AVM compartments. The MRA study was compared with a MS CTA study performed on the same day in all subjects. The study was approved by the local ethical committees and all patients gave their written informed consent. Images are going to be evaluated in a qualitative matter with special attention about the role of the dynamic component in the MRA studies.

RESULTS
So far we were able to include 20 patients with no residual AVM components on the conventional TOF MRA examinations (inclusion criteria). In 15 out of these patients residual AVM components could be visualized on the dynamic and high-resolution contrast-enhanced MRA sequences. The MS CTA was able to visualize residual vessel components in only eight patients. In two patients massive artifacts from previous embolization hindered the visualization. In three patients no vascular components were seen on both CTA and contrast-enhanced MRA. In the MRA studies the hemodynamic information from the TWIST technique was found to be very helpful in the differentiation between physiologic and pathologic vessels.

CONCLUSION
In conclusion these preliminary results could prove that high temporal and spatial resolution 4D MRA is able to assess even small residual AVM compartments at a high sensitivity. Based on the initial patient studies, Gadobutrol with its unique high molar concentration seems to be the ideal contrasting agent in this study concept. The high concentration allowed for a small bolus which is ideal for the high temporal resolution of the MRA, the higher relaxivity was found to be ideal for the vessel assessment in the high-resolution MRA.

KEY WORDS: Arteriovenous malformations, 4D MRA, contrast media
**Poster 111**

**Independent Validation of the Secondary Intracerebral Hemorrhage Score with Catheter Angiography and Findings of Emergent Hematoma Evacuation**

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**PURPOSE**

The secondary intracerebral hemorrhage (SICH) score, derived from a cohort of 623 intracerebral hemorrhage (ICH) patients examined with CT angiography at the Massachusetts General Hospital, utilizes clinical and non-contrast CT (NCCT) characteristics at presentation to predict a patient’s risk of harboring a vascular etiology for the ICH, such as arteriovenous malformations, aneurysms or dural sinus thrombosis (Table 1). We aim to determine whether the SICH score can predict the risk of harboring a vascular etiology in an independent population of ICH patients examined with either catheter angiography or emergent hematoma evacuation.

**MATERIALS & METHODS**

We retrospectively reviewed all patients who presented to our institution between January 1st, 2005 and December 1st, 2009 with nontraumatic ICH and were evaluated with catheter angiography or underwent emergent hematoma evacuation with intraoperative inspection of the hematoma cavity. We applied the SICH score to this independent patient cohort and compared the incidence of vascular etiologies per score group in both cohorts. The NCCT categorization, defined as admission INR > 3, PTT > 80, platelet count < 50,000, or daily antplatelet therapy ICH: intracerebral hemorrhage.

### Table 1. Calculation of the SICH Score

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. NCCT Categorization:*</td>
<td></td>
</tr>
<tr>
<td>a. High-probability:</td>
<td>2</td>
</tr>
<tr>
<td>b. Indeterminate:</td>
<td>1</td>
</tr>
<tr>
<td>c. Low-probability:</td>
<td>0</td>
</tr>
<tr>
<td>2. Age Group:</td>
<td></td>
</tr>
<tr>
<td>a. &lt; 46 years:</td>
<td>2</td>
</tr>
<tr>
<td>b. 46-70 years:</td>
<td>1</td>
</tr>
<tr>
<td>c. &gt; 70 years:</td>
<td>0</td>
</tr>
<tr>
<td>3. Female sex:</td>
<td>1</td>
</tr>
<tr>
<td>4. Neither known HTN nor IC at presentation:</td>
<td>1</td>
</tr>
</tbody>
</table>

*High-probability NCCT: an examination with either (1) enlarged vessels or calcifications along the margins of the ICH, or (2) hyperdensity within a dural venous sinus or cortical vein along the presumed venous drainage path of the ICH. Low-probability NCCT: an examination in which neither (1) nor (2) is present and the ICH is located in the deep gray matter or brainstem. Indeterminate NCCT: an examination that does not meet criteria for a high or low-probability NCCT.

The score is calculated by adding the total number of points for a given patient. NCCT: Noncontrast CT HTN: hypertension IC: impaired coagulation, defined as admission INR > 3, PTT > 80, platelet count < 50,000, or daily antplatelet therapy ICH: intracerebral hemorrhage.

**RESULTS**

Three hundred twenty-one patients were included in our study, with a mean age of 56.1 years (range 1-88 years, median 57 years). One hundred seventy-two patients were male (53.6%) and 149 female (46.4%). Two hundred seventy-six patients were evaluated with catheter angiography (86%) and 45 with emergent hematoma evacuation (14%). One hundred fourteen NCCTs were categorized as low-probability (35.5%, yield 6.1%), 197 as indeterminate (61.4%, yield 21.8%), and 10 as high-probability (3.1%, yield 70%). Interobserver agreement for the NCCT categorization was almost perfect (kappa 0.95, 95%CI: 0.91-0.99). The SICH score successfully predicted an increasing incidence of underlying vascular etiologies in our patient cohort, which was similar to the derivation cohort examined with CT angiography. The MOP in both cohorts was reached at a SICH score > 2, with high sensitivity and specificity for detecting underlying vascular etiologies for the ICH. There was no significant difference in the AUCs between both cohorts (Table 2).

### Table 2. Independent Validation of the SICH Score

<table>
<thead>
<tr>
<th>Score</th>
<th>Retrospective Derivation Cohort (N = 623)</th>
<th>Independent Validation Cohort (N = 321)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N (%)</td>
<td>% Positive CT Angiograms</td>
</tr>
<tr>
<td>0</td>
<td>37 (5.9)</td>
<td>0</td>
</tr>
<tr>
<td>1</td>
<td>145 (23.3)</td>
<td>1.4</td>
</tr>
<tr>
<td>2</td>
<td>209 (33.5)</td>
<td>5.3</td>
</tr>
<tr>
<td>3</td>
<td>138 (22.2)</td>
<td>18.1</td>
</tr>
<tr>
<td>4</td>
<td>61 (9.8)</td>
<td>39.3</td>
</tr>
<tr>
<td>5</td>
<td>28 (4.5)</td>
<td>85.7</td>
</tr>
<tr>
<td>6</td>
<td>5 (0.8)</td>
<td>100</td>
</tr>
</tbody>
</table>

AUC (95% CI): 0.86 (0.83-0.89) 0.81 (0.76-0.85)

MOP: >2 >2

Sensitivity: 85.7 80.7

Specificity: 71.1 65.9

p-value: <0.0001 <0.0001

N: number of patients n/a: not applicable AUC: area under the curve after receiver operating characteristic analysis CI: confidence interval MOP: maximum operating point.

**CONCLUSION**

The SICH score successfully predicted a patient’s risk of harboring an underlying vascular etiology for the ICH in an independent patient population evaluated with either catheter angiography or emergent hematoma evacuation. This practical scoring system could be used to select ICH patients for emergent neurovascular evaluation.

**KEY WORDS:** Intracerebral hemorrhage, arteriovenous malformations, aneurysms
**Poster 112**

**Surgical Retreatment of Ruptured Intracranial Aneurysms Previously Coiled at a North American High-Volume Neurovascular Center: Angiographic Characterization and Collaborative Management**

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Atlanta, GA

**PURPOSE**
The 2007 follow-up to the International Subarachnoid Aneurysm Trial (ISAT) supports endovascular coiling of ruptured intracranial aneurysms compared to surgical clipping. However, a significant number of coiled aneurysms recur and concern remains for the long-term durability of this treatment modality. Denser coil packing of intracranial aneurysms is believed to result in lower recanalization rates. Here we report our initial and follow-up experience and management after coiling ruptured intracranial aneurysms.

**MATERIALS & METHODS**
A retrospective review of aneurysmal subarachnoid hemorrhage (SAH) was performed from 1999 through 2006, at a single institution. Of 469 patients, 19 aneurysms were identified that previously underwent coil embolization of a ruptured intracranial aneurysm, and later required surgical repair. The electronic medical records were reviewed and immediate and subsequent treatment results were graded using the Roy classification. Roy class 1 was defined as complete aneurysm occlusion, class 2 as residual neck filling, and class 3 as residual aneurysm filling. For the aneurysms retreated, recurrence was defined as a worsening Roy classification or further recanalization of a Roy class 3 aneurysm. The average time between embolization and surgical clipping was 1.6 years (min 13 days; max 7.2 years).

**RESULTS**
Of the 19 ruptured aneurysms, there were 15 small (10 mm, but < 25) and 2 giant (> 25 mm) aneurysms. The average size of the aneurysm was 8 mm (min 3 mm, max 30 mm), and the average neck size was 3.3 mm (min 2 mm, max 7 mm). There were 14 anterior and 5 posterior circulation aneurysms. Of the ruptured aneurysms, 9 were right-sided while 10 were left. Six patients had multiple aneurysms. Ten aneurysms had documented incomplete occlusion after initial embolization. Based on Roy classification the initial angiographic results of Roy class 1, 2, and 3, were 26%, 21%, and 53%, respectively. On follow up, Roy class 1, 2, and 3, was 0%, 16%, 84%, respectively. Recurrence was noted in 14 aneurysms, with a total of 16 treatments (14 clipping, 2 recoiling). Of these aneurysms, the most frequent angiographic finding was coil compaction with aneurysm recurrence. Two cases developed visual changes prompting surgical intervention. Three cases involved intentional partial embolization of clinically poor surgical candidates at the presumed site of rupture, with the ultimate goal of surgical clipping. One case involved an intraventricular hemorrhage prompting emergent surgical intervention.

**CONCLUSION**
These 19 aneurysms comprise 4.1% of all endovascular cases performed at our institution during the same time period. The majority of these aneurysms were incompletely treated initially with residual luminal filling, and angiographic recurrence as the most frequent indication for retreatment with surgical clipping. One case reruptured 2 months after initial coiling. Close angiographic follow up is necessary in postembolization patients to insure long-term obliteration for previously ruptured aneurysms.

**KEY WORDS:** Aneurysm, coiling, clipping

**Poster 113**

**Dynamic MR Perfusion Characteristics of Dural Metastases and Meningiomas: Characterizing the First Pass Wash-in Phase Beyond rCBV**

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Bronx, NY

**PURPOSE**
Dural metastases and meningiomas are extraaxial lesions that may be difficult to distinguish based on conventional imaging methods. This distinction, however, is clinically important. Perfusion MRI may play a role in preoperative assessment. The goal of this study is to determine if, in addition to rCBV, metrics MTT, TTP-T0, relative wash-in time (rWI) and wash-in slope (WIS) better discriminate benign and malignant extraaxial lesions. We evaluate two new metrics (rWI and WIS) that reflect the first-pass wash-in characteristics of perfusion.

**MATERIALS & METHODS**
Patients with intracranial extraaxial masses who underwent MR perfusion imaging were included. Region of interest analysis was performed and several perfusion metrics were calculated including rCBV, mean transit time (MTT), and time to peak from initial bolus enhancement (TTP-T0). Two metrics characterizing first pass wash-in enhancement were measured: relative wash-in time (rWI) and wash-in slope (WIS). These two metrics were defined as follows: \( rWI = \left( \frac{TTP-T0}{WIS} \right) \frac{within \ the \ lesion}{within \ normal \ brain} \). WIS = percent change in signal from T0 to TTP using a linear regression analysis. Lesions were divided into two subject groups: meningioma and metastasis. Comparisons between the two groups were made using Wilcoxon Rank Sum and Fisher's Exact tests. All tests of significance were two-tailed and conducted at alpha = .05.

**RESULTS**
Sixteen extraaxial lesions were included in the study (10 meningioma and 6 metastases). There were seven females and three males with an average age of 62 ± 10 years. Compared with meningiomas, rWI was statistically lower in metastases (1.0 ± 0.3 vs 1.6 ± 0.8; \( p = 0.03 \)). No other statistically significant differences were observed. Specifically, there was no difference in rCBV between the two study groups.
CONCLUSION
Significantly shorter rWI distinguished dural metastases from meningioma despite no difference in rCBV, possibly due to differences in vascular pathology between the lesions. First-pass wash-in characteristics of dural lesions may be useful in evaluating and characterizing extraaxial lesions.

KEY WORDS: Perfusion, MR imaging, dural

Poster 114
Analysis of Brain Tumors and Metastases by Quantitative MT Imaging with bSSFP: Initial Experiences
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PURPOSE
The efficacy of quantitative magnetization transfer (qMT) imaging for the characterization of different brain tumors and metastases is analyzed with balanced steady-state free precession (bSSFP) (1). MT effects are described in terms of MTR, relaxation times (T1, T2), MT exchange rate (kf) and the macromolecular content (F).

MATERIALS & METHODS
Eleven patients (4 glioblastoma multiforme (GBM), 4 meningiomas and 3 metastases) were investigated on a clinical 1.5 T MR scanner. The MR examination consisted of a complete conventional MR imaging (MRI) protocol and qMT imaging using bSSFP (1), which was completed within 10 minutes, providing whole-brain images with 1.3 mm isotropic resolution. Evaluation of qMT data (MTR, T1, T2, F, kf) were performed by placing ROIs within the contrast-enhancing (CE) portion of the lesions (Figure), the surrounding edema and the normal-appearing tissue.

Table. MTR and qMT parameters for different brain regions and lesions.

<table>
<thead>
<tr>
<th></th>
<th>T1 [ms]</th>
<th>T2 [ms]</th>
<th>MTR [%]</th>
<th>kf [1/s]</th>
<th>F [%]</th>
</tr>
</thead>
<tbody>
<tr>
<td>CE portion GBM</td>
<td>1736±87</td>
<td>141±14</td>
<td>22.4±2.4</td>
<td>0.6±0.1</td>
<td>2.7±1.2</td>
</tr>
<tr>
<td>Meningiomas</td>
<td>1228±55</td>
<td>109.5±9</td>
<td>23.5±1.1</td>
<td>1.2±0.6</td>
<td>2.6±0.7</td>
</tr>
<tr>
<td>Metastases</td>
<td>1613±56</td>
<td>135±17</td>
<td>27±2.1</td>
<td>0.8±0.1</td>
<td>3.1±0.9</td>
</tr>
<tr>
<td>Edema GBM</td>
<td>1312±94</td>
<td>157±14</td>
<td>31.2±1.9</td>
<td>1±0.4</td>
<td>4.8±1</td>
</tr>
<tr>
<td>Meningiomas</td>
<td>1642±49</td>
<td>206±18</td>
<td>26.9±2.3</td>
<td>0.8±0.3</td>
<td>4±1.3</td>
</tr>
<tr>
<td>Metastases</td>
<td>1351±48</td>
<td>123±7</td>
<td>34.8±1.8</td>
<td>1.3±0.2</td>
<td>5.9±1.1</td>
</tr>
<tr>
<td>Healthy tissue GBM</td>
<td>768±50</td>
<td>63±6</td>
<td>42.3±2.8</td>
<td>3.5±0.4</td>
<td>13.2±2.8</td>
</tr>
<tr>
<td>Meningiomas</td>
<td>889±122</td>
<td>67±7</td>
<td>41.3±3.5</td>
<td>3.1±0.8</td>
<td>11±3.3</td>
</tr>
<tr>
<td>Metastases</td>
<td>886±97</td>
<td>66±8</td>
<td>40.1±4.9</td>
<td>3±0.8</td>
<td>11±3.3</td>
</tr>
</tbody>
</table>

RESULTS
MTR was higher in the normal-appearing than in the damaged brain tissue. For quantitative estimates, F and kf were markedly lower and relaxation times higher in tumors and metastases than in normal-appearing tissue. Between the different regions within the same lesion as well as between the different lesions several significant differences were found (Table). Despite similar MTR for the CE-areas in GBM and meningiomas, kf tended to result in higher and relaxation times in significantly lower values compared to GBM, despite similar F.

CONCLUSION
In different pathologies CE tissue and surrounding edema, which appear similar in signal intensity on conventional MRI, show differences in qMT parameters, which might be attributed to differences in edema, cell infiltration and myelin properties. Differences in relaxation times despite similar MTR values between GBM and meningiomas indicate a higher diagnostic potential for qMT in comparison to simple MTR assessment. Quantitative magnetization transfer might play a major role in adding information for diagnostic tumor characterization. However, more data have to be collected to confirm the value of qMT imaging in the clinical setting.

REFERENCES

KEY WORDS: Quantitative MT imaging, tumor characterization, bSSFP

Poster 115
Imaging of the Claustrum
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PURPOSE
Due to advancements in high-resolution MR imaging technology, area of the brain previously below the resolution of the scanner now are visualized easily. The goal of this study was to examine the gross anatomy, cell composition, and projection fibers of an MR visualized gray matter tract that is hypothesized to be the claustrum. Specimen analysis and MR techniques were used to confirm this proposition and to deduce the function and role of this relatively unexplored area of the brain.
MR studies of normal brain and pathologic brain involving lesions of the claustrum area were obtained using 3 T high-resolution MR scanners. Gross anatomy slices of the human brain in the axial and coronal plane were examined histologically at the corresponding level displayed on the MR images.

RESULTS
The gross specimens of the suspected area matched the gray matter tract observed on MR images, in terms of both composition and course of fiber tracts. Gross anatomy analysis of the corresponding MR area of interest makes this region of the brain to be the claustrum highly likely.

CONCLUSION
MR studies of normal and abnormal brains with claustrum lesions supports previous research studies’s difficulties with deciphering its exact role and function.

KEY WORDS: Claustrum, MR imaging, anatomy

Poster 116

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PURPOSE
Bilateral carotid artery agenesis is an exceptionally rare condition. We aim to describe such a case with associated hypoplastic vertebrobasilar system using angiographic, and skull-base imaging and review the literature pertaining to this condition with reference to mechanisms of collateralization and internal carotid artery embryology.

MATERIALS & METHODS
We report on a case of a 36-year-old woman who presented with chronic headache and transient right hemiparesis and subsequently was treated with a left external to internal carotid artery bypass. Following investigation using computed tomography (CT) angiography and catheter angiography, as well as skull-base CT and cranial MR imaging, she was found to have bilateral agenesis of the internal carotid arteries and hypoplastic vertebrobasilar arteries with numerous patterns of collateralization via the circle of Willis, persistent embryonic vessels and external carotid branches. We compare this case to those described in the literature, illustrating the relevant anatomy with the modalities described and explore the potential embryologic abnormalities with reference to the theory of segmental agenesis proposed by Lasjaunias and Santoyo-Vazquez (1): the internal carotid artery forms via a series of seven embryologic segments. Segments are developmentally independent. The branching of a series of embryonic vessels separates them. Persistence of these vessels as collateral supply to the distal internal carotid artery lends a clue to the site of embryologic insult.

RESULTS
Our patient showed occlusion of both internal carotid arteries in the neck with various collateral pathways that differed on either side. CT showed an absent left carotid canal implying complete agenesis. The left internal carotid supply came via the anterior and left posterior communicating arteries. The distal right internal carotid supply came predominantly via a persistent trigeminal artery, as well as a trans-sellar arcade with perfusion of a primitive internal maxillary artery. Numerous skull base collaterals also were identified with a significant contribution provided via an enlarged inferior tympanic branch of the ascending pharyngeal artery. The hypoplastic vertebral vessels were boosted by the ascending cervical arteries. With reference to the segmental theory of agenesis, it is plausible that our patient suffered an insult involving a large number of embryonic segments, with embryonic vessels, fed by external carotid collaterals traversing the cervical, petrous, and intracavernous segments. The left side relied on the right for perfusion through the circle of Willis.

CONCLUSION
Bilateral internal carotid artery agenesis is a rare condition. Collateral pathways that develop in this setting include the circle of Willis, persistence of embryonic vessels, and transcranial collaterals via the external carotid artery. These anomalies have important implications if the patient is symptomatic and surgical bypass is being considered.

REFERENCES

KEY WORDS: Internal carotid artery agenesis, embryology, angiography

Poster 117
“Forgettable Lymph Nodes”: Review of the Occipital, Parotid and Facial Lymphatic System

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In patients with head and neck malignancy, knowledge of the lymphatic pathways relevant to tumor location, is important for treatment preparation, both in radiation therapy and in surgery. The lymphatic drainage of the head and neck area consists of various nodal groups which are connected by numerous small vessels, giving rise to a complex subcutaneous and deep lymphatic network. The deep cervical lymph nodes, (Levels I-VI) have been reviewed intensively in radiology and classified by well established levels. The more superficial groups, notably the occipital, parotid and facial groups play a very important role in cancer management and staging but are not well recognized or understood. We present a review of the anatomy and literature of these “forgotten lymph nodes” (occipital, parotid AND facial) including their location, afferent and efferent drainage tracts accompanied by cross-sectional imaging CT examples of normal and metastatic involvement.

KEY WORDS: Lymph nodes, facial, occipital, parotid, anatomy
**Poster 118**

**Forgotten Foramina of the Skull Base: A Pictorial Review**

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**PURPOSE**

Numerous canals and foramina of the skull base are unknown and not familiar to general radiologists. Our objectives are to review the anatomy of the “forgotten” foramina of the skull base and their contents, demonstrate the visibility of these foramina in high-resolution CT images, study their location and spatial relationships and provide examples of pathologic process affecting these structures.

**MATERIALS & METHODS**

For the study of these structures we have high-resolution images from a 16-channel multidetector CT scanner in axial sagittal and coronal planes. Six millimeter slices of routine CT head scans, and an advantage workstation GE 4.4 for posttreatment are used to study normal CT anatomy of these foramina. We view the slices using a high-resolution reconstruction algorithm and bone windowing.

**RESULTS**

We study eleven structures: anterior and posterior ethmoidal canals, foramen venosum, craniopharyngeal canal, canalis basilaris medianus, petro mastoid canal, posterior condylar canal, zygomatico orbital canal, palato vaginal canal, Inferior tympanic canaculus and mastoid canaliculus. We also review the anatomy of these foramina, their neurovascular contents, and their spatial relationships between the head and intracranial contents. We also present CT scans of pathologic process affecting rare and less known foramina.

**CONCLUSION**

Knowledge of rare and unfamiliar foramina of the skull base is important in head and neck radiology to recognize the pathologic process affecting these structures.

**KEY WORDS:** Skull, foramen, anatomy

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**Poster 119**

**Frontal Sinus and Zygomatico-Maxillary Complex Fractures: What the Reconstructive Surgeon Wants to Know**

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**PURPOSE**

To familiarize radiologists/neuroradiologists with the surgical implications of frontal sinus and zygomatico-maxillary complex fractures.

**MATERIALS & METHODS**

We will present the chief imaging parameters that affect surgical management of both frontal sinus and zygomatico-maxillary complex fractures. These management issues include both functional considerations as well as cosmetic issues.

**RESULTS**

For the typical fracture patterns through the frontal sinus and zygomatico-maxillary complex (ZMC), there are several key imaging features that can dictate whether the patient will go to surgery, whether the surgery will be open or with a camera-assisted technique, and what types of incisions and approaches will be used. For frontal sinus fractures, the primary imaging features that are of concern to the surgeon include the degree of obstruction of the nasofrontal sinuses, likelihood of a cerebrospinal fluid (CSF) leak, and disruptions in the basic contour of the patient’s face. Reporting the degree of displacement and comminution, likelihood of nasofrontal duct obstruction, and the presence of any underlying brain injury is of utmost value to the treating clinician. For ZMC fractures, stability of the orbit, involvement of adjacent facial bones, and suture dehiscence are the chief concerns in terms of facial stability. Facial symmetry becomes an important cosmetic parameter and can play a large role in determining surgical management. For example, while isolated zygomatic arch fractures may seem of minimal consequence to the radiologist, the cosmetic implications of abnormal healing at the zygomatic arch can greatly influence the decision whether to proceed to surgery versus simply observe.

**CONCLUSION**

By understanding the surgical approach to commonly encountered frontal sinus and zygomatico-maxillary complex fractures, the radiologist can better tailor their reports to offer the most relevant information for the referring clinician. Additionally, with the increasing popularity of navigational imaging, surgeons often rely on the radiologists interpretation of the raw, source images to guide their surgical decisions.

**KEY WORDS:** Fractures, facial, reconstructive
Poster 120

Chronic Sclerosing Sialadenitis: Characteristic Findings on Ultrasonography, CT and MR Imaging with Detailed Histopathologic Correlation

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PURPOSE

The purpose of this retrospective study was to describe the characteristic findings of chronic sclerosing sialadenitis on ultrasonography (US), computed tomography (CT), and MR imaging (MRI) and to correlate them with histopathologic findings.

MATERIALS & METHODS

Fourteen submandibular glands of eight patients with chronic sclerosing sialadenitis were included in this study. Ultrasonography of 13, unenhanced CT of 8, enhanced CT of 5 and MRI of 10 glands were reviewed, especially focusing on internal architecture of the lesion to correlate with their histopathologic findings. Detailed radiologic-pathologic relationship was evaluated for three patients with the affected submandibular gland resection.

RESULTS

On US, of the 13 glands, severe hypoechoic infiltration and multiple hypoechoic nodules prominent to surface area were seen in 7 (53.8%), indistinct small hypoechoic foci scattered against a heterogeneous background of submandibular gland in 2 (15.8%), focal mass in 3 (23%) and normal appearance in 1 glands (7.4%). Prominent intraglandular vessel was seen in 5 of the 8 glands (62.5%) on Doppler imaging. On unenhanced CT, internal heterogeneity was seen in 5 of the 8 glands (62.5%). On enhanced CT, well enhancement with the fissured pattern in low density area was seen in all of the 5 glands (100%) (Figure). On T1- and T2-weighted images of MRI, internal heterogeneity was seen in 8 of the 10 glands (80%). On diffusion-weighted images, all of the 9 glands were homogeneously hyperintense and ADC values of these glands ranged from 0.84 to 1.28 x 10^-6 mm²/s (mean 0.97 x 10^-6 mm²/s). No inflammatory change was seen in the soft tissue around the glands. The lymph node around the gland was not exceeded more than 10 mm in minimum diameter. Radiologic-pathologic correlation revealed that hypoechoic lesion on US and internal heterogeneity on unenhanced CT and T1- and T2-weighted images represented fibrosis. Well enhancement with the fissured pattern in low density area on enhanced CT also was due to severe fibrotic band in the gland. Hyperintensity on diffusion-weighted images was attributable to abundant infiltration of lymphocytes and plasmacytes in the gland.

CONCLUSION

Characteristic imaging findings of chronic sclerosing sialadenitis were severe hypoechoic infiltration and multiple hypoechoic nodules on US, the fissured pattern in low density area on enhanced CT, and diffuse hyperintensity on diffusion-weighted image. These imaging findings showed good correlation to the pathologic changes such as extensive fibrosis and diffuse lymphocytic infiltration.

KEY WORDS: Submandibular gland, ultrasonography, MR imaging

Poster 121

Patterns of Regional Spread for Esthesioneuroblastoma

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PURPOSE

Esthesioneuroblastoma (ENB) is a rare malignant neoplasm that affects the anterior skull base. Disease stage is a significant predictor of survival, in particular the presence or absence of lymph node metastases. Multiple studies have identified the cervical lymph nodes as the most frequent site of spread, however no studies have attempted to characterize the radiographic appearance of metastatic lymph nodes or identify the primary nodal drainage for these tumors.

MATERIALS & METHODS

We retrospectively reviewed the medical records and imaging examinations of patients with a pathologically proved diagnosis of ENB from a single tertiary care institution from 2004 to 2009. A head and neck radiologist with 9 years of experience evaluating ENB reviewed the imaging of all patients with lymph node metastases to confirm the lymph node findings.
RESULTS
Spread of ENB to cervical lymph nodes was discovered in 13/45 patients (29%). Of the 13 patients, 4 (31%) were discovered to have lymph node involvement at initial staging, while 9 (69%) developed disease in the cervical nodes on surveillance examinations. Level II lymph nodes were involved the most frequently (all 13 cases). Level I (62%), Level III (54%) and retropharyngeal (38%) nodes also were involved frequently. Metastatic lymph nodes were predominantly solid and demonstrated marked contrast enhancement, often approaching the degree of enhancement of nearby blood vessels. Metastatic nodes were moderately or highly FDG-avid.

CONCLUSION
Esthesioneuroblastoma exhibits a predictable pattern of metastasis to cervical lymph nodes, spreading first to Level II nodes, with frequent involvement of Level I, Level III and retropharyngeal nodes. Metastatic lymph nodes have characteristic imaging features that can assist radiologists in the identification of nodal disease.

KEY WORDS: Esthesioneuroblastoma, lymph nodes, metastasis

Poster 122
Phosphaturic Mesenchymal Tumors of the Head and Neck: “Strange Tumors in Strange Places”
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PURPOSE
To describe the presentation and imaging features of phosphaturic mesenchymal tumors (PMTs) of the head and neck. Typically, these extremely rare tumors present in the soft tissues of the appendicular skeleton with less than 5% being craniofacial in origin.

MATERIALS & METHODS
Case 1: 35-year-old female who presented with 2 years of symptomatic phosphatemia including muscle spasms and excessive fatigue. Ultimately, she presented more acutely with worsening neck pain and spasms and MR imaging demonstrated a large, lobular-enhancing mass centered on the right lateral mass of C1 with destructive involvement of the posterior elements, extension into the paravertebral soft tissues and epidural space, destruction of the right skull base, petrous bone, and clivus, and extension into the right cerebellopontine angle. Subtotal resection confirmed the diagnosis of PMT. In retrospect the patient’s phosphatemia was related to tumor-induced osteomalacia (TIO) related to fibroblast growth factor 23 (FGF23) production. Case 2: 67-year-old female presented with 1-month history of unexplained depression and incontinence. MR imaging demonstrated a large (6 x 4.6cm), heterogenously enhancing, partially cystic, predominantly extraaxial left frontal mass with small areas of macroscopic fat. This mass appeared to arise from the region of the cribriform plate and CT demonstrated minimal extension into the ethmoid sinuses. Electrolytes, including calcium and phosphate, were normal at presentation. Biopsy and surgical resection confirmed the diagnosis of PMT only after the FGF23 gene showed positive amplification results.

RESULTS
While appendicular PMTs can be small tumors which can be difficult to localize, even when clinically suspected, our cases demonstrate that these infiltrating tumors can grow quite large when involving the skull base and cervical spine. The imaging findings of a large, heterogenously enhancing mass centered in bone with soft tissue spread should raise the possibility of PMT, especially in the correct clinical setting of TIO. Tumor-induced osteomalacia has been reported as the most common presentation of PMTs, but our second case demonstrates that even tumors that produce FGF23 can present with mass effect rather than hypophosphatemia. FGF23, however, can be monitored postoperatively as a serologic tumor marker for recurrence though, even in cases without TIO. In addition, the radiographic osteomalacia that often is reported with peripheral PMTs was not seen in either of our cases, even though the first case had a protracted course of symptomatic hypophosphatemia.

CONCLUSION
1. Phosphaturic mesenchymal tumors of the skull base and cervical spine can be quite large at diagnosis which is unusual for peripheral soft-tissue PMTs. 2. Even PMTs which pro-
duce FGF23 can present with mass effect alone with normal electrolytes. 3. In a patient with TIO and/or hypophosphatemia, PMT should be considered more strongly.

**KEY WORDS:** Phosphaturic mesenchymal tumor

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**Poster 123**

**Diffusion-Weighted Imaging of Parotid Gland Tumors**

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**PURPOSE**

The purpose of this prospective study was to identify the values of the apparent diffusion coefficient (ADC) with diffusion-weighted MR sequences in parotid gland tumors at 3 T.

**MATERIALS & METHODS**

Twenty-five patients with biopsy-proved parotid masses were examined on a clinical 3 T MR imager with a 16-channel head and neck coil. In addition to conventional MR sequences, a diffusion-weighted sequence (DWIBS) in the axial plane was acquired using b-values of 0 and 800 mm²/s. Apparent diffusion coefficient maps were calculated automatically. The tumors’ ADC values, as well as the ADC value of the contralateral parotid gland were measured by region of interest (ROI). T-tests were performed.

**RESULTS**

Histopathology revealed 12 pleomorphic adenomas, 6 Warthin tumors, 4 malignant tumors, 1 cyst, and 2 inflammatory masses (pseudotumors). Benign tumors showed a mean ADC value of 1.69 ± 0.45 (10⁻³ mm²/s), which thus was significantly higher (p < 0.001) than mean ADC values of normal parotid tissue (1.04 ± 0.13 x 10⁻³ mm²/s) or malignant tumors (1.01 ± 0.37 x 10⁻³ mm²/s). The highest ADC values (1.7 ± 0.4) among all entities were found in pleomorphic adenomas. Warthin tumors showed a mean ADC of 1.37 ± 0.37.

**CONCLUSION**

With DWI, benign parotid tumors can be differentiated with more confidence from malignant entities. However, because of the considerable overlap of ADC values, further differentiation within the benign group is difficult.

**KEY WORDS:** Pleomorphic adenoma, Warthin tumor

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**Poster 124**

**Hypertrophic Retro-Orbicularis Oculi Fat and Suborbicularis Oculi Fat in Thyroid-Associated Orbitopathy: A CT Analysis**

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**PURPOSE**

To compare the prominence of retro-orbicularis oculi fat (ROOF) and suborbicularis oculi fat (SOOF) in patients with thyroid-associated orbitopathy (TAO) to normal subjects using computed tomography (CT).

**MATERIALS & METHODS**

A retrospective analysis of orbital CT of 35 consecutive patients was performed from October 2005 to June 2009. Orbital CT interpreted as normal or significant for thyroid orbitopathy was selected. Images were acquired using helical 1.5 mm thick scans every 1.5 mm from just below the floor of the orbit to just above the roof of the orbit. Using the axial soft tissue windows, the ROOF and SOOF tissue were identified. The maximum ROOF thickness was measured perpendicular to the frontal bone, immediately superior to the supraorbital rim. Similarly, the maximum SOOF thickness was measured perpendicular to the zygomatic bone, immediately inferolateral to the infraorbital rim. The radiologist was blinded to the patient’s clinical history and the initial interpretation of the exam while conducting the measurements. Multivariate analysis of the two groups then was performed for comparison.

**RESULTS**

Seventy ROOF and SOOF measurements were obtained from 14 patients with TAO and 21 normal patients. The female-to-male ratio was 6 to 1 in the TAO group and 3 to 2 among the normal subjects. The mean axial ROOF thicknesses was 3.8 + 1.9 and 2.8 + 1.0 mm in patients with and without TAO, respectively, while the SOOF thickness was 4.4 + 1.0 and 3.4 + 1.0 mm in the two groups, respectively. After multiple linear regression, controlling for age, gender, and bilateral measurements, the TAO subjects’ ROOF and SOOF thicknesses were 1.2 mm (p = 0.002) and 1.0 mm (p < 0.001) greater than the control group. The ROOF model also revealed that subjects greater than or equal to 45 years of age had on average 0.8 mm (p = 0.03) thicker ROOF tissue compared to subjects under 45 years of age.

**CONCLUSION**

Retro-orbicularis oculi fat and suborbicularis oculi fat hypertrophy are two additional computer tomographic measures that may be valuable in the diagnosis of thyroid-associated orbitopathy.

**KEY WORDS:** Thyroid-associated orbitopathy, retro-orbicularis oculi fat, suborbicularis oculi fat
Poster 125

Seeking the Useful Findings of CT and MR Imaging for Detection of the Extranodal Spread in Patients with Head and Neck Cancer

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PURPOSE
Extranodal spread (ENS) of the head and neck cancer is very important because it influences locoregional and distant metastasis, survival, and treatment. We studied to find the useful CT and MR findings for the detection of extranodal spread (ENS) in metastatic neck nodes.

MATERIALS & METHODS
CT and MR imaging of 111 nodes in 69 patients with head and neck cancer were evaluated to seek the useful findings such as necrosis, diameter (longest, shortest), volume, and known CT and MR findings suggesting ENS. CT and MR findings suggesting ENS are indistinct nodal margin, irregular nodal capsular enhancement, and infiltration into the surrounding tissue. A node was considered to have ENS if a node has either one of above three findings. The results were compared with pathology from the surgical resection.

RESULTS
Useful CT and MR findings were necrosis > 90% (p = 0.006), shortest diameter of the node (p = 0.045), the longest and shortest diameter and the volume of node in the level II of the neck (p = 0.005, 0.001, 0.01, respectively), and three CT and MR findings suggesting ENS. Especially infiltration into the surrounding tissue is useful in contrast-enhanced CT and T2-weighted imaging, and indistinct nodal margin and infiltration in contrast-enhanced T1-weighted imaging.

CONCLUSION
We should be familiar with CT and MR findings that are useful to expect extranodal spread in patient with head and neck cancer.

KEY WORDS: Lymph node, cancer

Poster 126

How Many Biopsies Should Repeat in Patients with Inconclusive Thyroid Nodule?

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PURPOSE
We usually do biopsy for thyroid nodules with suspiciously malignant ultrasonographic findings. However, biopsy of the thyroid nodule with inconclusive or indeterminate nodule depends on decision of radiologist or physician. We evaluated how many biopsies should be performed in inconclusive or indeterminate thyroid nodule.

MATERIALS & METHODS
Two hundred seventy-nine nodules in 266 patients who had biopsies performed more than three times were enrolled in this study: 227 nodules, three times; 44 nodules, four times; eight patients, five times. We classified thyroid nodules in suspicious malignant, indeterminate, probably benign nodules depending on ultrasonographic findings. We classified the result of biopsy as benign, atypical, malignant, and inadequate result. We correlated the classified nodules with cytoplogic results.

RESULTS
Malignant result was seen in 3% (7/227) of three repeat biopsies, in 2% (1/44) of four, and in 0% of five. All eight malignant nodules had suspicious malignant findings on ultrasonography. There was no malignant result in thyroid nodules with indeterminate or probably benign findings on ultrasonography.

CONCLUSION
We recommend three repeat biopsies in inconclusive or indeterminate thyroid nodules.

KEY WORDS: Thyroid, biopsy

Poster 127

CT Perfusion as a Decision-Making Tool for Clinical Evaluation and Treatment in Head and Neck Disease

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PURPOSE
To present a comprehensive review of the current CT perfusion (CTP) data in head and neck disease and propose a decision-making algorithm based on these results for the evaluation and treatment of the studied conditions.
RESULTS
It has been shown through multiple studies that blood flow (BF), blood volume (BV), and capillary permeability (PS) generally are increased and mean transit time (MTT) is decreased in diseased vs nondiseased tissue. More specifically, MTT can be used to differentiate between benign tissue and malignancy to diagnose primary and recurrent cancer as malignant lesions were shown to have MTT values of < 3.5 s. This is a significant implication in the decision to treat as further chemo-radiation and/or surgical management would be selected if a suspicious lesion had an MTT of < 3.5 s. Management also can be selected according to CTP value-based prediction of tumor behavior. Tumor response after radiotherapy correlates with pretreatment perfusion and volume as an increased perfusion and a decreased volume indicate a better response with decreased local failure (1, 2). In addition BV is a very good predictor of response of squamous cell carcinoma to chemotherapy with a sensitivity of 91.7% and specificity of 80%. The curve of probability of response vs BV shows a value of 6.4 ml/100 g with a 90% chance of induction response. Therefore this value can be used as a cut-off; tumors with a BV of 6.4 or greater should be treated directly with chemo-radiation. Those with values significantly less than this should first undergo induction to increase in chance of loco-regional recurrence and thus definitive treatment would need to be considered immediately for these tumors.

CONCLUSION
CT perfusion in the head and neck is an excellent assessment tool of disease behavior and valuable for determining a general treatment algorithm, thus avoiding unnecessary delays or exposure to unneeded treatment and expediting definitive treatment.

REFERENCES

KEY WORDS: CTP, head, neck
Table 2. Percentage of metastatic nodes at each lymph node level according to primary site with average SUV.

<table>
<thead>
<tr>
<th>Primary location</th>
<th>N @ Primary location</th>
<th>I</th>
<th>II</th>
<th>III</th>
<th>IV</th>
<th>V</th>
<th>Avg SUV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oropharynx</td>
<td>23</td>
<td>2 (9)</td>
<td>20 (87)</td>
<td>10 (43)</td>
<td>2 (9)</td>
<td>0 (0)</td>
<td>8.4</td>
</tr>
<tr>
<td>Larynx</td>
<td>20</td>
<td>0 (0)</td>
<td>17 (85)</td>
<td>14 (70)</td>
<td>15 (75)</td>
<td>1 (5)</td>
<td>7.6</td>
</tr>
<tr>
<td>Palatine Tonsil</td>
<td>14</td>
<td>3 (21)</td>
<td>14 (100)</td>
<td>3 (21)</td>
<td>0 (0)</td>
<td>1 (7)</td>
<td>7.9</td>
</tr>
<tr>
<td>Oral Cavity</td>
<td>9</td>
<td>4 (44)</td>
<td>4 (44)</td>
<td>2 (22)</td>
<td>1 (11)</td>
<td>0 (0)</td>
<td>7.5</td>
</tr>
<tr>
<td>Tongue</td>
<td>7</td>
<td>2 (29)</td>
<td>6 (86)</td>
<td>3 (43)</td>
<td>0 (0)</td>
<td>0 (0)</td>
<td>6.1</td>
</tr>
<tr>
<td>Nasopharynx</td>
<td>5</td>
<td>1 (20)</td>
<td>5 (100)</td>
<td>0 (0)</td>
<td>0 (0)</td>
<td>3 (60)</td>
<td>9.42</td>
</tr>
<tr>
<td>Salivary Glands</td>
<td>2</td>
<td>0 (0)</td>
<td>2 (100)</td>
<td>1 (50)</td>
<td>0 (0)</td>
<td>0 (0)</td>
<td>11.2</td>
</tr>
<tr>
<td>Hypopharynx</td>
<td>1</td>
<td>0 (0)</td>
<td>1 (100)</td>
<td>0 (0)</td>
<td>0 (0)</td>
<td>0 (0)</td>
<td>9</td>
</tr>
<tr>
<td>Totals</td>
<td>81</td>
<td>12 (15)</td>
<td>69 (85)</td>
<td>33 (41)</td>
<td>6 (7)</td>
<td>5 (6)</td>
<td></td>
</tr>
</tbody>
</table>

Table 3. Percentage of ipsilateral and contralateral metastases according to primary site

<table>
<thead>
<tr>
<th>Primary location</th>
<th>N @ primary location</th>
<th># containing IL mets</th>
<th>% IL</th>
<th># containing CL mets</th>
<th>% CL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oropharynx</td>
<td>23</td>
<td>22</td>
<td>96%</td>
<td>14</td>
<td>61%</td>
</tr>
<tr>
<td>Larynx</td>
<td>19</td>
<td>19</td>
<td>100%</td>
<td>9</td>
<td>47%</td>
</tr>
<tr>
<td>Palatine Tonsil</td>
<td>14</td>
<td>13</td>
<td>93%</td>
<td>2</td>
<td>14%</td>
</tr>
<tr>
<td>Oral Cavity</td>
<td>9</td>
<td>8</td>
<td>89%</td>
<td>3</td>
<td>33%</td>
</tr>
<tr>
<td>Tongue</td>
<td>7</td>
<td>7</td>
<td>100%</td>
<td>2</td>
<td>29%</td>
</tr>
<tr>
<td>Nasopharynx</td>
<td>5</td>
<td>5</td>
<td>100%</td>
<td>3</td>
<td>60%</td>
</tr>
<tr>
<td>Salivary Glands</td>
<td>2</td>
<td>2</td>
<td>100%</td>
<td>0</td>
<td>0%</td>
</tr>
<tr>
<td>Hypopharynx</td>
<td>1</td>
<td>1</td>
<td>100%</td>
<td>0</td>
<td>0%</td>
</tr>
<tr>
<td>average</td>
<td></td>
<td></td>
<td>97%</td>
<td>0</td>
<td>26%</td>
</tr>
</tbody>
</table>

Conclusion

Our results were in agreement with the classic studies of nodal spread (1, 2) PET CT of primary head and neck cancer allows a more confident diagnosis of metastatic nodal involvement when morphologic changes are subtle or absent.

References


Key Words: Pet CT, lymph node, cancer

Poster 129

Comparative Imaging Characteristics of Central Skull-Base Chordomas and Chondroid Tumors

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Purpose

Advances in surgical technique now permit resection of a range of central skull-base tumors. Because lesions of differing histology represent a range of aggressiveness, accurate preoperative identification of tumor type is an important aid to treatment planning. Two lesions that are found at the skull base, chordoma and chondroid tumor, not uncommonly present a difficult diagnostic choice. This study attempts to identify imaging characteristics that can assist in differential diagnosis.

Materials & Methods

The radiology and pathology databases at our institution were searched for patients with a previously untreated central skull-base chordoma or chondroid tumor. Both preoperative MR imaging and CT were available for most patients, a few had only MR imaging or CT. CT and MR images were searched for an osseous origin for the lesions. Signal level within the lesion was quantitatively evaluated on T2-weighted sequence. Postcontrast MR enhancement was evaluated relative to that of normal white matter. CT bone windows were examined for intraleisional matrix.

Results

The majority of lesions showed an identifiable osseous origin on either MR imaging or CT. This generally was fairly broad based, but a significant number of tumors demonstrated a narrow “beak” appearance where a small intraosseous lesion broke through the cortex to produce a larger extraosseous component. Visible origin from the clivus was highly specific for chordoma, similarly origin from the medial petrous apex or at the petroclival synchondrosis was specific for chordoid lesion. Both lesion types demonstrated generally high T2 signal with a few outliers; the difference between the two tumor types did not reach statistical significance. The chordoid lesions did show significantly greater enhancement on postcontrast MR images. Less than 20 percent of lesions demonstrated internal calcific density detectable on CT. This did not differentiate between the two tumor types, and was seldom in an identifiable “arcs and rings” chordoid pattern. Well formed narrow linear “cords” of signal intensity were detectable on pre or postcontrast T1-weighted images in about one sixth of the chordomas, but not in any chordoid tumors.

Conclusion

The most accurate sign for differential diagnosis was the anatomical location of osseous origin when visible. This corresponds to the generally accepted origin of chordomas from notochordal remnants and of chordoid lesions from chordoid rests often found at synchondroses. Elevated T2 signal was present in both types of lesion and did not distinguish them. As a class chordoid lesions enhanced significantly more than chordomas. A visible internal matrix was uncommon and did not assist in diagnosis. An MR identifiable pattern of “cords” within the lesion was found in a minority of
chordomas, but not in any chondroid lesions. This may relate to the known histologic tendency of chordomas to form sheets of cells.

**KEY WORDS:** Chordoma, chondroma, chondrosarcoma

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**Poster 130**

**Sensorineural Hearing Loss: CT Study of Lateral Semicircular Canal Morphology**

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**PURPOSE**

Association between the small lateral semicircular canal (LSCC) and sensorineural hearing loss (SNHL) is controversial. Our purpose was to determine whether there is association between the two using CT-based measurement.

**MATERIALS & METHODS**

We retrospectively reviewed the high-resolution images of the temporal bone obtained with a 64-detector CT at our hospital. Images were reconstructed at a 0.5 mm thickness. Patients who had any abnormality in the middle ear or the inner ear other than the LSCC were excluded. Two radiologists independently measured the width and cross-sectional area of the bony island of LSCC. We evaluated the correlation between LSCC bone island width or cross-sectional area and hearing level in all cases using Pearson correlation coefficients. In addition, we compared hearing levels among the patient group with normal-sized LSCC (≥ mean-SD), small LSCC (< mean-SD) and very small LSCC (< mean-2SD) as defined by the width and cross-sectional area of the bony island using Student’s t-test.

**RESULTS**

A total 136 years of 68 patients (25 men and 43 women; age range: 20 to 85 years old, mean 49.8 years) were included in this study. No significant correlation was shown between LSCC bony island width or cross-sectional area and hearing level (P > 0.05). No significant difference in hearing levels were found among groups of the normal-sized, small and very small LSCC (P > 0.05).

**CONCLUSION**

We concluded that there was no association between the small LSCC and SNHL.

**KEY WORDS:** Lateral semicircular canal, sensorineural hearing loss, CT

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**Poster 131**

**Vertebral Artery Doppler Ultrasound in Intracranial Hypotension Syndrome**

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1Cerrahpasa Medical School, Istanbul, TURKEY, 2Bakirkoy Sadi Konuk Hospital, Istanbul, TURKEY

**PURPOSE**

The objective is to evaluate whether spontaneous intracranial hypotension syndrome (SIHS) has an effect on vertebral artery flow.

**MATERIALS & METHODS**

Twenty-two consecutive patients, 13 men and 9 women, with the diagnosis of SIHS were enrolled in the study. The mean (± standard deviation) age of the patients was 37.50 years (±8.59 years). The Doppler ultrasound (DUS) examination was performed after contrast-enhanced MR imaging (MRI) and before MR myelography examinations. The peak systolic velocity (PSV), end-diastolic velocity (EDV), pulsatility index (PI), resistive index (RI) and blood flow volume (BFV) were measured while the patient was at an upright position and was supine on the examination table. The findings on right and left side separately and average for the right and left sides were recorded. All data are expressed as mean ± SD. Twenty-two healthy sex- and age-matched volunteers also were examined with the same DUS protocol. The physician who performed the DUS examination was blinded to the patients’ diagnosis. Statistical analysis included analysis of variance (ANOVA) of the spectral DUS indices between SIHS group and healthy volunteers, Student t-test for side to side differences and Student t-test for differences between an upright and supine position.

**RESULTS**

In the SIHS and control group upright mean PSV (average 47.52 ± 10.02, average 47.01 ± 10.01), EDV (average 16.74 ± 4.80, average 17.82 ± 5.72), PI (average 1.22 ± 0.36, average 1.20 ± 0.42), RI (average 0.63 ± 0.08, average 0.63 ± 0.13) and BFV (average 85.13 ± 26.57, average 92.79 ± 30.70), and supine mean PSV (average 53.51 ± 10.79, average 52.77 ± 16.07), EDV (average 19.54 ± 5.26, average 19.91 ± 6.55), PI (average 1.10 ± 0.28, average 1.10 ± 0.29), RI (average 0.62 ± 0.07, average 0.61 ± 0.08) and BFV (average 101.88 ± 25.35, average 111.21 ± 36.65) were not statistically significant. Statistical analysis was insignificant for side to side differences among groups. In the SIHS group the PSV, EDV and BFV were significantly higher in the supine position when compared to upright position (p = 0.028, p = 0.008, p = 0.024, respectively). The PI was significantly higher in the upright position in the SIHS group (p = 0.017). Such a statistical significance was not observed in the control group except for the decreased upright BFV when compared to supine position (p = 0.022).

**CONCLUSION**

Increase in PI in erect position, and decrease in PSV, EDV, and BFV may be attributed to the downward displacement or sagging of the brain and subsequent compression of vascular structures in front of the brainstem.

**KEY WORDS:** Vertebral artery, Doppler ultrasound, spontaneous intracranial hypotension syndrome
Poster 132

Endovascular Treatment of Very Small Ruptured Intracranial Saccular Aneurysms

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1 University of Wisconsin, Madison, Madison, WI, 2 University of South Carolina, Charleston, SC

PURPOSE
The role of endovascular treatment for very small (≤3 mm) ruptured intracranial aneurysm remains unclear. Some authors have reported an intraprocedural rupture risk for very small aneurysms to be five times higher than that of larger aneurysms (11% versus 2%) (1). Other authors have suggested that the adjunctive use of balloon-remodeling may allow temporary tamponade in the event of rupture, reducing poor outcomes (2).

MATERIALS & METHODS
An internal database was searched for ruptured saccular intracranial aneurysms ≤3 mm. Between February 2004 and November 2009 26 patients with subarachnoid hemorrhage from saccular cerebral aneurysms ≤3 mm in size were evaluated. Patients with dissecting aneurysms were excluded.

RESULTS
There were 10 males and 16 females, with ages from 35 to 81 years. CT angiography was performed before catheter angiography in 22 patients and accurately predicted aneurysm location in 20 patients (91%). The most common aneurysm location was the anterior communicating artery (14 patients, 54%). Endovascular treatment was undertaken in 23 patients: 22 were coiled (two with stent assistance), and one was double-stented initially and coiled 1-month later. Four patients were initially treated with microsurgical clipping, but one of these required coiling for a residual that re-hemorrhaged. Balloon-remodeling was performed in seven cases. Intraprocedural complications included asymptomatic thromboembolism in three patients (13%) and intraprocedural aneurysm rupture in three patients (13%). One patient who underwent balloon-remodeling suffered a thromboembolic complication. Furthermore, temporary balloon-tamponade was used in one of the cases of intraprocedural rupture. Of the endovascularly-treated aneurysms, the Raymond score was zero (no residual) for 12 patients (53%), one or two (dogear or filling at the neck) for four patients (17%) and three (partial filling of the aneurysm) for seven patients (30%) immediately following treatment. No aneurysms rehemorrhaged after endovascular treatment. Follow-up MR angiography (MRA) was obtained in 15 patients a mean of 22.4 months after endovascular treatment. Eleven patients had no residual (73%), three had filling at the aneurysm neck (20%) and one had partial filling of the aneurysm (7%).

INTERVENTIONAL
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Poster 133

Trigeminocardiac Reflex in a Child during Onyx Embolization for Juvenile Nasopharyngeal Angiofibroma

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PURPOSE
We report a case of reflex sinus bradycardia in a child, as a component of the trigemino-cardiac reflex (TCR), during slow injection of dimethyl sulfoxide (DMSO) in preparation for tumor embolization with Onyx. Trigemino-cardiac reflex is fully manifest with sinus bradycardia, systemic hypotension, apnea, and gastric hyper-motility resulting from stimulation of any of the sensory branches of the trigeminal nerve.

MATERIALS & METHODS
The patient is a 10-year-old boy with a history of epistaxis and CT findings of a left nasopharyngeal mass. Attempted excision at an outside institution was aborted due to intraoperative bleeding, and pathology was consistent with juvenile nasopharyngeal angiofibroma (JNA). He was referred to Children’s Hospital Boston for preoperative embolization followed by resection.

RESULTS
General anesthesia was induced using sevoflurane and nitrous oxide and maintained with sevoflurane. A guide catheter was positioned in the left external carotid artery distal to the facial artery origin. An Echelon 14 (ev3, Irvine, CA) microcatheter was advanced into the distal left internal maxillary artery, where selective injection demonstrated all flow to be directed towards the tumor. During preparation for embolization with Onyx, as the dead space of the microcatheter was slowly filled with DMSO, there was an acute onset of bradycardia to the 40s. Rapid administration of 0.4 mg of Atropine by the anesthesiologist led to normalization of the patient’s heart rate, and there was no other physiologic instability. Thereafter, embolization was performed using polyvinyl alcohol particles and detachable coils, with no further episodes of bradycardia. After embolization, the patient was extubated and found to be at his neurologic baseline.

REFERENCES

KEY WORDS: Subarachnoid hemorrhage, cerebral aneurysm
Resection was grossly complete, with minimal intraoperative blood loss. The TCR has been described previously during craniofacial surgery, surgery in the cerebellopontine angle, skull-base surgery, transnasal sphenoidal surgery, and during trigeminal sensory root rhizotomy. There has been a single case report of TCR manifest during Onyx embolization of an intracranial dural fistula but no prior reports of TCR during extracranial embolization. The TCR reflex occurs due to stimulation of the sensory nerve endings of the trigeminal nerve, which transmit impulses to the sensory nucleus of the trigeminal nerve via the gasserian ganglion. Sensory nucleus neurons connect to the motor nucleus of the vagus via the reticular formation, and cardio-inhibitory fibers from the vagal motor nucleus terminate in the myocardium to complete the reflex arc. In some cases, cessation of the offending stimulus can lead to disruption of the reflex and return to baseline, though vagolytics and possibly sympathomimetics may be needed. When procedures involving the sensory territory of the trigeminal nerve are planned, it is important to be cognizant of this reflex, so that quick action can be taken if needed.

**CONCLUSION**

We report the occurrence of the trigemino-cardiac reflex during Onyx embolization from the internal maxillary artery. Familiarity with this clinical reflex and its proper management is important when neurointerventional procedures that may involve DMSO injection in the trigeminal territory are undertaken.

**KEY WORDS:** Trigeminocardiac reflex, embolization, juvenile nasopharyngeal angiofibroma

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**Poster 134**

**Assessing the Severity of Vasospasm after Subarachnoid Hemorrhage Using Dyna-CT to Measure Cerebral Blood Volume: A Feasible Method for the Neuro-ITU Patient**

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¹University of Oxford, Oxford, UNITED KINGDOM, ²Siemens AG, Healthcare, Forchheim, GERMANY

**PURPOSE**

Developments in flat detector technology and high-frame rate rotational angiography can be exploited to estimate cerebral blood volume (CBV) (1). The speed and ease of measurements in patients with altered cerebral hemodynamics in the angiography room has the potential to provide a single investigation to select patients for angioplasty. To assess the feasibility of this approach, accuracy of CBV estimates was compared with MR perfusion-weighted imaging (MR PWI).

**MATERIALS & METHODS**

Patients from the neurointensive treatment unit (ITU) with suspected vasospasm were scanned using a biplane angiography system (Axiom Artis dBA; Siemens Healthcare, Germany). The imaging protocol comprised of two 8-seconds rotational acquisitions: mask and contrast-enhanced runs, each comprising 419 projections at 0.5 degree steps. Cerebral blood volume maps were constructed after registration of the two volumes, voxel-by-voxel subtraction, and normalization with an automatically estimated input function. The reconstruction is done on a dedicated prototype software (Siemens AG, Healthcare). MR PWI scan was performed contemporaneously to obtain CBV values for comparison. Relative CBV (rCBV) values, calculated for the gray and the white matter regions of interest (ROIs), placed on the coregistered CBV maps, were analyzed using Pearson correlation and Bland-Altman test to explore the agreement between the two techniques.

**RESULTS**

For the two techniques, CBV parametric maps were similar and the rCBV values measured for gray and white matter ROIs had good correlation (gray matter $r = 0.73$, $p < 0.001$; white matter $r = 0.96$, $p < 0.001$; overall $r = 0.84$, $p < 0.001$). Bland-Altman analysis showed a level of agreement between the rCBV values measured using C-arm system and MR-PWI (95% limits of agreement ranged from: -0.218 to 0.239 for gray matter ROIs, -0.0715 to 0.0615 for white matter ROIs, and -0.165 to 0.171 for combined gray and white matter ROIs) that included clinically significant rCBV discrepancies. Bias in measurements was minimal (gray matter ROIs 0.011; white matter ROIs -0.005; combined gray and matter ROIs 0.0029).

**CONCLUSION**

Our results demonstrate the feasibility of CBV measurement using C-arm technique in the neuro-ITU patient with altered cerebral hemodynamics that would assist decision making in patients with suspected delayed neurologic deficits after SAH. The ability to measure a physiologic parameter, known to be of prognostic significance in patients with acute stroke (2), inside the neuro-interventional room has implications for the management of patients with other causes of cerebral ischemia. A combination of this capability with the existing Dyna-CT facilities of generating angiographic and parenchymal soft tissue images could help in the triage of patients with acute stroke in an optimized interventional environment, reducing time delays between diagnosis and treatment stages.

**REFERENCES**


**KEY WORDS:** Vasospasm, CBV, flat-detector CT
**Poster 135**

**Temporal Evolution of Thromboembolic Ischemic Stroke in the Canine Model**

Mehra, M. • Walvick, R. P. • Wakhloo, A. K. • O’Callaghan, J. M. • Gounis, M. J.

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Worcester, MA

**PURPOSE**
To characterize the evolution of ischemic infarction in the thromboembolic acute ischemic stroke model in dogs.

**MATERIALS & METHODS**
Ten purpose bred adult beagle dogs (Mean weight: 10.02 kg) were maintained under general anesthesia as per the procedures approved by our Institutional Animal Care and Use Committee. Autologous blood clot was prepared by injecting a mixture of whole blood with bovine thrombin and barium into the silicone tube (ID: 2.4 mm and 1.98 mm) 24 hours prior to stroke. Stroke Induction: Following baseline MR imaging, a 5F catheter was delivered to the selected internal carotid artery (ICA) under fluoroscopic guidance to inject the clot (Mean diameter: 2.33 mm, mean length: 1 cm). Catheter angiography was performed to confirm the clot location and the animal was shifted to the MR imaging suite. MR imaging was performed on a 3.0 T system using an 8-channel receive only SENSE knee coil and serial diffusion (prestroke and 00:24,1:11,2:37,4:04 hours poststroke) and perfusion (1:40,4:01 hours poststroke) sequences were acquired. Animals then were euthanized and the coronal brain sections were stained with 2% 2,3,5-triphenyltetrazolium chloride (TTC). Image analysis: apparent diffusion coefficient (ADC) maps were generated and imported into Matlab (Mathworks, Natick, MA). Apparent diffusion coefficient values below 0.53 *10^-3 mm²/s were identified and segmented. Volumes were derived by taking the product of the segmented area and the slice thickness (3 mm). Time-to-peak perfusion images were analyzed using Philips Viewforum software.

**RESULTS**
Thrombolysis in myocardial infarction (TIMI) grade 0 flow was induced successfully with an embolus lodged in the middle cerebral artery in all animals. The perfusion imaging revealed hypoperfused brain with heterogeneous severity due to the variability of collateral circulation. The final infarct size, as determined by the ADC decrease, was 7579.61 ± 1769.96 mm³ (mean ± standard error of the mean) approached the mean perfusion lesion (7836.03 ± 1082.07mm³) and was found comparable to lesion volume measured histologically using TTC (7482.95 ± 1546.44 mm³). The infarct evolved rapidly to the volume of the perfusion deficit, reaching 95% within the first 60 minutes of ischemia (Figure).

**CONCLUSION**
There are a number of advantages to a nonprimate, gyrencephalic preclinical model of acute ischemic stroke. The results presented here provide essential baseline characteristics of the canine thromboembolic ischemia model for preclinical testing of stroke treatments.

**KEY WORDS:** Stroke, penumbral imaging, animal model

**Figure:** Representative TTP map and DWI for each time point. Data show growth ADC lesion as percent of hypoperfused volume.

**Poster 136**

**Ex Vivo Modeling of Cerebral Emboli-Mimicking Clots**

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**PURPOSE**
Mechanical endovascular treatment (MET), such as thrombectomy or stenting, of acute ischemic stroke is evolving rapidly. Criteria for successful preclinical evaluation of these devices are efficacy (ability to recanalize an occluded vessel) and safety (vascular histopathology). However, the mechanical properties of the clot models employed in these evaluations have never been studied nor compared with human sources of arterioembolic or cardioembolic clots. The aim of this study is to explore the structure and mechanical properties of the possible sources of the cerebral emboli extracted from patients and model clots produced in vitro using human, porcine and bovine donors.

**MATERIALS & METHODS**
Patients’ thrombi removed from carotid atherosclerotic plaques and in vitro human, porcine and bovine clots were examined. Three variables of in vitro clotting included species, thrombin concentration and addition of barium sulfate. The stress-strain relationship of each specimen was monitored with dynamic mechanical analyzer (TA Instruments, DMA Q800, New Castle DE) in the controlled force mode. A creep experiment was conducted in which the clot sample was subjected to a constant stress causing an initial strain of 70% for 5 min, followed by a recovery period.
of 15 min. Scanning electron microscopy (SEM), and Martius Scarlet Blue (MSB) stained sections were used to investigate the structure and composition of the clots.

**RESULTS**

Two secant moduli, designated as E1 and E2, were calculated from the toe region (initial to 75% strain) and high strains (75%–95%) of the stress-strain curve, respectively. As compared to the in vitro human clot models, bovine clot had higher fibrin density and higher E1 and E2 (p < 0.05). It also had a higher strain recovery (30%) as compared to that of the porcine and human clots (10%). Addition of thrombin (5 NIHU/ml blood) significantly increased the secant moduli of the human and porcine clot models. Less clot shrinkage and an increase of E1 in human clot models were seen in the presence of barium sulfate. A layer of dense fibrin network was formed on the surface of the in vitro clot models; whereas, thicker fibrin fibers were observed within patients’ thrombi. The white thrombus exhibited greater moduli than those of the red thrombus. E1 and E2 of the red thrombus were 276.5 and 5847.1 Pa, respectively, which were similar to those of the in vitro human clot with 5 NIHU thrombin/ml blood (208.84 and 5305.67 Pa, respectively).

**CONCLUSION**

Donor species and preparation methodology generates large variations in the hardness, elasticity, and structure of the in vitro clot models. In our initial study, bovine clots have the highest moduli, followed by porcine and human clot models. We continue to extract clots that could potentially lead to an embolic stroke from patients in order to provide a library of mechanical properties that will provide a framework to further develop clot models. These validated clot models will provide a more realistic preclinical evaluation of new MET devices.

**KEY WORDS:** Acute ischemic stroke, clot modeling, interventional neuroradiology

**Poster 137**

**Initial Presentation Time on Door-to-Therapy Time for Intraarterial Stroke Therapy**

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**PURPOSE**

It has been demonstrated that good clinical outcome after ischemic stroke is dependent upon time to revascularization. There also is literature that suggests patients with ischemic strokes experience higher mortality rates when admitted during times that hospitals do not have their regular staff compliments (“the weekend effect”). Our institution utilizes a Comprehensive Stroke Team with Joint Commission accreditation as a Primary Stroke Center. Two dedicated neurinterventional radiologists are part of the Stroke Team and offer intraarterial stroke therapy 24 hours daily. Stroke Team attending physicians are present in-house during normal workday hours including weekend mornings. Residents and fellows initially evaluate patients at other times. We reviewed our 4-year database of patients who received intraarterial stroke therapy that either presented directly to our emergency department or who were transferred for stroke and received intraarterial therapy. Specifically, we evaluated time-of-day presentation to determine effect on door-to-therapy times.

**MATERIALS & METHODS**

Fifty-eight patients were found to have been treated only with intraarterial therapy (intraarterial thrombolytics, mechanical thrombectomy, or both) for ischemic stroke over the past 4 years at our institution. Of these, 32 patients presented either directly to our emergency department or were transferred to our hospital for the acute care of CVA-like symptoms. Complete records were available initially for 29 of these patients. We compared arrival times to our institution with treatment initiation times as recorded in our PACS system. We separated patients into two groups based on their initial presentation time to our hospital: “Staff” patients presented from 8 am to 6 pm Monday to Friday or from 8 am to noon on the weekend/holidays, and “Resident” patients fell outside of these times.

**RESULTS**

Data shows significant differences (p = 0.03) between the average door-to-therapy times for “Staff” (n = 17, range = 29 to 241 minutes) and “Resident” (n = 12, range = 61 to 761 minutes) patients, with the average time to treatment for “Resident” patients taking approximately 2 hours more (152.0 minutes vs 280.5 minutes, mean difference = 128.5 minutes, 95% CI = 14.3 to 242.7 minutes).

**CONCLUSION**

Our analysis shows an approximate 2-hour delay in the initiation of intraarterial stroke therapy for candidate patients with ischemic stroke who present to our institution outside of the hours of normal attending in-house coverage. We will continue to evaluate data to apply the above evaluation to vessel-specific therapy as well as identification of variables affecting the time differences. Once variables that adversely affect patient treatment times are identified, these can be minimized within our institution. We may determine communication between Stroke Team members, prioritization of stroke imaging, resident call responsibilities and attending availability, as well as other variables may all affect door-to-therapy times. Furthermore, 24-hour in-house attending coverage may offer a distinct advantage over the resident coverage model.

**KEY WORDS:** Stroke, intraarterial, time
In Vitro Quantitation of Coil Homogeneity within a Model of Cerebral Aneurysm as a Function Coil Design

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PURPOSE
To study the variation in the homogeneity of coil distribution compartmentalization using helical, complex and the new DeltaPaq microcoil systems (Micrus Endovascular, San Jose, CA).

MATERIALS & METHODS
Coiling Procedure: Seven sidewall silicon aneurysm models having an 8 mm dome in each arm (Arm I: Cashmere, Arm II: Helipaq, Arm III: DeltaPaq) were packed underfluorescopic guidance using a pulsatile flow loop. Coiling ceased after complete aneurysm obliteration, catheter dislodgement from aneurysm, or herniation of coil loops. Aneurysm Sectioning: The coiled silicon aneurysm models were embedded in low viscosity epoxy embedding medium (Spurr’s Resin, SPI Supplies, West Chester, PA) and sectioned using a low speed saw (Buehler; Lake Bluff, IL) to obtain sections at the neck and two on either side of the center of the aneurysm dome. The sections then were mounted on the slides, ground, polished and imaged. Image Analysis: The images were imported into Matlab (Mathworks, Natick, MA) and sectioned using a low speed saw (Buehler; Lake Bluff, IL) to obtain sections at the neck and two on either side of the center of the aneurysm dome. The sections then were mounted on the slides, ground, polished and imaged. Image Analysis: The images were imported into Matlab (Mathworks, Natick, MA) and mask was overlaid to confine the analysis to the aneurysm. The resultant image was divided into radial regions of interest, 8 for the neck and 24 for the dome sections. The number of pixels from thresholding that represent the coil mass was divided by the number of pixels within the region of interest. The fractional surface area calculation provided a quantitative endpoint representing the percentage of the given ROI that was consumed by coils. For a given section, the standard deviation of the surface area fractions is inversely proportional to the uniformity of coil distribution.

RESULTS
The surface area fractions (SAF) for both the neck and the dome sections were independent of the coil design (range 41-49%) and were not a function of packing density (p > 0.05). In the analysis of the dome region it was found that the DeltaPaq was distributed more uniformly in comparison to the larger Cashmere and the Helipaq coil systems (p = 0.018, ANOVA). Conversely, the uniformity of the neck sections was not dependent on the coil type. The uniformity index of the dome region correlated with the packing density (R = 0.48, p = 0.029), however this relationship was not observed for the neck sections.

CONCLUSION
The DeltaPaq system that features a novel primary wind design with a triangular profile and microscopic rotating rings, achieves a more homogenous distribution of coil mass across the aneurysm dome in comparison to the complex or helical coil systems, even though the surface area fractions are comparable. Permeability that affects particle residence times and intraneurysmal thrombosis, may be related to coil distribution. Future studies may elucidate this relationship. Our results taken in combination with the literature imply that achieving a higher uniformity of coil distribution along with a higher packing density as requisite parameters for coil design may enhance the durability of endovascular treatment of cerebral aneurysms.

REFERENCES

KEY WORDS: Brain aneurysm, coil embolization, coil mass distribution

Poster 139
Matrix2 Coils for Endosaccular Occlusion of Intracranial Aneurysms: Comparison of 1-Year Outcomes with Bare Platinum Coil Cohort

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PURPOSE
The durability of aneurysm occlusion has shown limitation in matrix coil as well as in the bare platinum coil (BPC). To overcome limited durability, in Matrix2, the percentage of polyglycolic acid-lactic acid were reduced from 70% to 30%. We evaluated the 1-year outcomes of the Matrix2 coil by comparing historical control of BPC.

MATERIALS & METHODS
The 121 consecutive aneurysms in 114 patients were embolized in our institution by using Matrix2 coils between April 2006 and September 2008. The historical control group consists of 151 aneurysms in 137 patients who underwent coil embolization by using BPCs alone during the period from October 2007 to October 2008. The initial endosaccular coiling outcomes including packing densities, occlusion grades, and complications, and the 1-year follow-up outcomes on MR angiography were compared between Matrix2 coil group and BPC group.

RESULTS
The Matrix2 coil group and BPC group with similar baseline demographic characteristics revealed comparable initial endosaccular coiling outcomes. The rates of overall recurrence, major recanalization, and retreatment of the Matrix2 coil and BPC were 17.4% (21/121) vs 7.3% (11/151), 14.0% (17/121) vs 5.3% (8/151), and 10.7% (13/121) vs 4.6%, respectively (p = 0.066). However, those with aneurysm volume between 50 mm3 to 200 mm3 were 23.7% (9/12) vs 2.2% (1/151), 10.5% (4/121) vs 0%, and 10.5% (4/121) vs 0%, respectively (p = 0.022). Those with packing density less than 30% were 38.3% (18/47) vs 13.3% (8/60), 31.9% (15/47) vs 11.7% (7/60), and 23.4% (11/47) vs 10% (6/60), respectively (p = 0.025). There were no differences of mean
packing density \((p = 0.152)\), initial occlusion grade \((p = 0.098)\), 1-year follow-up outcomes \((p = 0.209)\) according to the length of Matrix² coils used.

**CONCLUSION**
The initial coiling outcomes including complications, packing densities, and occlusion grades of Matrix² coil are comparable to those of BPC on our single center experience, but the 1-year durability of Matrix² is inferior to that of bare platinum coils in specific subclass of aneurysm volume and packing density. Despite the cost and technical disadvantages, there is no benefits from the use of Matrix² coil over the use of BPC.

**KEY WORDS:** Matrix², coil, durability

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**Poster 140**

**Revascularization with MERCI Retrieval Device in Conjunction with Intravenous and/or Intraarterial Tissue Plasminogen Activator Is Feasible to Achieve Favorable Outcome in Patients with Acute Ischemic Stroke in Posterior Circulation: A Single-Center Experience**

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**PURPOSE**
Posterior circulation ischemic strokes are associated with high morbidity and mortality. Endovascular thrombolytic treatment results in some but not optimally improved outcomes. We report our experience with endovascular clot retrieval and disruption using the MERCI device and tissue plasminogen activator in these cases. Objectives: We hypothesize that revascularization of posterior circulation in acute ischemic stroke by means of MERCI retrieval device in conjunction with intravenous and/or intraarterial tissue plasminogen activator can generate encouraging outcome.

**MATERIALS & METHODS**
From August 2003 to December 2007, 12 patients, eight male (66.6%) and four female (33.3%) aged from 22 to 85 years (median 63 years) with symptoms compatible with acute stroke in posterior circulation were treated with the MERCI device and/or tissue plasminogen activator. Nine patients (75%) presented with clot in basilar artery, one patient (8.3%) presented with clot in both vertebral arteries, one patient (8.3%) with clot in both vertebral and basilar artery and, one patient (8.3%) occluded the basilar artery after GDC coiling for subarachnoid hemorrhage. Nine patients (75%) also were treated with tissue plasminogen activator (tPA). Two of the nine patients (22.2%) received only intravenous (iv) tPA in emergency room (ED), and three patients (33.3%) received both iv tPA in the ED and intraarterial (IA) tPA after clot retrieval. Four patients (44.4%) received IA tPA in the distal territories after clot retrieval. Seven patients (58.3%) were treated with the L6 device, one patient (8.3%) with L5 device, two patients (16.6%) with LX, one patient (8.3%) with X5, and one patient with X6. The balloon-guide catheter was placed in subclavian artery and was inflated during clot retrieval for flow arrest. All cases were assessed clinically before and after the procedure with a neurologic examination and baseline National Institute of Health Stroke Scale (NIHSS) score. Outcome measures were (1) Improvement in NIHSS score at discharge, (2) Revascularization as measured by end of procedure TICI score, (3) In hospital mortality, (4) Symptomatic intracranial hemorrhage (SICH), and (5) 90 days mRS.

**RESULTS**
Technical success as measured by postprocedure TICI of 2-3 was achieved in 91.6% (11/12). Of those revascularized cases, 36% (4/11) had discharge NIHSS of 0-1 and 45% (5/11) had mRS scores of 0-2 at 90 days. Mortality rate was 41% (5/12), two of whom had SICH.

**CONCLUSION**
1. A high degree of technical success is achieved using the Merci device for posterior circulation strokes. 2. Although the mortality rate remains high, it is approximately half that reported in untreated cases. 3. It is reasonable to offer treatment with mechanical embolectomy to patients with posterior circulation stroke.

**KEY WORDS:** Interventional neuroradiology, brain and stroke, posterior circulation

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**Poster 141**

**Effect of Iodixanol on rt-PA Thrombolysis in Human Clots**

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**PURPOSE**
Iodinated contrast material has been associated with anticoagulation, thrombus formation, and reduced response to thrombolysis in different studies. We studied whether iodinated contrast material may inhibit thrombolysis of human clots in vitro.

**MATERIALS & METHODS**
An established, validated method was used to form human whole blood clots in vitro. The clots were exposed for 30 minutes at 37 degrees Celsius to 1 mL of a 50%/50% combination of iodixanol [Visipaque 270 (270 mgI/mL); GE Healthcare, Waukesha, WI] and human fresh frozen plasma containing rt-PA (1-10 microgram/mL). Clot lysis was measured over time, using a video microscopic imaging technique. The fractional clot-width loss (FCL) over the last 15 minutes was used to quantify lytic efficacy. Data were compared with established control data. Data are reported as means with standard errors. Student’s t-test was used to compare among groups and a \(p < 0.05\) was considered significant.

**RESULTS**
Clots exposed to rt-PA and iodixanol lost approximately 28% +/- 4 of the total clot width within 30 minutes. Within the first 15 minutes, lysis paralleled the effects of rt-PA alone in the absence of contrast. The contrast curve plateaued and
diverged from the no-contrast curve after 15 minutes (Figure). Lysis of clots exposed to iodixanol in plasma (11% +/- 5) was similar to that of the control group (14% +/- 0.7) over 30 minutes. Clots exposed to rt-PA alone lost approximately 38% +/- 0.8 of the clot width over 30 minutes. The addition of iodixanol decreased FCL for rt-PA treated clots (P = .0002).

**CONCLUSION**

Iodixanol may inhibit thrombolysis of blood clots with rt-PA. There is no difference between the iodixanol and control groups in clot lysis in the first 15 minutes. Apparent decrease in lysis after 15 minutes is of uncertain significance and additional further studies will be required to examine this observation.

**KEY WORDS:** Contrast material, thrombolysis

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**Poster 142**

**Hemodynamics in a Cerebral Aneurysm that Bled after Treatment with a Flow Diverting Stent**

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**PURPOSE**

To analyze the hemodynamic conditions created by a flow diverting device used to treat a cerebral aneurysm that ruptured 4 days after treatment.

**MATERIALS & METHODS**

A giant aneurysm in the left internal carotid artery at the superior hypophysal origin was imaged with 3D rotational angiography and treated using a braided flow diverting stent. The parent artery had a mild (50%) stenosis just proximal of the aneurysm neck. When the stent was deployed, the proximal end did not open fully, therefore a balloon was used to expand the stent. This maneuver not only opened the stent, it also compacted the stent wires at the aneurysm neck and reduced the degree of stenosis to about 20%. A subsequent angiogram revealed little or no contrast entering the aneurysm and the patient was released. Four days later the aneurysm ruptured and the patient died. A patient-specific computational fluid dynamics model was created to study the hemodynamics in this aneurysm before and after stenting.

**RESULTS**

The present model shows flow acceleration at the proximal stenosis and high speed blood entering the aneurysm, creating a complex flow recirculation pattern within the aneurysm, and a region of high wall shear stress near the flow impaction zone in the aneurysm body. Additionally, the stenosis induced a peak pressure drop from the proximal artery to the aneurysm of approximately 25 mmHg. After stenting and balloon remodeling, the aneurysm inflow, the intraaneurysmal velocity and wall shear stress were reduced substantially. The partial resolution of the stenosis resulted in a reduction of the pressure drop from the proximal parent vessel. Therefore, this caused the intraaneurysmal peak pressure to increase by about 20 mmHg.

**CONCLUSION**

This study introduces the notion that the reduction of the pressure drop at a proximal stenosis during the treatment of a cerebral aneurysm with flow diverting devices can potentially result in an increased intraaneurysmal pressure. This then may cause the aneurysm to rupture. This effect is not linked to a specific device, it is connected to the patient-specific anatomy. Personalized virtual stenting models can help us identify patients at a higher risk, i.e., those in which the deployment of a flow diverting device would cause a significant increase in the intraaneurysmal pressure, and help physicians decide whether in such cases to deploy extra stents or coils in order to help accelerate the thrombosis and occlusion of the aneurysm.

**KEY WORDS:** Flow diverting devices, cerebral aneurysm, hemodynamics

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**Poster 143**

**Gene Expression Changes: Five Years after Creation of Elastase-Induced Aneurysms**

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**PURPOSE**

Intracranial, saccular aneurysms are associated with chronic remodeling of the arterial wall. The pathobiology of aneurysm growth and rupture is poorly understood. The
objective of the present study was to study the gene expression patterns in elastase-induced saccular aneurysms in rabbits 5 years after aneurysm creation as compared to control, unoperated arteries.

**MATERIALS & METHODS**
Elastase-induced saccular aneurysms were created in 25 rabbits and followed up to 5 years. Thirteen rabbits died during follow up for reasons unrelated to the aneurysms. RNA was isolated from aneurysm tissue and the control contralateral common carotid artery in five of the 12 surviving subjects and analyzed for gene expression using human gene microarrays. Genes with statistical differences between groups (p < 0.05, false discovery rate < 0.1 and fold change ≥ 1.5 and ≤ 0.5) were considered differentially expressed. RT PCR was used for confirmation of gene microarray findings for selected genes.

**RESULTS**
Fifty-six (0.23%) of 22,493 genes were expressed differentially in the aneurysms compared with the unoperated control arteries. Molecular and functional pathway analysis revealed that immunoregulatory molecules, growth factors, cell adhesion molecules, and structural molecules were expressed differentially in the aneurysms as compared to controls. RT PCR results of selected genes confirmed the differential expression identified using the gene chip microarray.

**CONCLUSION**
Significant modulation in a variety of biochemical and cellular functions in chronic aneurysms provides molecular insights into the pathophysiology of saccular aneurysms.

**KEY WORDS:** Saccular aneurysm, gene expression, pathobiology

**Poster 144**

Immediate Anatomical Results after the Endovascular Treatment of Ruptured Intracranial Aneurysms: Comparison of Results with GDC and Matrix Coils in CLARITY Series

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**PURPOSE**
To compare the quality of immediate anatomical results after the endovascular treatment of ruptured aneurysms using GDC and Matrix coils in CLARITY series.

**MATERIALS & METHODS**
Postoperative anatomical results were evaluated on DSA, anonymously and independently by two experienced neuroradiologists. Two different scales were used: the Montreal scale and a new scale specifically designed for the present study (Clarity scale).

**RESULTS**
Four hundred one aneurysms were treated using GDC coils and 373 using Matrix coils. Immediate anatomical results (Montreal scale) were not significantly different with GDC or Matrix coils. In GDC group, result was complete occlusion for 197 aneurysms (49.1%), neck remnant for 155 aneurysms (38.7%), and aneurysm remnant for 49 aneurysms (12.2%). In Matrix group, result was complete occlusion for 168 aneurysms (44.9%), neck remnant for 171 aneurysms (45.7%), and aneurysm remnant for 35 aneurysms (9.4%). Similar results were obtained using Clarity scale. The factors affecting the quality of aneurysmal occlusion have been studied in both GDC and Matrix groups.

**CONCLUSION**
The postoperative occlusion after endovascular treatment of ruptured aneurysms is satisfying with a high percentage of complete occlusion or neck remnant in both GDC (87.8%) and Matrix (90.6%) groups.

**KEY WORDS:** Ruptured aneurysms, coils, Matrix

**Poster 145**

CLARITY Study: Comparison of Clinical Results in GDC and Matrix Groups

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**PURPOSE**
To evaluate the clinical results of the endovascular treatment of ruptured intracranial aneurysms using GDC and Matrix coils.

**MATERIALS & METHODS**
A prospective, multicenter registry was conducted in France from October 2006 to June 2007 in 19 neurointerventional centers to compare the endovascular treatment of ruptured aneurysms with GDC and Matrix coils. Four hundred five patients were treated with GDC coils and 377 with Matrix coils.

**RESULTS**
Endovascular treatment failed in 3/405 cases (0.7%) in GDC group and in 2/377 cases (0.5%) in Matrix group. Adverse events related to the treatment were encountered in 71/405 patients (17.5%) in GDC group and in 68/377 patients (18.0%) in Matrix group. Thromboembolic events were encountered in 54/405 patients (13.3%) in GDC group and 45/377 patients (11.9%) in Matrix group, intraoperative rupture in 15/405 patients (3.7%) in GDC group and 19/377 patients (5.0%) in Matrix group, and early rebleeding in 2/405 patients (0.5%) in GDC group and 4/377 (1.1%) in Matrix group. Finally morbidity and mortality to the treatment were respectively 4.0% (16/405) and 1.5% (6/405) in GDC group and 4.0% (15/377) and 1.3% (5/377) in Matrix group.
CONCLUSION
Clarity study demonstrates that the immediate safety of the endovascular treatment of ruptured intracranial aneurysms using GDC and Matrix coils is similar with low morbidity and mortality with both types of coils.

KEY WORDS: Ruptured aneurysms, coils, matrix

Poster 146
Cerecyte Coil Trial: The Angiographic Outcome of Endovascular Coiling in Patients with Ruptured and Unruptured Intracranial Aneurysms Treated with Cerecyte Coils Compared with Bare Platinum Coils. Results of a Prospective Randomized Trial
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PURPOSE
To report the 6-month angiographic results in patients treated with Cerecyte or bare platinum coils in a prospective randomized trial.

MATERIALS & METHODS
Five hundred patients undergoing coil treatment of a ruptured or unruptured cerebral aneurysm in 23 centers in Europe, North America and Japan were randomly assigned to receive either Cerecyte Coils or bare platinum coils. The primary objective was to determine if Cerecyte coils improved the angiographic outcome on follow-up digital angiography 6 months after treatment. Angiographic follow-up also was obtained at 12 to 24 months after enrollment. Imaging data were transferred to a core lab on CD and uploaded into a PACS system and analyzed blind by an experienced neuroradiologist. Secondary objectives included whether Cerecyte coils reduced major recurrence or the need for aneurysm retreatment. Angiographic assessment was carried out by an independent core lab blind to the treatment allocation. Success was defined in the protocol as “Complete angiographic occlusion, improvement or no change in the angiographic appearances from the postprocedural angiography.”

RESULTS
The proportion of patients with success on the primary outcome, minor and major recurrence and retreatment rates will be reported at first follow up and the frequency of late recurrence of second follow up will be reported for all patients with available data.

CONCLUSION
The study will provide objective evidence whether Cerecyte coils improve angiographic outcome after coil treatment of cerebral aneurysms.

KEY WORDS: Aneurysm, coiling, angiographic outcomes

Poster 147
Creation of Large Elastase-Induced Aneurysms Using Arteriovenous Fistula Formation Prior to Aneurysm Creation
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PURPOSE
To determine whether creation of a carotid-jugular arteriovenous fistula, (AVF) to induce remodeling and enlargement of the right common carotid artery (RCCA) prior to aneurysm creation, results in induction of larger, elastase-induced aneurysms in rabbits.

MATERIALS & METHODS
Right common carotid artery-right jugular AVFs were created in New Zealand White rabbits (n = 11). Subjects were followed for 4 weeks at which time digital subtraction angiography (DSA) was performed. Patency of the AVF and aneurysm of the RCCA was determined. Following DSA, additional surgery was performed to create RCCA elastase aneurysms, in which AVFs, if patent, were ligated, elastase incubated in the RCCA, and distal RCCA ligation performed. Follow-up DSA was performed 3 weeks after this aneurysm creation surgery at which time aneurysm sizes (neck diameter, width and height) and volume in the two groups were measured and calculated. Diameters of the RCCA were compared between the groups of subjects with patent vs occluded AVFs. The aneurysm volume between these same two groups was compared using the Student’s t test.

RESULTS
Six AVFs remained patent and five were occluded. Mean RCCA diameter at initial follow up was 2.6 ± .9 mm in the patent AVF group as compared to 1.4 ± .5 mm in the occluded AVF group. Differences between them were significant (p < .05). The mean aneurysm neck for the patent group was larger than occluded AVF group (4.6 ± .9 mm and 2.6 ± .7 mm, respectively, p < .01). Differences of aneurysm width between patent and occluded AVF group were not significant (4.7 ± 1.1 mm and 3.7 ± .3 mm, respectively, p > .05). Mean aneurysm height for the patent group was larger than occluded AVF group (13.8 ± 3.2 mm and 8.9 ± 2.0 mm, respectively, p < .01). Aneurysm volume for Group 1 was significantly larger than that of Group 2 (272.9 ± 172.1 and 95.8 ± 22.8 mm3, p < .01) (see following figures).
CONCLUSION

Carotid-jugular AVFs, in our experience, remain patent in approximately half of cases at follow up and, if patent, result in RCCA remodeling that yields large elastase-induced aneurysms.

KEY WORDS: Aneurysm volume, arteriovenous fistula, elastase-induced model

Poster 148

Endovascular Treatment of Intracranial Aneurysms with Silk Stent

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PURPOSE

Treatment options in endovascular intracranial aneurysm treatment is continuously showing development. Silk stent has been one of the options of late years. In our study our aim is sharing our experience and data in 21 patients with 22 aneurysm who have been treated with silk stent.

MATERIALS & METHODS

Between March 2008 and November 2009 22 cerebral aneurysms in 21 patients (6 male, 15 female) were treated with silk stents. Age interval of patients were between 24 and 72 years (median age 55 years, average age 50.14 years).

RESULTS

Nine parophthalmic, three carotid cave, three cavernous segment, four C1 segment, one hypophyseal, one supraclinoid segment, total of 21 ICA aneurysms, and one vertebral artery V4 segment aneurysm had been treated. There were no technical complications. One patient died 2 hours after treatment due to myocardial infarction. We have 14 follow-up digital subtraction angiography (DSA) and 14 MR angiography that have shown aneurysm occlusion and two in-stent restenosis, one resolved totally. In two patients near occlusion of the parent artery and new pial-pial collaterals were seen.

CONCLUSION

Silk stents are one of the important options in endovascular aneurysm treatment, especially for the cases who have giant and bizarre aneurysms. Silk stent made possible hemodynamic treatment without mass effect of aneurysm sac and flow reversal is possible; however, there are no long-term results and this issue seems to be a disadvantage.

KEY WORDS: Silk stent, aneurysm, endovascular treatment

Poster 149

Quality of Life after Endovascular Coiling for Aneurysmal Subarachnoid Hemorrhage: A Follow-Up Study in Good-Outcome Patients

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PURPOSE

In the present treatment arena, meta-analyses evidenced that, if an intracranial aneurysm is suitable for both neurosurgical clipping and endovascular coiling, the latter is associated with better results. Specifically, death or disability is less frequent among patients treated with coil embolization. However, the risk of aneurysm recurrence dictates repeated angiographies to be performed at scheduled intervals after coiling. While such issues have been thoroughly discussed in several studies, less is known about the psychosocial impact of endovascular treatment for aneurysmal subarachnoid hemorrhage. To evaluate health-related quality of life in patients undergoing follow-up angiography, a subset of cases was extracted from our database encompassing, as a whole, 339 intracranial aneurysms coiled in 271 subjects from June 2002 to October 2009. Sampling was aimed to minimize the role of confounding variables and performed in accordance with the following criteria: size greater than one tenth of the entire population; series of consecutive patients treated for aneurysmal subarachnoid hemorrhage; good outcome with resumption of normal activities; negative result for aneurysm recurrence. Two-year follow-up data are reported here.

MATERIALS & METHODS

Thirty subjects (age: 24-73 years; M: 12 F: 18) were recruited and administered the validated Italian version of the Medical Outcome Study 36-item short-form questionnaire (SF-36). Specifically, the SF-36 is a widely used instrument...
which requires participants to answer 36 questions covering eight domains: physical functioning, role limitations because of physical problems, bodily pain, general health, vitality, social functioning, role limitations because of emotional problems, and mental health. An absence of problems is indicated by a score of 100 for each domain. To assess differences between the patient group and the reference population, the Student’s t test was employed.

RESULTS
On average, good-outcome coiled patients did not differ from the reference population in the overall SF-36 score. Besides, domain-by-domain analysis showed significant differences of means for social functioning (-10.5 95% CI -2.2 to -18.8 p < 0.05), role limitations because of emotional problems (-16.9 95% CI -3.5 to -30.3 p < 0.05), and mental health (-13.6 95% CI -7.0 to -20.2 p < 0.01).

CONCLUSION
After neurosurgical clipping for aneurysmal subarachnoid hemorrhage, a substantial proportion of subjects who have made a good neurologic recovery, nevertheless, presents with protracted psychosocial disturbances. Our results suggest that quality of life is affected to a lesser degree in good-outcome patients who underwent endovascular coiling. Still, they also underline that the mere presence or absence of functional or cognitive deficits does not give insight into the patients’ subjective feelings of physical, psychologic, and social well-being.

REFERENCES

KEY WORDS: Aneurysmal subarachnoid hemorrhage, endovascular coiling, clinical outcome of ruptured intracranial aneurysm

Poster 150
CT Angiography vs Three-Dimensional Digital Subtraction Angiography for Treatment Planning of Intracranial Aneurysms

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PURPOSE
The International Subarachnoid Aneurysm Trial (ISAT) showed better patient outcomes with endovascular coiling than surgical clipping for patients with acutely ruptured aneurysms. Traditionally digital subtraction angiography (DSA) incorporating 3D rotational analysis has been used to identify and triage aneurysm treatment between coiling and clipping. CT angiography (CTA) offers many advantages over DSA including availability, cost, and convenience with many institutions now utilizing CTA as the first-line or only study in cerebral aneurysm imaging. However, CTA has inherently less spatial resolution than DSA and may underestimate the suitability for endovascular coiling, potentially excluding some patients from optimal therapy. Previous studies comparing CTA and DSA have not specifically addressed treatment planning. The objective of this blinded retrospective analysis is to compare CTA with DSA to determine suitability for endovascular coiling based on imaging characteristics alone.

MATERIALS & METHODS
Retrospective analysis of 51 consecutive patients receiving both CTA and 3D DSA for aneurysm evaluation at Emory University Hospital during 2008 was performed. Three diagnostic neuroradiologists and interventional neuroradiologists performed blinded review of the CTA, and blinded review of the corresponding DSA was performed by an interventional neuroradiologist. Readers evaluated the studies for identification of aneurysms and suitability for coiling by imaging characteristics. For treatment-planning analysis, both blinded CTA and blinded DSA interpretations were compared to the actual treatment offered to the patient and statistical analysis was performed using Fisher’s Exact Test. Sensitivity data for CTA was calculated also using DSA results as the standard.

RESULTS
Fifty-one patients were evaluated, with a total of 62 aneurysms detected on 3D DSA. Sensitivity for detection of aneurysms by CTA ranged from 73% to 82%. Positive predictive values ranged from 88% to 96%. The aneurysms not detected by CTA had a mean dome size of 2.55 mm (range, 0.87 mm - 4.47 mm). Greater than 50% of these were associated with the cavernous or supraclinoid internal carotid artery and its branches. Statistical analysis of CTA interpretation relative to treatment offered did not reach statistical significance for the diagnostic neuroradiology readers (p = 0.070 and 0.209) but did for the interventionalists’ interpretation (p = 0.025). The interventionalist’s blinded interpretation of the DSA showed greater statistical significance (p < 0.0001). Of the aneurysms determined not appropriate for endovascular treatment by the interventional neuroradiologist interpreting the CTA, four patients (7.8%) with five aneurysms (8.1%) ultimately were offered endovascular treatment based on the DSA findings and clinical scenario.

CONCLUSION
CT angiography has relatively good sensitivity for aneurysm detection, best for those 3 mm in size or greater. Agreement of CTA treatment stratification with actual treatment choice reached statistical significance only in the interpretation by the experienced interventional neuroradiologist. Blind evaluation of DSA images alone correlated well with ultimate treatment offered to the patient. If CTA alone were used to stratify patients to endovascular treatment or surgical therapy, some patients (approximately 8% in our study) would have missed the opportunity for endovascular treatment.

KEY WORDS: Aneurysms, CT angiography, digital subtraction angiography
Poster 151

Evaluation of the Incidence of Vasospasm Post-SAH in Patients Treated by Arto-vastatine®

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PURPOSE
To evaluate the interest of using a neuroprotective agent: the Artovastatine®, for the management of vasospasm related to SAH.

MATERIALS & METHODS
Retrospective study involving 66 patients attended in our institution for SAH related to aneurysm rupture, divided into two groups: 26 patients that received, in addition to regular treatment of vasospasm, iv injection of Arto-vastatine®, 40 mg/d from d0 to d21; 39 patients that did not received Artovastatine®, but just the regular treatment of vasospasm. S100B protein was measured daily for all patients. One hundred sixty-six angiograms were reviewed: 66 at the moment of the admission; 100 performed for suspected vasospasm (1 to 10 DSA/patient; m = 1.5). Analysis of the severity of the vasospasm was quantified on macrovascular stenosis degree and on a qualitative criterion evaluating the microcirculation. A quantitative assessment of the volume of delayed ischemia was performed on CT at 1 month of the SAH. Modified Rankin Scale was evaluated at 1-year follow up.

RESULTS
Population was divided according to WFNS grade: grade 1-2: 68%; grade 3-5: 32%. Aneurysms were embolized in 55/66 cases (83%) and surgically treated in 11/66 cases (17%). S100B protein was reduced significantly in the group treated with Artovastatine®. The analysis of proximal vascular stenosis on DSA did not show significant difference. However there was a tendency for a reduction of occurrence of vasospasm in the group treated with Arto-vastatine®. No significant difference was observed on mRS evaluation at 1-year follow up.

CONCLUSION
Systematic injection of Arto-vastatine® after SAH secondary to aneurysm rupture is efficient on the reduction of a neuronal suffering marker (S100B protein) and may reduce the occurrence of vasospasm.

KEY WORDS: Vasospasm, Arto-vastatine®

Poster 152

Clinical and Angiographic Outcomes following Balloon Angioplasty and Stenting of Venous Sinus Occlusion Coupled with Dural Arteriovenous Fistulas

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PURPOSE
The purpose of our retrospective study is to investigate the feasibility, safety, effectiveness and outcome of balloon angioplasty and stenting of venous sinus occlusion coupled with dural arteriovenous fistulas (DAVFs).

MATERIALS & METHODS
Inclusion criteria for analysis were patients (1) who were admitted to our institution from January 2008 to September 2009, (2) who presented some neurologic symptoms, (3) with venous sinus occlusion coupled with DA VFs displayed on angiograms, (4) who underwent balloon angioplasty and/or stenting of venous sinus occlusion. Procedural success, complications, clinical symptoms, 3-month angiographic and clinical outcomes were investigated.

RESULTS
During the study periods, five patients were included for analysis. Cerebral angiography showed the transverse-sigmoid (T-S) sinus occlusion in three cases and inferior petrous sinus (IPS) occlusion in two cases. Venous sinus occlusion was recanalized successfully in five cases. Venous sinus stenting was performed in four cases and balloon angioplasty alone in one case. Successful recanalization immediately diminished reflux into cerebral cortical or deep veins from venous sinus and venous sinuses drained antegradely into the internal jugular vein. Neurologic symptoms were improved. No procedural complications occurred. No neurologic symptoms have recurred for 3 months after procedures. Five patients underwent follow-up angiogram at 3 months, demonstrating that stent thrombosis and retrograde drainage into cerebral veins recurred in three cases and sinuses remained to drain antegradely in two cases.

CONCLUSION
Successful balloon angioplasty and/or stenting of venous sinus occlusion coupled with DAVFs normalized cerebral venous drainage and improved neurologic symptoms immediately. However, stent thrombosis and persistent retrograde drainage limits may limit long-term outcome.

KEY WORDS: Arteriovenous fistulas, balloon angioplasty, stenting
Endovascular Therapy for Traumatic Cervical Internal Carotid Artery Injuries: Characterization, Treatment, and Follow Up

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PURPOSE
Although numerous case reports and small series describe the use of endovascular stent placement and coil occlusion for traumatic extracranial carotid injury, there is little data on long-term outcomes with regard to vessel patency and retreatment rates. We report our retrospective series of 26 patients with 29 traumatic internal carotid injuries who have undergone endovascular repair.

MATERIALS & METHODS
We retrospectively reviewed records and imaging studies of patients who underwent endovascular treatment for acute traumatic extracranial internal carotid injury at the University of Maryland Medical Center. Patients were evaluated with regard to age, sex, injury grade, injury location, complications, initial treatment results, and outcomes. We used the Biffl classification to grade injuries, with an additional modification to stratify grade 2 and 3 injuries into non-flow limiting (2a or 3a) and flow limiting lesions (2b or 3b). Location of injury was divided into proximal ICA (> 3 cm below the skull base) and distal ICA (< 3 cm below the skull base). Initial treatment results and follow-up outcomes were classified into four categories: complete restoration of normal vessel lumen diameter; clinically acceptable result with mild residual pseudoaneurysm filling or narrowing less than 30%; residual or recurrent narrowing greater than 30%; and aborted procedure or inability to deploy stent. Follow-up studies included CTA, MRA, and follow-up catheter angiograms.

RESULTS
Twenty-six patients (16 men, 10 women) underwent endovascular treatment for a total of 29 carotid injuries due to blunt or penetrating trauma over a period of 12 years. Average age at time of treatment was 36 years (range 17 to 71 years). Injury grades were as follows: grade 2a, 3; grade 2b, 1; grade 3a, 16; and grade 3b, 9 vessels. Six of the 29 injuries involved the proximal ICA; the distal ICA was involved in 23 injuries. Seventeen injuries were treated with a single stent and 12 injuries required multiple stents. Three patients suffered complications related to the treatment procedure (transient weakness, 2; transient visual loss, 1; and new pseudoaneurysm following stenting, 1 patient). Stents alone were used in 26 vessels (89.7%); and stents and coils were used in 3(10.3%). There was complete restoration of normal vessel lumen diameter in 16 vessels and acceptable restoration in 13 vessels. In one patient with fibromuscular dysplasia, stent placement was aborted. Twenty-two patients (85%) had either CT or MR follow up, and 11 patients had follow-up conventional angiogram procedures. Follow-up examinations included a total of 38 CT/CTA examinations, 9 MRI/MRA examinations, and 18 catheter angiograms. The follow-up intervals ranged from 1 day to 6 months with length of follow up ranging from 4 days to 7 years. Three patients(12%) underwent retreatment with stent and coil placement for recurrent or residual pseudoaneurysm; the average time to retreatment was 2.3 weeks (range 1 to 6 weeks).

CONCLUSION
Endovascular stent or stent and coil treatment is a safe and effective treatment option for cervical internal carotid injury, including dissection and pseudoaneurysm formation, secondary to blunt and penetrating injury.

KEY WORDS: Internal carotid artery injury, pseudoaneurysm, trauma

Symptomatic Atherosclerotic Middle Cerebral Artery Stenosis Treatment with Self-Expandable Intracranial Stents: Single Center Experience

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PURPOSE
Endovascular treatment of intracranial stenosis with self-expandable stents (SES) is a new challenge for prevention and treatment of acute stroke. We report our single center experience in middle cerebral artery stenosis treatment focusing on the adequate preprocedural and postprocedural management.

MATERIALS & METHODS
In this prospective, multicenter, single-arm study, medically refractory patients with symptoms evaluated with Rankin score attributable to angiographically demonstrated intracranial stenosis > 50% in vessels of 2.5 to 4.5 mm in diameter were enrolled. Intracranial lesions were predilated with an undersized balloon catheter to 80% of the native vessel diameter, followed by deployment of the self-expanding Wingspan stent to facilitate further remodeling of the atherosclerotic plaque and to maintain vessel patency. All patients underwent postprocedural neurologic examinations and angio-MR were performed 3 and 6 months after the procedure.

RESULTS
Eleven patients were enrolled in our study. Eight patients had an acute ischemic stroke (AIS), the remaining had transient ischemic attacks (TIA). There was successful deployment of the Wingspan stents in all patients. The M1 (n. 8) and M2 (n. 3) middle cerebral artery segments were treated. Successful recanalization occurred in 100% of patients with reduction of the stenosis from 84 ± 4% down to 18 ± 2%. No immediate postprocedural complications occurred. Twenty-four hours postprocedural MR diffusion analysis showed absence of acute ischemic lesions. No restenosis were showed at 6 months angio-MR follow up.
CONCLUSION
Our experience with SES in treatment of middle cerebral stenosis demonstrated the technical feasibility and high rate of recanalization with acute stenting. Good planning associated with the choice of adequate devices in dedicated centers with highly experienced operators permits gaining excellent results.

KEY WORDS: Atherosclerotic intracranial stenosis, intracranial stenting

Poster 155
Use of Intraarterial CT Angiography to Find the Vascular Supply to Spinal Dural Arteriovenous Fistulae and Recognize the Artery of Adamkiewicz

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PURPOSE
Spinal dural arteriovenous fistulae (SDAVFs) rare but treatable spinal vascular malformations which are difficult to localize and cause progressive myelopathy. Catheter spinal angiography is the gold standard method of locating the vascular supply. As SDAVF can be supplied by the external carotids, vertebral, thyrocervical trunk, iliac, intercostal, or lumbar arteries the angiography can be time consuming with a high radiation dose, large volumes of contrast and extensive catheter manipulation. This can mean a longer general anesthetic for the patient. Intraarterial CT angiography (IACTA) has been documented as a useful technique in preoperative visualization of the artery of Adamkiewicz (1). We therefore decided to adapt this technique to aid in the detection of the vascular supply to SDAVF.

MATERIALS & METHODS
Over a 14-month period, October 2008 to December 2009, six patients presented to our center with clinical and MR findings suggestive of a SDAVF. They all underwent an IACTA and spinal angiography. Our technique has been refined over the course of these patients. Under fluoroscopy we place a 6F pigtail catheter into the descending aorta, just below the level of the left subclavian artery. The patient then is transferred to our 64-slice CT scanner. One hundred mls of Iomeron 400 is injected by pump, with the injection being administered using bolus tracking while monitoring the aorta at the level of the diaphragm. The patient is scanned from the top of the aortic arch to the pelvis. The images then are reconstructed in sagittal and coronal planes. The images are assessed by the interventional neuroradiologist and a decision made as to the level of the vascular supply of the SDAVF and whether the artery of Adamkiewicz can be identified. The patients then undergo a catheter angiography to assess the vascular supply of the SDAVF and identify the artery of Adamkiewicz.

RESULTS
With the initial two cases the IACTA did not aid in the localization of the SDAVF or identify the artery of Adamkiewicz. We then changed our technique and in the next four the IACTA did aid in finding the vasculare supply of the SDAVF, but did not identify the artery of Adamkiewicz. In the final case we changed the timing of the injection. In this patient we clearly identified the artery of Adamkiewicz and the vascular supply of the SDAVF. This method has led to quicker spinal catheter angiography time, less radiation and lower contrast volume. There is also less catheter manipulation in this predominantly older group of patients who often have atheromatous, tortuous vessels.

CONCLUSION
This cost-effective safe simple procedure has helped in localizing SDAVF and identifying the artery of Adamkiewicz.

REFERENCES

KEY WORDS: Intraarterial CT angiography, spinal dural arteriovenous fistulae

Poster 156
Image-Guided Placement of Lumbar Drains

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PURPOSE
Describe the indications and technical details of image-guided lumbar drain.

MATERIALS & METHODS
During the period of 03/22/2005 to 12/01/2009 a total of 18 lumbar drains have been placed using fluoroscopic guidance. All the patients underwent placement of the drain in lateral decubitus using sterile techniques and a bi-plane angiographic suite. For all patients the Codman drain and external ventricular draining systems were used. The insertion level was in all cases below L1-L2 and was selected according to the larges interspinous space available. The tip of the lumbar drain was advance to the lower thoracic spine as far as technically possible. When the position was reached it was verified by fluoroscopic-guided insertion of myelographic contrast material. The drain was secured to skin and connected to an external ventricular draining system. When the patient arrived in the recovery room, the drain was leveled to the patient’s shoulder. The drains were kept in place between 1 and 14 days. For patients who had their drains in place more than 1 day, a daily regimen of antibiotic was prescribed. All patients were followed clinically throughout the draining period. The indications for placement of lumbar drains were as follows: patients with subarachnoid hemorrhage of grade I or II Hup and Hess and no trapped ventricles, patient with obvious CSF fistula for either cysternograms of draining of CSF; HIV infected patients with complicating meningitis and headaches secondary to increased intracraniatal pressure without noncommunicating hydrocephaus.
RESULTS
All drains were technically successful with proper placement in the subarachnoid space. One patient with subarachnoid hemorrhage had a transient Parinaud syndrome which resolved completely after temporary closure of the system. There were no infectious complications.

CONCLUSION
Image-guided placement of lumbar drains is a safe and useful intervention for either diagnostic or patient management purposes. Proper clinical follow up and awareness of potential neurologic complications and their management by the neurointerventional team is mandatory.

KEY WORDS: Image guidance, lumbar drains

Poster 157
Long-Term Clinical Outcome following Emergency MR Imaging and Early Treatment of Acute Internal Carotid Artery Occlusion in Hyperacute Stroke Patients

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PURPOSE
Clinical outcome of patients suffering from internal carotid artery (ICA) occlusion seems poor. However, long-term clinical outcome following emergency MR imaging (MRI) and early treatment of acute ICA occlusion remains unclear. The aim of our retrospective study was to investigate long-term clinical outcome following emergency MRI and early treatment of acute internal carotid artery occlusion in hyperacute stroke patients.

MATERIALS & METHODS
Included for retrospective analysis were patients (1) who were admitted to our institution within 24 hours of onset from 2006 to 2009, (2) who underwent emergency MRI on admission, (3) in whom emergency MRA showed ICA occlusion. Age, sex, National Institutes of Health Stroke Scale (NIHSS) on admission, time from onset to admission (TOA), time from onset to treatment (TOT), diffusion-weighted image (DWI) findings estimated as involving <1/3 or 1/3 - 2/3 or >2/3 of the territory of the middle cerebral artery (MCA) and emergency reperfusion therapy (ERT) such as intravenous rt-PA or endovascular treatment were investigated. Clinical outcome was measured using modified Rankin Scale (mRS) at 3 months (3M mRS) and categorized as favorable (mRS 0 - 2), poor (mRS 3-5) and death (mRS 6).

RESULTS
Seventy-three patients were included for analysis. Male were 39/73. The average age was 76.2 years. The median NIHSS on admission was 21. The median TOA and TAT were 1.8 hours (range 0 - 23) and 3.8 hours (range 0.8 - 26.5) respectively. Diffusion-weighted imaging showed high signal intensity involving less than 1/3 of the MCA territory in 35 patients, 1/3 - 2/3 in 12, more than 2/3 in 26. Twenty-one patients underwent ERT in acute stroke stages. One patient received intravenous rt-PA and other 20 patients underwent endovascular treatment. Clinical outcome of 3M mRS was favorable in 11 patients (15.1%), poor in 35 (47.9%); and dead in 27 (37.0%) patients. There were no significant relationships between 3M mRS and factors such as age, sex, NIHSS on admission, TOA, TAT, and DWI findings. In ERT and no ERT group, there were 7 (33.3%) * and 4 (7.7%) ** patients with favorable outcome (p < 0.05), respectively, and median 3M mRS was 5 and 5 (p = 0.34), respectively.

CONCLUSION
Three-month mortality was 37% and clinical outcome was not satisfactory despite early treatment of acute ICA occlusion following emergency MR imaging. Emergency reperfusion therapy, if performed, may improve 3-month clinical outcome.

KEY WORDS: ICA occlusion, MR imaging

Poster 158
Long-Term Clinical Outcome after Emergency Reperfusion Therapy for Acute Basilar Artery Occlusion Based on MR Imaging

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PURPOSE
It remains uncertain whether or not emergency reperfusion therapy (ERT) can improve hyperacute stroke patients suffering from basilar artery occlusion (BAO) based on MR imaging. The purpose of our retrospective study was to investigate long-term clinical outcome after emergency reperfusion therapy for acute BAO based on MR imaging (MRI).

MATERIALS & METHODS
Included for retrospective analysis were patients (1) who were admitted to our institution during the period from January 2004 to June 2009, (2) who were admitted within 48 hours from stroke onset, (3) who presented neurologic symptoms due to BAO diagnosed by emergency MR imaging, (4) whose NIHSS score on admission was 5 or more, (5) who were candidates for emergency reperfusion therapy. Excluded were patients (1) in whom MRI-DWIs showed extensive high signal intensity area, (2) who presented NIHSS score of less than 5, (3) who were comatose on admission, or (4) who had contraindications for ERT. Some patients underwent ERT (E group) of intravenous rt-PA or endovascular treatment and others did not give written informed consent for ERT (C group). Basic patients’ characteristics on admission (age, gender, final diagnosis), NIHSS on admission, NIHSS on discharge, mRS on admission and mRS at 3 months were investigated.

RESULTS
During the study periods, 40 patients were included for analysis. Among them, 25 patients underwent ERT (E group), and 15 patients did not (C group). In E and C groups, a median age was 74 and 77 years, man (%) was 68 and 73,
cardiogenic (%) was both 40, a median NIHSS on admission was 22 and 14 (p < 0.05), a median NIHSS on discharge was 14 and 37, a median mRS on admission was both 5, a median mRS at 3 months was 4 and 5 (p < 0.05), respectively.

CONCLUSION
Although patients with serious neurologic symptoms underwent ERT for acute BAO, ERT improved their 3-month clinical outcome.

KEY WORDS: Basilar artery occlusion, MR imaging, endovascular treatment

Poster 159
Mechanical Thrombolysis for Acute Carotid Occlusion: Single Center Experience

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PURPOSE
Acute stroke due to internal carotid artery occlusion has a poor prognosis. Clinical outcomes are related to efficacy and timing of vessel recanalization. We report our single center experience focusing on the adequate preprocedural and post-procedural management.

MATERIALS & METHODS
We retrospectively reviewed 15 consecutive endovascular cases of acute internal carotid artery occlusions treated at our center between July 2009 and November 2009. Preprocedural symptoms were evaluated through NIHSS. Mechanical thrombolysis was performed through Penumbra system. Adjunctive intraarterial pharmacologic therapy (urokinase) was performed only if time to stroke was inferior or to 6 hours. If thrombosis was associated to a significant vessel stenosis, a stent was deployed. All patients underwent postprocedural neurologic examinations and angio-MR performed at 3 and 6 months after the procedure.

RESULTS
Penumbra mechanical thrombolysis was performed in all cases. 86.6% of the treated vessels were revascularized to TIMI 2 of 3. Intraarterial thrombolysis was associated to mechanical approach in 13 patients (86.6%). One patient died after the procedure (7%). In five patients (33.3%) a carotid stenting procedure was necessary. In four patients (26.6%) stenting of the middle cerebral artery was performed. In the other patients we observed a significant improvement of symptoms (mean baseline NIHSS 19.5 ± 0.3; mean postprocedural NIHSS 3.5 ± 0.2 p < 0.0001).

CONCLUSION
Mechanical thrombolysis associated with intraarterial pharmacologic therapy and stenting is an efficient treatment for acute stroke.

KEY WORDS: Stroke, Penumbra system

Poster 160
Withdrawn

Poster 161
Endovascular Management of Cerebral Vasospasm following Aneurysmal Subarachnoid Hemorrhage: A Tertiary-Care Referral Center Experience

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PURPOSE
Cerebral vasospasm (CV) is common following aneurysmal subarachnoid hemorrhage (SAH) and has been associated with significant morbidity and mortality. Noninvasive methods to prevent and reverse CV have been met with mixed success. Medically refractory cases may be treated with invasive techniques through a combination of percutaneous transluminal angioplasty and intraarterial vasodilator administration in order to restore luminal caliber and, therefore, cerebral perfusion. In this descriptive study, we report our experience in managing medically refractory CV using endovascular techniques at a tertiary-care referral center.

MATERIALS & METHODS
A retrospective review of patients with aneurysmal SAH presenting within 72 hours of symptom onset to the University of California, San Francisco (UCSF) was conducted from July 2003 to January 2008. Following surgical or endovascular aneurysm exclusion, patients received standard medical management in the neurointensive care unit. Those patients with evidence of CV despite maximal medical management underwent diagnostic cerebral angiography. Transluminal angioplasty and/or intraarterial verapamil infusion were performed if CV was present angiographically. Relevant clinical data were recorded from medical charts and radiology images and reports.

RESULTS
During the study period, 546 patients were admitted to UCSF for aneurysmal SAH within 72 hours of symptom onset. Of these, 231 (42%) patients experienced symptomatic CV and 189 (82%) patients underwent endovascular therapy. A total of 346 endovascular treatment sessions were performed consisting of one (0.3%) angioplasty alone, 286 (83%) intraarterial verapamil infusions, and 59 (17%) combined treatments. In total, angioplasty was performed on 151 vessel segments and verapamil infused in 720 vessel segments. The amount of verapamil infused per vessel segment was between 2.0 to 30.0 mg and increased with the CV severity (P < 0.05). The median total verapamil dose infused per treatment session was 20.0 mg (range, 3.0 - 55.0 mg). Repeat treatments were necessary in 101 patients with persistent or worsening symptoms. There were 6 (1.7%) treatment-related complications which include 3 arterial dissections, 1 vessel perforation, 1 embolus, and 1 intractable ICP elevation. None of these complications resulted in patient
death; only the embolus resulted in a new clinical deficit. Nineteen (10%) patients died and 55 (29%) patients had a poor outcome as defined by a modified Rankin score = < 3.

**Conclusion**

Endovascular treatments are integral to the management of patients with medically refractory CV following aneurysmal SAH at our tertiary-care referral center. This descriptive study demonstrates that modern endovascular vasospasm management is safe and effective at increasing luminal diameters of intracranial arteries in the setting of acute SAH. Further studies are required to determine if these treatments ultimately improve clinical outcomes.

**Key Words:** Vasospasm, subarachnoid hemorrhage, management

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**Poster 162**

**Long-Term Clinical Outcome following Emergency MR Imaging and Reperfusion Therapy for Acute Middle Cerebral Artery Occlusion**

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**Purpose**

Long-term clinical outcome remains uncertain after emergency MR imaging and reperfusion therapy (eMR RT). The aim of our retrospective study was to investigate long-term clinical outcome following eMR RT for acute middle cerebral artery (MCA) occlusion.

**Materials & Methods**

Included for retrospective analysis were acute stroke patients 1) who were admitted to our institution during the period from Oct 10 2005 to Sep 10 2009, 2) who were admitted within 6 hours from stroke onset, 3) who presented serious neurologic symptoms of NIHSS score of 5 or more due to acute MCA occlusion diagnosed by emergency MRA, 4) who underwent emergency MR imaging on admission, and 5) who underwent emergency intravenous rt-PA or endovascular treatment. Patients, who had contraindications of rt-PA or in whom intravenous rt-PA could not be injected within 3 hours from onset, underwent endovascular treatment. Evaluated were age, sex, onset-to-admission hours (OTAH), NIHSS score on admission, long-term survival and modified Rankin scale.

**Results**

During the study period, 601 acute stroke patients were admitted within 6 hours. Among them, 42 patients underwent eMR-RT. Age (mean +/- SD) is 75.2 +/- 9.8 years, man is 25 (59.5%), OTAH (median) is 2.42 hours, NIHSS on admission (median) is 12, follow-up period (median) is 115 days, survival probability by Kaplan-Meier method is 76.1%, mRS (median) on the follow-up day is four, and 14 patients (33.3%) had favorable outcome of mRS of 0 to 2. Among 42 patients, 22 patients underwent intravenous rt-PA (R group) and 20 patients did endovascular treatment (E group). In R and E group, age (mean +/- SD) is 75.7 +/- 10.6 and 74.9 +/- 9.3 years old, man is 9 (40.9%) and 16 (80%) (p < 0.05), OTAH (median) is 0.88 and 1.28 hours (p < 0.05), follow-up period (median) is 113 and 117.5 days, survival probability by Kaplan-Meier method is 68.6 and 85.2% (p = 0.15), and the number of patients who had mRS of 0 to 2 was five (22.7%) and nine (45%), respectively. Cox proportional hazard model showed that NIHSS score on admission, age, sex and group were significant predictors (p < 0.05) for long-term survival.

**Conclusion**

After eMR-RT, long-term survival rate was 76.1% and favorable clinical outcome rate was 33.3%. Patients who underwent endovascular treatment may be alive longer and have better clinical outcome than intravenous rt-PA.

**Key Words:** Stroke, reperfusion therapy, MR imaging

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**Poster 163**

**CT Perfusion-Guided Revascularization in Acute Ischemic Stroke Using the Penumbra Aspiration System: A Single Center Experience**

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**Purpose**

In the treatment of acute ischemic stroke, timely restoration of blood flow to ischemic areas is crucial for favorable stroke outcomes. The role of intraarterial (IA) therapy, initially using thrombolytics such as tissue plasminogen activator (tPA), has expanded with the introduction of mechanical thrombectomy devices such as the MERCI retriever and the Penumbra aspiration device. We report our center’s experience in using the Penumbra system for the treatment of acute ischemic stroke.

**Materials & Methods**

Sixteen patients were treated using the Penumbra device between September 25, 2008 and November 19, 2009, ages ranging from 37-84 years (mean 61 years). All patients were assessed on the NIH Stroke Scale (NIHSS) at presentation. Patients received initial treatment with intravenous (iv) tPA if eligible and were referred for endovascular intervention if they were ineligible to receive iv tPA or if there was no clinical response to iv tPA. Fifty-six percent (9/16) of patients received variable doses of iv tPA prior to arriving for intervention, while 94% (15/16) received IA tPA in combination with mechanical intervention. Sixty-nine percent (11/16) of patients underwent CT perfusion imaging (CTP) before the procedure, and all patients had a follow-up noncontrast head CT following the procedure to evaluate for hemorrhagic conversion. Clinical outcomes at 30 days postprocedure, including assessment of modified Rankin Scale (mRS), also were assessed in all applicable cases.

**Results**

The median NIHSS at presentation was 18.5 (range 10 to 24). The mean time from onset was 235.75 minutes. All patients had TIMI flow scores of 0 on initial angiography.
Sixty-nine percent of patients received CTP imaging prior to endovascular treatment that demonstrated a large (> 1/3) MTT CBV mismatch. Ninety-four percent (15/16) of the patients had clot fragmentation with distal occlusion after operation of the Penumbra aspiration device and were treated additionally catheter-directed thrombolysis or thrombectomy using successively smaller Penumbra aspiration devices. All 16 patients achieved a TIMI score of 3 posttreatment. There were no procedural complications. Three patients (18.75%) developed hemorrhagic conversion and subsequently expired. One patient died of complications related to myocardial infarction. Fifty percent (6/12) of the surviving patients evaluated at 30 days postintervention achieved good functional outcomes (mRS ≤ 2). There was no difference in functional outcome or mortality in the cohorts of patients that received penumbral imaging vs those that did not have CTP.

CONCLUSION
Revascularization with the Penumbra aspiration device has proved to be effective resulting in complete restoration of flow in all cases. Our initial experience with this thrombectomy device has confirmed its ease of use and safety. Clot fragmentation is observed in a majority of the cases, but successful recanalization is attainable after further treatment with smaller Penumbra devices and IA thrombolytics. Mortality was high in this small series, but a large proportion of survivors achieved good functional outcomes. Large mismatch on CTP was not predictive of a better outcome.

KEY WORDS: Acute ischemic stroke, penumbra, CT perfusion

Poster 164
Effects of Collateralization, Perfusion-Diffusion Mismatch, Time to Recanalization, and TIMI Grade on Infarct Extension after Mechanical Thrombectomy in Acute Ischemic Stroke

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PURPOSE
The purpose of this study was to assess the extent to which the degree of collateralization, PD mismatch, time to recanalization, and TIMI grade after mechanical thrombectomy affects tissue loss from infarct extension and 90-day functional outcome.

MATERIALS & METHODS
In a prospective, single center study, tissue loss from infarct extension in 31 acute stroke patients who had mechanical thrombectomy was evaluated. Inclusion criteria were proximal cerebral artery occlusion in the middle cerebral artery (MCA) or internal carotid artery (ICA), symptom onset to initial CT imaging < 6 hours, infarct volume < 15 ml or an ASPECTS score < 9 from initial noncontrast CT (NCCT) imaging. Mechanical thrombectomy was performed with the Phenox clot retriever (6 cases) or the Penumbra System (20 cases). In five cases, stent angioplasty was used as adjunctive therapy. Ischemic stroke was diagnosed by multimodal imaging on admission including NCCT, CT angiography (CTA), and CTP. Collateralization and PD mismatch (penumbra to infarction core) was graded visually on a 3-point scale (excellent, moderate, poor) on CTA and CTP, respectively. Time to recanalization was estimated from the onset of stroke imaging time stamps to the end of interventional angiography showing the recanalization result. Brain tissue outcome (final infarct volume) was calculated from change in volume of segmented infarcted brain lesions in pre and postinterventional CT by semiautomated registration (Analyze 9.0 software).

RESULTS
From April 2008 to July of 2009, 31 consecutive patients with acute stroke in the ICA or MCA who underwent mechanical thrombectomy were enrolled. Of these, 17 (54.8%) male and 14 (45.2%) female. Mean age was 68.8 years (range 18-83 years) and baseline mean NIH score was 13. A total of 65.5% of the patients presented with good collateralization. Among the 28 patients in whom PD mismatch could be assessed from NCCT, 21 (67.7%) presented with sufficient mismatch, but all were treated. After treatment, 25 (80.6%) of the patients achieved a TIMI 2-3 grade. MR spectroscopy evaluation at 90 days revealed a good outcome (MRS = 2 or less) in 35.5% of patient. Age and recanalization grade (TIMI) showed the strongest correlation with MRS score (TIMI r = - 0.544, p = 0.002, age r = 0.439, p = 0.038). There was a significantly reduced final infarct size with higher TIMI score, higher grades of collateralization, size of mismatch and time to recanalization after excluding age a covariate (mismatch: p = 0.002, TIMI: p = 0.02, collateralization P = 0.036, time to recanalization = 0.002).

CONCLUSION
Favorable tissue outcome and MRS after fast mechanical recanalization of acute proximal cerebral artery occlusion depends on grade of recanalization, perfusion mismatch, time to recanalization (TTR), and collateralization on initial CT imaging after excluding the influence of age as a covariate. The concept of multimodal stroke imaging allows selection of patients that will benefit from mechanical recanalization.

KEY WORDS: Stroke, mismatch, mechanical thrombectomy
Evidence of Prolonged Apparent Diffusion Coefficient Decrease in Fetal MR Imaging of Demised Twin

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PURPOSE
In this report we discuss the potential role of diffusion-weighted imaging (DWI) and apparent diffusion coefficients (ADC) in fetal MR examinations. The use of DWI and the quantitative changes on the resulting ADC maps long have played a central role in the detection and quantitative analysis of acute cerebral ischemia in the mature (adult) brain (1) and also become standard of care for detecting acute ischemic injury in the neonate (2). In basal ganglia type of perinatal hypoxic-ischemic injury, the ADC value decreases within hours after birth started in ventrolateral thalami and or caudal aspects of the corticospinal tracts and reached nadir in 2-3 days and persists to be low in subsequent days (3-5 days), following gradual recovery of value to reach pseudo-normalization in the range of 4-8 days after birth (2, 3). Variety of injury mechanism and geographical propagation complicate this time course (2). The role of DWI and ADC maps in the evaluation of fetal brain injury has yet to be determined. We report the clinical cases with abnormal diffusion-weighted images in demised twin fetus brain and discuss the implications of our findings.

MATERIALS & METHODS
Two cases of intrauterine co-twin demise with diagnosis of TTTS were studied by nonsedated 1.5 T fetal MR imaging (1.5 T Signa HDxT, GE Medical Systems, Milwaukee, WI) using an 8-channel cardiac coil concentrating on imaging the fetal brain: one at 22 + 2/7 week, documented on ultrasound to be spontaneously demised 23 days prior to MR imaging and another at gestational age 22 + 2/7 week, 7 days after umbilical ligation and presumed demise. Fetal MR sequences included multiple single shot FSE T2, FSPGR T1 and diffusion sequences.

RESULTS
Case 1: The demised twin had low ADC values and high DWI signal diffusely throughout the cortex. The surviving fetal brain was normal. Case 2: The demised fetal brain had increased T2 signal throughout the brain with decreased distinction of the cortical plate. The entire brain showed diffuse increased DWI signal and corresponding low ADC values. The surviving fetal brain was normal.

CONCLUSION
These two cases of demised fetuses showed decreased ADC values 7 to 23 days after the date of presumed demise. This is far beyond the time period of decreased ADC values observed in neonates after hypoxic ischemic injury or in adults after acute arterial stroke (2, 3). This is a concerning finding that suggests we have an incomplete understanding of the pathologic response and natural time course of fetal brain injury. Therefore we should exercise extreme caution when interpreting diffusion abnormalities in fetal brains. In particular when opining the timing of injury the typical time course observed in neonates and adults with focal or global arterial ischemic injury may not apply. This could affect clinical and legal decisions.

REFERENCES

KEY WORDS: Fetal MR imaging, diffusion MR imaging, fetal brain injury

Measurement of Cerebrovascular Reactivity in Pediatric Patients with Cerebral Vasculopathy Using BOLD MR Imaging

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PURPOSE
Cerebrovascular reactivity (CVR) is a measure of cerebral autoregulatory capacity. In adults with cerebrovascular disease, an impaired CVR has been shown to be associated with an increased risk of stroke. In children however, CVR studies are not common. This may be perhaps due to the difficulties and risks associated with current CVR study methodologies. We have developed a novel noninvasive method to study CVR and the aim of this study was to introduce this technique to a pediatric population with neurovasculopathy and demonstrate the type of information that can be derived.

MATERIALS & METHODS
Eleven pediatric patients (eight with moyamoya disease, two with nonmoyamoya intracranial vascular stenosis, and one with suspected, nonmoyamoya intracranial vascular stenosis) underwent angiography, MR imaging and BOLD MR mapping of the cerebrovascular response to hypercapnia. The results of the CVR study then were compared to both the structural imaging and clinical status. Three patients additionally, underwent follow-up CVR imaging.

RESULTS
There was a strong concordance between CVR and angiographic findings. Ten patients with angiographic abnormalities also had CVR deficits in the corresponding downstream vascular territories. CVR deficits also were seen in eight out of the nine symptomatic patients and in two of the asymptomatic patients. Ten of the 11 patients demonstrated reductions in CVR extending beyond the boundaries of the ischemic lesions as identified with MR structural imaging into normal appearing brain parenchyma. Head motion and
CO\textsubscript{2} inhalation tolerance levels are two potential limitations of this methodology. In this study, head motion was not a factor. The inhalation of CO\textsubscript{2}, however, was not tolerated by one patient during a follow-up study despite an unremarkable initial study.

CONCLUSION
BOLD MR imaging measured CVR provided information on the severity and distribution of hemodynamic compromise that could not be obtained from traditional clinical assessment and structural imaging. The use of this method appears to be efficient in a pediatric population. In 11 consecutive pediatric patients only one out of a total of 15 studies was not successful (6.7%). This compares with our experience in adults in which we have seen a 5% dropout due to noncompliance with the exam. In an additional 5%, exams fail secondary to excessive head motion.

KEY WORDS: Cerebrovascular reactivity, pediatric vasculopathy, BOLD MR imaging

Poster 167
Characteristic MR Findings in Megalencephalopathic Leukoencephalopathy with Subcortical Cysts
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PURPOSE
Megalencephalic leukoencephalopathy with subcortical cysts (MLC) is an extremely rare white matter disease, recently described by van der Knaap (1995). There are only sporadic case reports describing MR findings in MLC. Using MR imaging, we present the largest comprehensive series of salient imaging features in MLC to date, including diffusion-weighted imaging and MR spectroscopic findings.

MATERIALS & METHODS
The disease is caused by mutation in the MLC1 gene. Although the phenotype is somewhat variable, the disease is characterized by clinically normal early development followed by loss of developmental milestones within the first 1 to 2 years of life. As the disease progresses, spasticity, ataxia and seizures develop. Survival is variable.

RESULTS
There is a broad neuroradiologic differential diagnosis, which includes the other "van der Knaap leukoencephalopathies": leukoencephalopathy with vanishing white matter (VWM), white matter disease with lactate (WML), and hypomyelination with atrophy of the basal ganglia and cerebellum (H-ABC).

CONCLUSION
Characteristic MR imaging features include diffuse swelling and increased T2 signal of the peripheral cerebral white matter with variable sparing of the central white matter structures. The cortical and deep gray matter are normal. Subcortical cysts are characteristically present in the anteri- or temporal poles but also are seen in the frontal and parietal lobes. Diffusion imaging shows increased ADC values. 1H-MR spectroscopic abnormalities, including N-acetylaspartate/creatine and choline/creatine ratio abnormalities typically are seen in the appropriate clinical circumstance, in addition to the van der Knaap leukoencephalopathies. We suggest consideration should be made to MLC in the presence of distinct conventional MR imaging and MR spectroscopy features that are described.

KEY WORDS: Leukoencephalopathy

Poster 168
Abnormal Axial Diffusivity in the Deep Gray Nuclei and Dorsal Brainstem in Infantile Spasm Infants Treated with Vigabatrin
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PURPOSE
Diffusion tensor imaging (DTI) indices of axial and radial diffusivity could be used as an indicator of changes in axon and myelin respectively. Animal studies have demonstrated intramyelin edema and myelin vacuolation in the white matter following vigabatrin exposure. The aim of this study is to evaluate the DTI changes in the globi pallidi, thalami and dorsal brainstem, which demonstrated abnormal T2 signal and diffusion restriction in infantile spasm infants treated with vigabatrin.

MATERIALS & METHODS
Six patients with infantile spasm were treated with vigabatrin and had high T2 signal and diffusion restriction affecting the globi pallidi, thalami and dorsal brainstem and six age-matched controls underwent DTI. Fractional anisotropy (FA), trace, axial and radial diffusivity of the globi pallidi, thalami and dorsal brainstem were assessed.

RESULTS
Patients on vigabatrin therapy had significantly lower FA in the right (p = 0.01) and left (p = 0.01) globi pallidi and dorsal brainstem (p < 0.01) compared to controls. Trace was significantly lower in the right (p = 0.01) and left (p = 0.01) globi pallidus and right (p = 0.02) and left (p = 0.01) thalami in patients. Axial diffusivity was significantly lower in right (p = 0.01) and left (p < 0.01) globi pallidi, right (p <0.01) and left (p <0.01) thalami, and dorsal brainstem (p = 0.03) in patients compared to controls.

CONCLUSION
Our findings of reduced axial diffusivity in the deep gray nuclei and dorsal brainstem in infantile spasm treated with vigabatrin suggested that axonal changes such as axonal swelling could have played a greater role in the observed abnormal signal, with lesser contribution from myelin changes, such as intramyelin edema.

KEY WORDS: Infantile spasm, DTI, vigabatrin
**Poster 169**

**Diffusion Tensor Imaging of Commissural and Projection White Matter in Tuberous Sclerosis Complex and Correlation with Tuber Load**

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**PURPOSE**

Cortical and white matter changes have been identified outside the MR imaging visible cortical/subcortical tubers in tuberous sclerosis complex (TSC). The aim of this study is to evaluate diffusion tensor imaging (DTI) changes in the corpus callosum and internal capsules and to correlate the DTI changes with cortical/subcortical tuber load.

**MATERIALS & METHODS**

Twelve TSC patients and 23 controls underwent MR imaging including DTI. Fractional anisotropy (FA), trace, axial diffusivity and radial diffusivity of genu and splenium of corpus callosum, right and left internal capsules were assessed. The number and volume of cortical/subcortical tubers were correlated with DTI indices of corpus callosum and internal capsules.

**RESULTS**

In the genu and splenium, FA was lower, and trace (p < 0.01) and radial diffusivity were higher (p < 0.01), and in the internal capsules, trace was higher (p = 0.04) in TSC patients compared with controls. The total tuber volume correlated positively with trace of genu (r = 0.77, p < 0.01) and splenium (r = 0.69, p = 0.01) and with radial diffusivity of splenium (r = 0.68, p = 0.01), and negatively with FA of splenium (r = -0.60, p = 0.04) of corpus callosum. The left and right hemispheric tuber volume correlated positively with trace of left (r = 0.56, p = 0.05) and right (r = 0.67, p = 0.02) internal capsules.

**CONCLUSION**

Our findings of reduced FA, elevated trace and elevated radial diffusivity in the corpus callosum and internal capsules may be related to abnormalities in myelin. The correlations between tuber volume and DTI indices in corpus callosum and internal capsules suggested that more extensive malformation as demonstrated by larger tuber load was more likely to be associated with more severe DTI changes in the commissural and projection white matter.

**KEY WORDS:** Tuberous sclerosis, diffusion tensor imaging

**Poster 170**

**Improving Magnetoencephalographic Language Mapping Using fMRI-Guided Spectro-Temporal Analysis**

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**PURPOSE**

This study attempts to improve upon magnetoencephalographic (MEG) clinical methodologies for mapping language hemisphere dominance in a pediatric population. Magnetoencephalography is a powerful tool for presurgical functional mapping of language laterality, but currently fMRI remains the gold standard for noninvasive mapping of language function. Promising MEG language activation protocols and analysis methods are still under development, and may not generalize directly to clinical pediatric populations. We targeted, retrospectively, specific cases where fMRI language mapping was more successful than MEG activations using published protocols. Through a data-driven approach, we applied individually optimized time-frequency analysis of MEG source waveforms based on fMRI functional language activations. By doing so, we aim to increase success rates of pediatric MEG language lateralization.

**MATERIALS & METHODS**

All 12 subjects (5 female; average age = 11.9 +/- 3.3 years) underwent whole-head 275-channel MEG and fMRI receptive language tasks. Time-frequency analyses driven by fMRI activity-based seed regions were performed for each subject and corresponding statistical images of spatially filtered activity were executed with synthetic aperture magnetometry (SAM). Recent observations have shown language activity across many spectral bands (1), thus event-related desynchronization (ERD) analysis assessed activity in alpha (8-12Hz), beta (12-30Hz) and low (30-50Hz) and high (50-100Hz) gamma ranges. Functional data in three forms (fMRI; MEG from current clinical protocols; MEG from a proposed new protocol) were read for language hemisphere dominance. Group averaging assessed overall improvements in language lateralization.

**RESULTS**

Synthetic aperture magnetometry peak analysis yielded the highest concordance with fMRI localization when performed from 40-55Hz, 200-700ms poststimulus onset. Rater confidence improved over original methods when assessing MEG data at this low-gamma range. Group analysis of statistical ERD volumetric images from patients with left hemisphere fMRI localization showed greater laterality of activation to left hemisphere language areas than with previous methods.
CONCLUSION

Magnetoencephalography is shown to be an excellent tool for functional language mapping of presurgical populations (1). In the present study, we focused on a subgroup of clinical pediatric patients which presented a challenge to conventional MEG analysis methods, but for whom fMRI was overall successful. Using seed locations from fMRI language areas, we observed novel and promising functional networks, observed primarily in the low-gamma frequency range. While still under development, these results indicate higher MEG sensitivity to eloquent language areas needed for successful presurgical planning.

REFERENCES


KEY WORDS: Functional brain mapping, language lateralization, magnetoencephalography

Poster 171

An Unusual Case of Hemimegalencephaly and Tuberous Sclerosis Complex in One Patient: Imaging Features

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PURPOSE

To discuss the imaging appearance of an unusual case of tuberous sclerosis and hemimegalencephaly and to describe the use of diffusion tensor imaging in reaching a more precise depiction of this complex pathology.

MATERIALS & METHODS

A full-term female born with a shagreen patch over her left parietal scalp was noted to have a partial seizure. A diagnosis of tuberous sclerosis complex (TSC) was suggested clinically and was confirmed via a positive result for the TSC2 gene mutation. A head CT obtained on the first day of life, in addition to showing imaging features typical for TSC, showed a grossly abnormal and enlarged left cerebral hemisphere, asymmetric enlargement of the ipsilateral ventricle, and abnormally hyperdense cerebral parenchyma. These findings were highly suggestive of hemimegalencephaly (HME), concomitant with clinically diagnosed tuberous sclerosis. Further evaluation of these cerebral abnormalities was performed on a Trio 3 T Siemens Magnet, with utilization of diffusion tensor imaging, sampling the data in 20 directions, with FA maps and corpus callosum and longitudinal fibers tractography. Additional evaluation with cardiac echography and renal ultrasound was performed to search for potential extracranial features of TSC.

RESULTS

Brain MR imaging confirmed the presence of pachygyria, dysplastic white matter, an enlarged and misshaped lateral ventricle, enlargement of the left cerebral hemisphere denoting HME, and imaging manifestations of tuberous sclerosis. T1- and T2-weighted MR images demonstrated numerous cortical/subcortical tubers and dysplastic white matter tracts. Subependymal hamartomatous nodules seen on all sequences included bilateral masses at the foramina of Monro which were worrisome for giant mixed cell tumors. Disturbed and asymmetric cerebral white matter tracts were demonstrated by DTI. Finally, multiple cardiac rhabdomyomas, numerous small renal cysts, abnormal renal echogenicity, and a possible punctate echogenic focus suggestive of a fat-contained lesion were demonstrated. The patient had multiple seizures daily and eventually developed refractory epilepsy. Information obtained from DTI mapping displaying the abnormal white matter tracts allowed the consideration of a highly specialized and selective surgical intervention.

CONCLUSION

A newborn child initially diagnosed with tuberous sclerosis complex was, in addition, found to have hemimegalencephaly, which is a rare combination only occasionally published in a few case reports. This case demonstrates that radiologists should be aware of the potential for HME and TSC to present in a single patient. Diffusion tensor imaging should be an essential part of such a patient’s evaluation, providing data that can enable selective sparing neurosurgery instead of a highly traumatic hemispherectomy.

KEY WORDS: DTI, hemimegalencephaly, tuberous sclerosis
Poster 172

Hemiatrophy and Venous Anomalies Associated with Linear Sebaceous Nevus Syndrome: A Rare Phakomatosis

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PURPOSE

Linear sebaceous nevus syndrome is a rare neurocutaneous disorder associated with mental retardation, linear sebaceous nevus of Jadassohn and seizures. The syndrome was recognized first by Feuerstein and Mims in 1962. Cases of hemimegalencephaly associated with this disorder have been reported. A few cases of cerebrovascular abnormality associated with this syndrome have been reported involving arterial, venous and capillary anomalies. We present a case of hemispheric hypoplasia with unusual draining veins associated with linear sebaceous nevus syndrome and demonstrate the clinical dermatologic appearance, CT and MR findings.

MATERIALS & METHODS

Nonenhanced CT scan: sequential 5 mm axial images. MR imaging precontrast sagittal and axial T1-weighted, axial and coronal T2-weighted turbo spin echo, T2 gradient echo, T2-FLAIR and postcontrast T1-weighted images (sagittal, axial and coronal).

RESULTS

CT scan demonstrates sulcal and ventricular prominence involving the left cerebral hemisphere with an associated increase in extraaxial space. Focal thinning of the left frontal bone. MR scan showed atrophy of the left (ipsilateral to the linear nevus) supratentorial cerebral cortex, most pronounced in the temporal and occipital lobes. After contrast administration, prominent draining veins were seen deep within the hemispheres and a single enlarged draining vein was seen on the surface of the posterior left parietal lobe.

CONCLUSION

At least five distinct epidermal nevus syndromes have been described and are characterized by the presence of epidermal nevi and involvement of other organ systems: particularly brain, eyes and skeleton. The syndromes are classified according to the different types of associated epidermal nevi. The combination of vascular anomaly and hemi-hypoplasia vs atrophy, in this case, is the only report of this combination, a definite correlation cannot be assumed. We hope that this case report will lead to further investigations of the pathophysiology of this proposed genetic disorder.

KEY WORDS: Linear sebaceous nevus syndrome, hemiatrophy, phakomatosis

Poster 173

Computer-Aided Diagnostic System for Infant/Pediatrics: Brain Volume and Sulcus

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PURPOSE

Quantitative CAD system for aged brain using MR imaging now is used widely, but not for infants and pediatric brain. Why can CAD of elderly people’s brain not apply to the pediatric brain? It is mainly because 1. Small sulci of infantile and pediatric brain makes it difficult for CAD for grown ups to extract the brain parenchyma from them. 2. Small sulci of pediatric especially infantile brain hardly detected by CAD for aged brain. 3. Rapid MR signal changes during infantile and pediatric age make it difficult to decide which is white matter and gray matter. We have been trying various methods to resolve difficulty. Difficulty 1: And it is still on the way. Purpose of this Poster is to use the newest method to extract infantile brain and challenge. Difficulty 2. And develop a new interactive gyrus labeling method for the infantile brain on MR imaging, and this availability of the methods is for clinical use.
**Materials & Methods**

Thirteen infants included in this study (male/female = 8:5, 3 weeks - 4 years 3 months old). The patients underwent MR imaging because of hypoxic ischemic injury or epileptic attack, but diagnosed normal on MR imaging and clinical follow up. Informed consent of each case was obtained from the patients. MR scanning was performed using a 1.5 T MR system (Philips INTERA), by 3D IRT1 images: T1FFE (TR 25, TE 4.6, FA 30, FOV 200, matrix 256*256, SENSE 1.5, slice thickness 1 mm, 180 slices). The proposed system automatically determines gyral boundaries with respect to guidelines. The guidelines are given by users with roughly indicating gyral boundaries on the cerebral surface. Brain parenchyma was extracted by using pediatric brain area extraction method, which our colleague Kobashi and Hujimoto developed (1). And made a bird’s eye picture of the brain. On the picture, we manually detected major brain sulci: longitudinal cerebral fissure, superior, middle and inferior frontal sulcus, precentral sulus, central sulcus. We applied our CAD system to the same pictures and compared the results of manual detection and CAD detection. We evaluated the segmentation accuracy using Sensitivity and False Positive Rate (FPR).

**Results**

On all subjects, CAD detected the major sulci successfully. The result showed that our CAD method labeled sulci with a sensitivity of 89.6%~96.9% (mean 92.8%), and false positive rate of 0.1~0.2%(mean 0.1%).

**Conclusion**

This CAD system can accurately label the sulci of infant brain and makes us monitor infant brain development quantitatively.

**References**


**Key Words:** Computer-aided diagnosis, pediatric brain, MR imaging

**Poster 174**

**Serial MR Imaging of Term Encephalopathic Neonates following Selective Head Hypothermic Therapy: Initial Basal Ganglia Diffusion Values and Subsequent Early Trends within the Subacute Phase following Therapy**

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**Purpose**

Therapeutic hypothermia may reduce morbidity and mortality of neonatal hypoxic-ischemic encephalopathy. Quantitative assessment of diffusion MR indices such as the apparent diffusion coefficient (ADC) in the subacute phase may be useful in assessing the extent of cerebral injury prior to cooling and efficacy of treatment in reducing the effects of secondary injury. Such objective information of the injury process would be useful when evaluating long-term outcomes data. Based on the previously reported known diffusion changes occurring in neonatal brain development and injury, we hypothesize that two distinct patterns of diffusion changes may be demonstrated within the subacute phase in severely encephalopathic neonates treated with hypothermic therapy. The first pattern, possibly representing a less severe initial injury with some resultant response to therapy would manifest as initial normal basal ganglia diffusion values with a subsequent gradual decrease diffusion values consistent with structural maturation unaffected by significant injury. The second pattern, possibly representing a severe injury, not significantly responsive to therapy would manifest as initial low basal ganglia diffusion values with subsequent rising diffusion values consistent with evolving injury.

**Materials & Methods**

The MR imaging performed at 1.5 T on term neonates completing 72 hours of therapeutic head cooling (Olympic Cool Cap System, Natus Medical San Carlos, CA) was reviewed. Prior to therapy, all neonates were assessed clinically and met the criteria of severe encephalopathy based on protocols for Cool Cap eligibility. Region-of-interest analysis was performed on the MR images of those infants who underwent serial imaging within the first 2 weeks of life. Apparent diffusion coefficient (ADC) values were obtained from the thalamus of each of these infant’s MR images. Comparison of these ADC values was made with known standard values and trends in normal development and following injury.

**Results**

Thirty neonates underwent MR imaging. Of these, the MR images of the 7 neonates who had two exams performed within the first 15 days of life (range 3-15 days) were reviewed and analyzed. Five neonates were initially imaged at 4 days of life, one at 1 day of life and one at 5 days of life. The first proposed pattern of diffusion changes were demonstrated by 4/7 (57%). The second pattern was demonstrated in 2/7 (28%) of infants. One neonate demonstrated a mixed pattern in which a normal ADC value was measured initially yet the value later trended up.

**Conclusion**

Therapeutic hypothermia has been shown to reduce neurologic injury in hypoxic ischemic encephalopathy. Within this small subset of initially severely encephalopathic and subsequently therapeutically cooled neonates, diffusion indices (ADC) from serial MR imaging within the subacute phase were evaluated. The results of this analysis largely conformed with the values and trends hypothesized to exist in this cohort. Two patterns based on diffusion values, one more and one less consistent with injury were demonstrated. Further study with a larger cohort of subjects will be necessary to more accurately evaluate these findings. Objective information regarding neonatal encephalopathy obtained closer to the time point of initial injury may prove useful in evaluating long-term outcomes data.

**Key Words:** Neonatal, diffusion, encephalopathy

**Poster 175**

Withdrawn
Regional Variations in Brain MR Imaging and Correlation with Outcome after Pediatric Cardiac Arrest

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PURPOSE
Survival after cardiac arrest (CA) in children ranges from 8-45% and more than half of the survivors sustain significant brain injury and neurologic deficits. Magnetic resonance imaging (MRI) is a sensitive tool to detect regional brain injury, and there is a scarcity of data describing the utility of various pulse sequences to predict brain injury in this population. Our objective is to determine patterns of brain injury on conventional and diffusion-weighted MRI in children surviving CA in the first 2 weeks after resuscitation, and to correlate the neuroimaging findings with hypothermia therapy and clinical outcome.

MATERIALS & METHODS
We reviewed an established database of children with CA from 2002-2008 who underwent brain MRI on a 1.5 T GE magnet at the Children’s Hospital of Pittsburgh. Subjects were children surviving CA and having a brain MRI in the first 2 weeks after resuscitation and absence of other acute brain injury. Two neuroradiologists blinded to outcome, use of hypothermia, and the original image analysis retrospectively evaluated images for evidence of regional (cortex, basal ganglia, thalamus, brain stem, cerebellum) brain injury using T1, T2, and diffusion MR pulse sequences. Apparent diffusion coefficient (ADC) maps were graded visually. Data were analyzed by brain region for survival to hospital discharge and use of hypothermia therapy using Fisher’s exact and logistic regression.

RESULTS
Thirty-three children, (11 female), median age 2.3 years (range 1.5 weeks -18 years) were included in this study and 26 (79%) survived to hospital discharge. Patterns of brain injury were region and pulse sequence-dependent. Increased T2 signal intensity in the basal ganglia and increased T1 signal in the thalamus and cerebellum brain injury using T1, T2, and diffusion MR pulse sequences. Apparent diffusion coefficient (ADC) maps were graded visually. Data were analyzed by brain region for hospital discharge and use of hypothermia therapy using Fisher’s exact and logistic regression.

CONCLUSION
We found regional patterns of injury on brain MRI in children up to 2 weeks after CA that were pulse sequence-dependent and associated with mortality. Similar to data in neonates with birth asphyxia, hypothermia therapy may have a protective effect on cerebral cortex.

T2 Relaxometry of the Human Brain between Birth and 4.5 Years of Age

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PURPOSE
Advances in imaging technology have enabled acquisition of very high-resolution images within time frames feasible for pediatric populations. Deciphering patterns of myelination in the first few years of life may be of considerable use in recognizing any anomaly during this period. Our analysis focuses on evaluating T2 relaxation times as a surrogate for myelination in the corpus callosum, frontal and occipital white matter in male and female children from neonatal period to 4.5 years of age.

MATERIALS & METHODS
Data from the NIH Pediatric MRI Data Repository were processed using MRICro and ImageJ to generate T2 maps. T2 values were measured in voxels of interest (VOI) in the genu, splenium, frontal and occipital white matter for 102 images obtained from 59 subjects. T2 values for each VOI were plotted against age.

RESULTS
An exponential fit for T2 values indicates that occipital white matter has a lower T2 value than the frontal white matter in both males and females in the first year of life. In the corpus callosum, splenium has a lower T2 value than the genu in both males and females in the first 2 years of life. VOIs in females have a lower T2 value than corresponding VOI in males in the first 2 years of life. After 2 years of age, T2 values were comparable in all the VOI in males and females.

CONCLUSION
Our analysis confirms that in the postnatal life, myelination proceeds in a postero-anterior direction. Secondly, it indicates that male and female brains myelinate differently.
While brain in the females are more myelinated than brain in males in the neonatal period (as evidenced by lower T2 values), the male brain myelination accelerates to equate the level of the female brain before the end of second year.

REFERENCES

KEY WORDS: T2 relaxometry, brain, corpus callosum

Poster 178
White Matter Changes in Neonates with Hypoxic Ischemic Encephalopathy Measured by Diffusion Tensor Imaging

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PURPOSE
Conventional MRI findings of hypoxic-ischemic encephalopathy (HIE) include deep gray matter and perirolandic white matter changes (1). We investigated if there may be white matter changes not detected on structural studies. We aimed to determine white matter changes using fractional anisotropy (FA) and apparent diffusion coefficient (ADC), comparing them to normal term babies, to better understand pattern of brain injury.

MATERIALS & METHODS
Diffusion tensor imaging (DTI) was performed on 12 term neonates with hypoxic ischemic encephalopathy who have undergone whole body hypothermia therapy. Eight normal term neonates served as controls. The study was IRB approved. Regions of interest were drawn bilaterally in the middle cerebellar peduncle, temporal white matter, parietal white matter, frontal white matter, occipital white matter, genu and splenium of the corpus callosum, and posterior limb of the internal capsule. Fractional anisotropy (FA) and apparent diffusion coefficient (ADC) were measured and analyzed using the T-test for independent samples.

RESULTS
Significant difference in FA in the genu of the corpus callosum (HIE FA = 0.39 ± 0.08 / mean ± sd; normal FA = 0.45 ± 0.06; P = 0.01) between the neonates with HIE and normal neonates was found. Differences also were noted in the ADC values of parietal white matter (HIE ADC = 1.38 x 10⁻⁴ ± 1.778 x 10⁻⁴ /mean ± sd; normal ADC = 1.51 x 10⁻⁴ ± 2.02 x 10⁻⁴; P = 0.04) and a trend at the posterior limb of internal capsule (HIE ADC = 1.11 x 10⁻⁴ ± 1.19 x 10⁻⁴ /mean ± sd; normal ADC = 1.00 x 10⁻⁴ ± 2.36 x 10⁻⁴; P = 0.06). On conventional imaging, none of the HIE neonates showed signal changes in the corpus callosum in our study.

CONCLUSION
While changes observed at the parietal white matter and posterior limb of the internal capsule was consistent with known findings, we found significant difference in FA in the genu of the corpus callosum between HIE and normal neonates, which has not been described previously. These findings may be linked with animal models of HIE that have shown extensive degenerative changes with loss of axons and neuronal degeneration in corpus callosum (2) in response to acute hypoxic injuries.

REFERENCES

KEY WORDS: Diffusion tensor imaging, neonates, hypoxic ischemic encephalopathy

Poster 179
Fetal Hippocampal Development: Analysis by MR Imaging Volumetry

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PURPOSE
The hippocampal formation plays an important role in cognitive function, notably learning and memory. Abnormal hippocampal formations have been described in several congenital cerebral abnormalities. Furthermore, in utero it is vulnerable to hypoxia, stress and undernutrition. This study
was performed to evaluate fetal hippocampal development in healthy fetuses of varying gestational ages using 3D reconstructed MR imaging (MRI).

MATERIALS & METHODS
A cohort of 20 healthy pregnant women underwent prenatal MRI using 2D single-shot fast spin-echo T2-weighted technique. Median gestational age was 25.1 weeks based on last menstrual period (range 21-36 weeks). Six patients also underwent a second fetal MRI which was performed on average 6.2 weeks after the first MRI. Fetal MR images were reconstructed using an automated intersection-based motion correction algorithm (1). Manual segmentation of the hippocampal formation subsequently was performed based on adult hippocampal volumetry methodology adapted to the cerebral fetal hippocampal anatomy. Right and left hippocampal volume (HV) as well as total HV were calculated for each subject. Right and left HV were compared using a paired t-test. Linear regression analysis was performed on HV with increasing gestational age. Intracranial volumes (ICV) also were calculated for 12 subjects (mean GA 23 weeks, range: 21.28-26.1 weeks) using automated segmentation methods (2); and the correlation coefficient between HV and ICV was determined. Seven scans also were selected randomly and the hippocampi were manually resegmented to assess intraobserver variability.

RESULTS
There was no significant difference between right and left HV (P=0.1). Analysis of total HV as a function of gestational age revealed a linear increase in HV between 21 and 36 gestational weeks (P < 0.001). For all subjects scanned at two time points, there was an increase in size of the hippocampus on the second fetal MRI. Intraobserver variability for manual hippocampal segmentation was 4.1%. There was 0.82 correlation of HV with ICV for fetuses aged 21-26 gestational weeks.

CONCLUSION
The fetal hippocampal formation can be analyzed using 3D reconstruction prenatal MRI. Using an adapted methodology for the fetal population we were able to establish normative volumetric data for this important cognitive structure. This normative data will be helpful for future comparison studies of suspected abnormalities of hippocampal structure and function which may occur prenatally.

REFERENCES

KEY WORDS: Hippocampus, prenatal MR imaging, volumetry
CONCLUSION
Intrathecal inflammatory masses are becoming recognized more frequently in patients receiving intraspinal opiates for chronic pain syndromes. It is imperative to recognize both the clinical and radiologic features when imaging patients with implanted pumps and to have a high index of suspicion for an intrathecal inflammatory mass occurring at the level of the catheter tip in any patient with new or otherwise unexplained neurologic signs or symptoms. Imaging studies must be designed to include the catheter tip level to ensure detection of this lesion when present.

KEY WORDS: Intrathecal, mass, granuloma

Poster 181
Tuberculosis Spondylitis: Review of MR Imaging Characteristics
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PURPOSE
Mycobacterium tuberculosis (MTB) remains a major public health hazard. In recent years there has been an increase in global prevalence not only in Africa and Asia but also in developed countries. Spondylitis is the most common osseous manifestation of MTB and MR imaging is the modality of choice for its radiologic detection due to its exquisite detail, multiplanar capabilities and superior soft-tissue contrast resolution. The purpose of this study is to describe the key MR imaging features of MTB spondylitis.

MATERIALS & METHODS
All microbiology-proved tuberculosis cases of the spine presenting at our institution over a 5-year period were reviewed and their MR images scrutinized for common patterns.

RESULTS
Our findings concurred with previous reports that three main patterns of vertebral body involvement occur: paradiskal, anterior and central. Paradiskal lesions are most common and tend to involve the disk either by direct infiltration or by herniation of the disk into the diseased vertebral body. Disk involvement with subsequent contiguous spread to adjacent vertebral bodies leads to the classic pattern of vertebral osteomyelitis with destruction of two or more contiguous vertebrae and apposed end plates and disk infection (Potts disease). MR imaging demonstrates low signal intensity on T1- and generally heterogeneous high signal intensity on T2-weighted imaging. The vertebral body shows abnormal increased signal following gadolinium and disk involvement usually is depicted by abnormal high signal on T2-weighted imaging. Progressive bone necrosis leads to collapse and wedging of multiple vertebral bodies resulting in the characteristic gibbus deformity. Involvement of the disk allows infection to disseminate to adjacent paraspinal soft tissues creating a paravertebral abscess. The classic, iliopsoas abscess can allow infection to track to the groin. Anterior lesions are subperiosteal, occurring under the anterior longitudinal ligament (ALL). Accumulation of pus causes striping of the periosteum and ALL away from the anterior vertebral bodies and permits the development of a large subligamentous abscess with relative sparing of the intervertebral disks. Central lesions are centered on the vertebral body with intervertebral abscess and adjacent disks are not involved. This pattern is uncommon but vertebral collapse can occur, giving rise to vertebra plana deformity. A small number of patients suffered significant neurologic complications from the accumulation of epidural pus and granulation tissue. Uncommon features of spinal MTB included involvement of multiple nonadjacent vertebrae, sparing of the disk, and reactive sclerosis. Involvement of posterior elements also was unusual but was usually infiltrative from the adjacent vertebral body. One patient had the rare manifestation of costovertebral joint septic arthritis.

CONCLUSION
Mycobacterium tuberculosis spinal involvement should be considered with a high index of suspicion in all patients with back pain, particularly those in high-risk populations. MR imaging is a pivotal tool in the diagnosis and management of this disease. Although no single imaging characteristic exclusively permits the diagnosis of MTB spondylitis, several simultaneous imaging features can strongly support its diagnosis. Radiologists should be familiar with these characteristics to enable a more rapid diagnosis and to facilitate in the prevention of potential life-limiting consequences.

KEY WORDS: Tuberculosis, spondylitis, MR imaging
New Vertebral Compression Fractures following Prophylactic Vertebroplasty in Osteoporotic Patients

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PURPOSE
Previous studies have shown the possible efficacy of prophylactic cement injection for nonfractured vertebrae during percutaneous vertebroplasty (PV) for compression fractures. The purpose of this study was to investigate risk factors for subsequent fractures after prophylactic PV.

MATERIALS & METHODS
This study included 116 patients with osteoporotic compression fractures who received prophylactic PV. The patients were followed with physical examinations and radiographs at 1 day, 3 and 12 months after PV. They were allowed to visit us if back pain relapsed. We analyzed the following multiple covariates to determine whether they were associated with recurrence: age, gender, steroid use, a number of unhealed compression fractures, or a number of chronic compression fractures.

RESULTS
Subsequent fractures occurred within 3 months after the procedure at 26 vertebrae in 21 patients (18.1%), and 36 new fractures occurred in 28 patients (24.1%) within 12 months. Subsequent fractures occurred frequently at adjacent vertebrae (21/36, 58.3%). The occurrence of new fractures within 12 months depended on the number of unhealed vertebrae, as follows: 16.9% (11/65) for 1 vertebra, 27.0% (10/37) for 2 vertebrae, and 50.0% (7/14) for 3 or more vertebrae. The incidence of new fractures was significantly higher in patients with 3 or more fractures than in those with 1 fracture (P < .05). There were no statistically significant differences in other factors. In multivariate logistic regression after adjusting for age, gender, the use of steroid, and the number of the chronic vertebral fracture, the number of unhealed vertebral fractures was still highly significant (P = 0.02, odds ratio = 5.2, 95% confidence interval = 1.4-19.6) in relation to fractures.

CONCLUSION
Patients with three or more fractures tended to have subsequent fractures, despite undergoing prophylactic PV. There is a correlation between the number of unhealed fractures and occurrence of new fractures after prophylactic PV.

KEY WORDS: Vertebroplasty, prophylactic, compression fracture

Electromagnetic Image-Guided Navigation for Percutaneous Guide-Wire Insertion: Accuracy and Efficiency Compared to Conventional Fluoroscopic Guidance

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PURPOSE
This study was performed to assess the accuracy and time efficiency (placement and fluoroscopy) using EM navigation versus conventional C-arm X-ray in the placement of a bone biopsy needle and pedicle guidewires as a first step in creating a transpedicular pathway for instruments used in vertebroplasty, kyphoplasty and MIS spinal fusion.

MATERIALS & METHODS
Four human cadavers were allocated randomly (two in each group) to be instrumented using fluoroscopy-based EM navigation (EM group) or fluoroscopy alone (Fluoroscopy group). Kirschner wire (K-wire) insertion was applied bilaterally at each level T10 to S1 in two specimens (one in each group) and from T8 to S1 in two specimens (one in each group) for a total of 80 wire placements (40 levels) using the FluoroTrak EM navigation system (GE Healthcare Surgery, Salt Lake City, UT). Frontal and lateral plane views were acquired to the navigation system with a GE C-arm. Bone biopsy needles were used for the K-wire insertions. In the Nav group, a small cubical transmitter is attached percutaneously via a bone pin to the spinous process. This creates the EM field to track a navigation needle accurately through the pedicle for K-wire delivery. Time for set up, placement, and fluoroscopy was recorded. After insertion, the accuracy for each side and level was assessed for the presence and location of facet joint, pedicle, or vertebral cortical perforation using computed tomography (CT) imaging with multiplanar reconstructions and using a 4-point grading scale from ideal placement (0 mm) to markedly displaced (5 mm+). Statistical analysis was performed using StatCrunch 4.0.

RESULTS
K-wire placements were 100% successful for both methods. Comparing EM-based IGS placement with the conventional fluoroscopy method showed a longer set-up time of 9.6 minutes versus 3.6 minutes, respectively. The set-up time was defined to begin when initial localization images were taken and end when the first bone biopsy needle penetrated the skin. However, mean placement times of 6.3 minutes versus 9.7 minutes (P = 0.005, Student’s t-test) and mean fluoroscopy times of 11 seconds versus 48 seconds (P < 0.0001) were both shorter for the EM group. There were no significant differences in the proportion of pedicle, vertebral body, or facet joint breaches and no neurologic or vascular intrusions. A higher proportion of ideal trajectories were achieved in the EM group.
CONCLUSION
In our study, the use of EM computer-assisted navigation systems in association with fluoroscopy can assist the interventional radiologist or spine surgeon in pedicle screw insertion by providing high accuracy K-wire placement with a significant reduction in fluoroscopy time relative to the use of a C-arm alone.

KEY WORDS: EM navigation, spine imaging

Poster 184
Interreader Agreement of Cerebrospinal Fluid Peak Velocity Measurements Processed from Phase-Contrast MR at the Foramen Magnum in Patients with Suspected Chiari I Malformations

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PURPOSE
The purpose of this study is to determine the inter-reader agreement between two independent observers of peak cerebrospinal fluid (CSF) velocities at the foramen magnum obtained in a routine clinical setting. Peak velocities are highly dependent on the region of interest (ROI) placed during analysis of phase contrast MR. Our hypothesis was that the degree of agreement as measured by the intraclass correlation coefficient would be greater than or equal to 0.80.

MATERIALS & METHODS
Forty consecutive MR phase-contrast CSF flow studies performed on a 3.0 T MR imager (Siemens Medical Systems) at Harborview Medical Center (Seattle, WA), with axial sequences performed at the foramen magnum, were identified. Using commercially available software (Argus Flow; Siemens Medical Systems), two observers (JYL, MPD) and a third reader (JGJ) formed a consensus method for ROI placement. Then one neuroradiology fellow and one MR technologist independently processed the axial phase-contrast images and recorded peak cranial and caudal CSF velocities at axial levels acquired just above, at, and just below the foramen magnum. These values were compared using the intraclass correlation coefficient.

RESULTS
During the consensus sessions, it was clear that the peak velocities were highly dependent on ROI position and shape. The consensus method of ROI placement was to include as much subarachnoid space as possible, including brain and spinal cord, while achieving a sinusoidal peak velocity curve. Keys for enhancing reproducibility were to exclude regions of aliasing, vessels, and bone. Following these guidelines, the intraclass correlation coefficient between the two observers was 0.97 (95% confidence interval, 0.96-0.98). Instances in which peak velocities differed most between observers tended to be cases in which one observer’s ROI failed to exclude the entire vertebral artery and/or vertebral artery flow signal was mistaken for subarachnoid space.

CONCLUSION
There are multiple qualitative ways to describe CSF flow. There are also multiple quantitative methods, including flow volumes, average velocity, and peak cranial and caudal velocity. Many studies have used phase contrast performed at a midsagittal plane to make measurements, which may underestimate peak velocities. This study suggests that measuring peak cranial and caudal velocities from axial phase-contrast images at the foramen magnum is highly reproducible between observers with different levels of training (technologist vs neuroradiology fellow). Future studies may delineate the ability of quantitative CSF flow measurement to predict Chiari symptomatology and response to surgery.

KEY WORDS: Chiari, phase-contrast MR imaging, CSF flow

Poster 185
Withdrawn

Poster 186
Diagnosis and Endovascular Treatment of Spinal Arteriovenous Malformations Supplied by Intercostal and Lumbar Arteries

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PURPOSE
Selective spinal angiography (SSA) is considered the preferred method for diagnosis of arteriovenous malformations (AVM) of the spinal cord in the detection of blood supply sources, blood outflow pathways, localization, hemodynamic characteristics and structure of the AVM’s vascular conglomerate. The decision for choosing a method of endovascular treatment of spinal AVM depends on these data. We determined the optimal endovascular methods in the treatment of thoracic and lumbar spinal AVMs.
Arteriovenous malformation (AVM) of spinal cord is diagnosed by vascular pathology mainly in patients at young and middle age. Selective spinal angiography (SSA) is considered the preferred method for diagnosis of spinal cord AVM in the detection of blood supply sources, blood outflow pathways, localization, hemodynamic characteristics and structure of the AVM’s vascular conglomerate. The decision for choosing a method of endovascular treatment of AVM in the cervical region of the spinal cord depends on these data. We determined the optimal endovascular methods in the treatment of cervical spinal cord AVM and investigated neurologic symptoms in patients before and after treatment.

**MATERIALS & METHODS**

Over a period of 25 years (from 1983 to 2009) 78 patients with AVM in the cervical region of the spinal cord were treated in the Burdenko Neurosurgery Institute (male-31, female-22, children-25). Endovascular treatment of AVMs was performed above 118 AVM vessels occlusions. All subjects underwent MR imaging and SSA. The endovascular methods used for occlusion of afferent AVM’s vessels were balloon-occlusion method by F. Serbinenko, occlusion with PVA-fragments, occlusion with Hystoacryl glue. The combined method was used for AVMs with multichannel blood supply. Arteriovenous malformation vessel occlusion by PVA-emboli was performed in 42 patients; 23 of them required repeated embolization. Occlusion by histoacryl and lipiodol glue compositions was used in 27 cases. For AVM afferent vessels catheterization we used different micro-guided “BALT” microcatheters.

**RESULTS**

Arteriovenous malformation gets blood supply mainly from radiculomedullary branches of the vertebral artery and costocervical trunk and thyroid axis. Aneurysm’s twisted vessels which have been reported to be hypointense on preoperative T1 images, were not detected (revealed) by postoperative control MR imaging. Instead of them a hyperintense signal from thrombosed AVM vessels was marked. The benefit from endovascular surgery and all symptoms of the disease were evaluated for each patient individually. Sixty-nine patients showed significant neurologic improvement though earlier they revealed severe neurologic symptoms: paraparesis, paraplegia, tetraparesis, tetraplegia associated with sensitive disturbances and pelvic organs dysfunction. Absence of neurologic regress was marked in six patients.

**CONCLUSION**

Thus, having analyzed positive neurologic outcome in 90% of patients with AVMs in the cervical region of the spinal cord operated by using endovascular technique we conclude that endovascular method of treatment is considered an adequate method of choice.

**KEY WORDS:** Spine
**Poster 188**  
Idiopathic Thoracic Spinal Cord Herniation: Retrospective Analysis Supporting a Mechanism of Dural Injury and Subsequent Tamponade

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**PURPOSE**
Idiopathic thoracic spinal cord herniation (tSCH) is a rare disorder typically presenting in middle-age patients with myelopathy in whom the anterior portion of the spinal cord herniates through a defect in the ventral dura. While spinal trauma or surgery may produce such defects, idiopathic herniation occurs in the absence of this history. Numerous mechanisms explaining its pathogenesis have been proposed, including unrecognized trauma, congenital meningeal malformations, CSF flow pulsations, and dural erosion by calcified disk remnants. While more than 100 cases have been reported, no consensus exists as to the most likely mechanism. Our observations, detailed below, support the presence of an unrecognized thoracic disk/osteophyte that erodes the anterior dural surface. Cerebrospinal fluid pulsations then propel the cord to tamponade the meningeal defect leading to cord herniation and possible strangulation by the lacerated dural edge. This also is supported by the presence of CSF leakage from the dural defect, which may predispose patients to transient intracranial hypotension (IH), which stops following cord herniation. The upper thoracic cord is a likely place for anterior dural puncture by calcified disk remnants because it is the spinal cord region most closely apposed to the posterior surface of the vertebral bodies and intervertebral disks. Here, we report that retrospective analysis of imaging published in all case reports and add our own cases to support this mechanism.

**MATERIALS & METHODS**
Published imaging from all available prior case reports in the scientific literature was reviewed to determine whether tSCH occurred at the disk or bone level. The presence of extradural CSF (ECSF), herniated nucleus pulposus (HNP), or an osteophyte (OP) in the spinal canal was determined from review of published axial images. Detection of ECSF, HNP and OP was limited to reviewing only the published images, which typically included one axial image representing a 2.5-5 mm cross-section through the spinal column. Additionally, three previously unreported cases from our department’s teaching file were assessed using the same criteria. All cases were examined for presence of headache in the patient history, a symptom possibly indicating IH. The number of cases examined and extent of image analysis was limited by the presence and quality of published images.

**RESULTS**
Our analysis identified 67 distinct cases of idiopathic thoracic spinal cord herniation with published images. In greater than two thirds (n = 47 of 67) of cases, tSCH occurred at a disk level. When assessment was possible, ECSF, HNP and OP were present in 26.8%, 30.7% and 26.2% of cases, respectively. Overall, 52.3% of cases with published axial images demonstrated evidence of at least one of these abnormalities.

**Conclusion**
Thoracic spinal cord herniation is a rare event whose pathogenesis is under considerable debate. Retrospective analysis, along with the inclusion of three unpublished cases, indicates that herniation preferentially occurs at the level of the intervertebral disk space. Based on assessment of ECSF, HNP, and OP in axial images, the findings are consistent with an etiology whereby the cord herniates through a clinically unrecognized intervertebral disk rupture or osteophyte formation that punctures the anterior dura and leptomeninges. 

**KEY WORDS:** Thoracic spinal cord, herniation, mechanism

**Poster 189**
Evaluation of iPhone-Based Teleradiology Solution for the Diagnosis of Cervical Spine Trauma: A Feasibility Study

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**PURPOSE**
Injury to the cervical spine is one of the most feared traumas, and spinal cord injury is a major cause of disability. Little controversy exists regarding the need for accurate and emergent imaging assessment of the traumatized spine in order to evaluate spinal stability and integrity of neural elements. We developed a solution that allows visualization of images on the iPhone (Apple Inc., Cupertino, CA) that has two unique features. First, all patient data remain on the visualization server and not saved on the iPhone device thus maintaining patient confidentiality. Second, the visualization server can rapidly load and allows diagnostic interpretation to begin almost immediately. The purpose of this study was to compare the diagnostic interpretation accuracy of cervical spine trauma CT scan using a smartphone (iPhone).

**MATERIALS & METHODS**
Seventy-five CT scan exams of the patients having cervical spine trauma were viewed retrospectively on an iPhone-based teleradiology solution by two radiologists. The radiologists viewed images on a diagnostic workstation; then, after a 4-week interval, they viewed the image on the iPhone. Two readers individually read each set of images so that interobserver variability could be assessed. Responses were recorded on proformas and assessed against the diagnosis from a diagnostic workstation. The images were analyzed for vertebral body fractures, posterior elements fractures, subluxation-dislocation, epidural hematoma and cord compression.

**RESULTS**
The images displayed on the iPhone were of good enough quality to make accurate diagnoses. Both readers detected vertebral body fractures and posterior elements fracture with an accuracy of 99%. Both readers detected subluxation-dislocation with 100% accuracy. Interobserver variability using a kappa value between the workstation and the iPhone was 0.8, indicating almost perfect agreement. There was no significant difference in the interpretation time between the
CONCLUSION

Traditional teleradiology is limiting because it presumes access to a workstation or laptop computer. Because smartphones are totally mobile, they have the potential to meet the demand for instant results. Current smartphones like iPhone have a high-quality touch sensitive display, greatly increased computational power and high-speed wireless network. Our solution allows rapid, remote, secure, two-dimensional (2D) and three-dimensional (3D) visualization of medical images on an iPhone device wherever wireless network connectivity is possible. Additionally, our solution does not require patient data to be loaded onto the iPhone. This allows immediate visualization of new patient images from remote locations, an important feature when timely interpretation is crucial for positive outcome. iPhone-based teleradiology developed by our informatics lab is highly accurate in the diagnosis of cervical spine trauma when compared with a workstation equipped with a medical-grade display. It allows rapid visualization of large datasets and obviates concerns related to patient confidentiality.

KEY WORDS: Acute spinal trauma, teleradiology, iPhone

Poster 190

Fluoroscopic-Guided Lumbar Puncture and Blood Patch: 5-Year Experience in a Single Institution

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PURPOSE

We noted an increase in fluoroscopic-guided lumbar punctures (FGLP) performed in our institution over the past 5 years. Related to this, is a potential increase in complication rate. We present a retrospective review of the volume of FGLP in our practice in the last 5 years, including our complication rate (specifically the complication of spinal headache). We submit the number of FGLP returning for epidural blood patch (EBP), with analysis of which patient subset is likely to require a blood patch.

MATERIALS & METHODS

Single hospital data on FGLP and EBP were collected from January 2005 to December 2009. Retrospective analysis of the following was made: A. Number of FGLP and EBP per year; B. Number of FGLP requiring EBP; C. Patients likely to require EBP after FGLP; and D. Outcome.

RESULTS

One thousand two hundred thirty-nine FGLPs were performed from 2005 to 2009. The number of procedures has been increasing, with a more than twofold increase in 2008 and in 2009. In 2005, 155/1,239 (12.5%) FGLP were performed. This more than doubled in 2008 - 322/1,239 (25.9%), with a similar trend in 2009 - 325/1,239 (26.2%). A total of 75 EBP were performed over the same period. Of these, 27 EBP were done to treat postspinal tap headaches. Twenty-seven EBP were seen in 26 patients, with 1 patient necessitating 2 EBPs. Epidural blood patch indicated for other reasons were excluded. Nine of the 26 patients treated with EBP (34.6%) had a referral diagnosis of pseudotumor cerebri. Five patients were suspected of having multiple sclerosis/demyelinating disease (19%). The rest of the patients had varying indications. The increasing volume of FGLP in our institution is coupled with an apparent increase in complication rate. Our 2005 complication rate of 0.6% increased to 2.8% and 3.1% in 2008 and 2009, respectively. There has been no change in our technical approach. There was no apparent increase in complication rate between procedures performed by trainees vs staff. In all EBP cases, a 22-gauge spinal needle was used in the initial FGLP, except on one occasion when a 20-gauge needle was employed. In all patients, clear colorless CSF was obtained. Cerebrospinal fluid volume ranged from 3 cc to 15 cc (median of 10 cc). Interestingly, 34.6% of patients treated with EBP had pseudotumor cerebri. It is unclear whether this is purely coincidental.

CONCLUSION

There is an increasing volume of FGLP and EBP in our practice. The apparent rise in our complication rate remains close to historical controls. It is unclear whether this increase in spinal headaches treated with EBP is related to patient selection or reporting bias, with an increasing number of cases returning to us rather than to other providers for management. We will assess the relationship between indication and complication rate. Clearly, self-reporting and reporting by referring physicians is a rough estimate of the complication rate of FGLP or success rate of EBP. We also note a trend in our practice pattern towards managing spinal headache with epidural blood patch for other services.

KEY WORDS: Fluoroscopic-guided lumbar puncture, epidural blood patch, lumbar puncture headaches

Poster 192

Rostral vs Caudal Pain Perception in Provocation Lumbar Diskography

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PURPOSE

The lumbar disk is innervated by two separate pain fiber groups: 1) level-specific somatic nociceptors return from the sinuvertebral nerve to the adjacent nerve root, 2) level-non-specific sympathetic nociceptors return from the sinuvertebral nerve, gray ramus and anterior ramus to a network of paraspinal sympathetic ganglia that ultimately enter the spinal canal at L1 or L2. Previous authors have noted that diskogenic pain may lateralize at provocation but little attention has been given to the patient’s rostral-caudal perception of provoked pain at diskography. The purpose of this retrospective study was to evaluate the patient’s rostral-caudal perception of provoked pain at diskography when two or more levels are painful.
**MATERIALS & METHODS**

Reports of 46 sequential diskograms were reviewed to assess for features of provoked pain encountered during the diskogram. In 26 of 46 diskograms, multiple disk levels were positive at provocation diskography (concordant or nonconcordant pain) and these patients are the focus of this retrospective study. Diskogram reports were assessed for patient’s rostral-caudal pain perception as reported at positive levels. Imaging features at diskography were evaluated also.

**RESULTS**

Patient’s perceived pain locations were reported in 25 of 26 diskograms. In 12 of 25 (48%) patients, a difference in rostral-caudal position of the provoked pain was perceived (7: multiple concordant levels; 5: one concordant with 1-2 nonconcordant levels). In 9 of 12, the patient could correctly determine the rostral-caudal location of the provoked pain (upper vs lower disk level injected). In 3 of 12, paradoxical pain sensation was encountered with the more rostral injected level perceived as lower in position and the more caudal injected level was perceived higher in position. In 9 of 25 (36%) patients, the provoked pain from all positive disk levels was perceived in the same location without rostral-caudal distinction (8: multiple concordant levels; 1: 1 concordant and 1 nonconcordant level). In 2 patients, only left-right distinction was reported and in 2 patients, pain was perceived in a small focal location in the paraspinal region. Diskogram imaging features (annular tear, degenerative changes) did not appear to correlate with rostral-caudal pain perception.

**CONCLUSION**

Provoked pain at diskography may or may not be perceived as occurring in different location in the patient’s back. Those with rostral-caudal distinction likely have primarily somatic nociceptor sensation of diskogenic pain. Those without rostral-caudal distinction likely have sympathetic nociceptor sensation of diskogenic pain. Paradoxical pain sensation might suggest mixed nociceptor innervation with the caudal painful disk innervated with sympathetic nociceptors and the rostral painful disk innervated with somatic nociceptors. Low back pain patients studied with diskography might require additional levels evaluated to ensure complete assessment of disk pain supplied by sympathetic nociceptors. In patients with axial pain disk surgery, recurrence of previous axial pain might not imply failed surgery but represent new pain sensed by sympathetic nociceptors at another disk level. In contrast, new axial pain after spine surgery could represent pain recurrence at the previously operated level due to alternate nociceptor pain fiber innervation.

**REFERENCES**


**KEY WORDS:** Diskogenic low back pain, disk degeneration, disk innervation

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**Poster 193**

**MR Imaging Findings of Intramedullary Spinal Cord Metastasis**

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**PURPOSE**

The incidence of intramedullary spinal cord metastasis is rare. The purpose of this study is to analyze MR findings of intramedullary spinal cord metastasis and to correlate MR findings with clinical symptoms and its course.

**MATERIALS & METHODS**

Patients consisted of seven males and five females. Ages range from 53 to 83 years old (average 67 years). MR studies were performed with 1.5 T scanner. T1-eighted, T2-weighted imaging and contrast study were done. MR imaging lesion extent, size, location, edema, contrast enhancement and associated syrinx were reviewed. Clinical condition of the patients was analyzed with chart reviewing.

**RESULTS**

Size of the tumor was less than 2 cm. Prominent edema was associated in all cases. Strong contrast enhancement was noted in all cases. No syrinx were observed. All of the patients had pain and motor weakness. Rapid progress of the clinical was seen. Most of the cases except one had multiple metastasis other than spinal cord. Most frequent primary tumors are lung cancer.

**CONCLUSION**

Characteristic MR finding of spinal cord metastasis are strong enhancement and disproportionate edema.

**KEY WORDS:** Spinal cord, metastasis, MR imaging

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**Poster 194**

**CT and MR Findings of Developmental Anomalies and Disease Processes Involving the Atlas and Atlantoaxial Joint**

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**PURPOSE**

To review the CT and MR appearance of developmental anomalies and disease processes involving the atlas and atlantoaxial joint.

**MATERIALS & METHODS**

The normal development and most common anatomical variants of the C1 vertebra and the odontoid process of C2 are described and illustrated. Case examples with CT and MR imaging correlation are used to demonstrate the characteristic findings of congenital clefts of the atlas, fractures of the atlas, os odontoideum, fracture of the odontoid base,
inflammation of the atlantoaxial joint due to rheumatoid arthritis, and calcium pyrophosphate dihydrate deposition involving the transverse ligament.

RESULTS
Lesions involving the atlas or atlantoaxial joint can present a diagnostic challenge when detected on CT or MR imaging either incidentally or in the setting of trauma. Congenital clefts of the C1 vertebra may be misinterpreted as fractures. Anterior and posterior clefts are midline defects through the ring of C1 with well corticated and slightly flared margins. Lateral clefts pass through the sulcus of the vertebral artery just posterior to the lateral mass and may be more difficult to distinguish from fractures due to their eccentric location. Although sagittal MR images of congenital clefts can be confusing, axial T1- and T2-weighted images showing discontinuity of the ring of C1 without evidence of mass or edema should be sufficient to confirm the nature of the anomaly. Sagittal reformatted CT images or MR sequences are best for identifying the round contour of os odontoideum and distinguishing the lack of fusion of the odontoid process from a fracture of the odontoid base. Abnormal soft tissue involving the atlantoaxial joint can be seen in both rheumatoid arthritis and calcium pyrophosphate dihydrate deposition; this can lead to atlantoaxial instability or spinal cord compression but should not be mistaken for infection or tumor.

CONCLUSION
Knowledge of the typical CT and MR appearance of developmental anomalies of the atlas and odontoid process should allow imagers to distinguish malformations from fractures and other disease processes involving the atlas and atlantoaxial joint.

KEY WORDS: Congenital, C1 vertebra, atlantoaxial joint

Poster 195
Value of Dynamic Susceptibility Contrast MR Perfusion-Weighted Imaging and Diffusion Tensor Imaging in the Differentiation of Nonenhancing Gliomas and Nonneoplastic Lesions in the Cervicomedullary Junction

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PURPOSE
To evaluate the value of MR dynamic susceptibility contrast perfusion-weighted imaging (DSCPWI) to establish the diagnosis in the case of nonenhancing gliomas in the cervicomedullary junction region.

MATERIALS & METHODS
This retrospective study involved six patients with nonenhancing gliomas in the medulla oblongata and six patients with nonenhancing, nonneoplastic lesions. The mean trace apparent diffusion coefficient (trace ADC), mean fractional anisotropy (FA), their ratios and relative cerebral blood volume (rCBV) ratio (tumor/normal white matter) values of gliomas and nonneoplastic lesions were assessed by Mann-Whitney U Test.

RESULTS
The mean ADC of nonenhancing gliomas (1.506 ± 0.66) was significantly higher than the nonenhancing nonneoplastic lesions (0.799 ± 0.121, p value of 0.03), and the mean FA of nonenhancing gliomas (0.226 ± 0.045) was significantly lower than the nonenhancing nonneoplastic lesions (0.434 ± 0.099, p value of 0.005). There was no significant difference of ADC ratio and FA ratio between the nonenhancing intramedullary gliomas and nonenhancing nonneoplastic lesions. The mean rCBV-ratio in the nonenhancing gliomas (1.195 ± 0.143, range from 1.075 to 1.471) was significantly higher than in the nonenhancing nonneoplastic lesions (0.403 ± 0.138, range from 0.245 to 0.575), p value = 0.002.

CONCLUSION
Nonenhancing gliomas in the cervicomedullary region had significantly increased rCBV and decrease FA values when compared with nonenhancing nonneoplastic lesions. Combination of DSCCPWI and DTI could be a useful to help in distinguishing nonenhancing gliomas from nonenhancing nonneoplastic lesions in the cervicomedullary junction region.

KEY WORDS: Diffusion tensor imaging, MR perfusion-weighted imaging, gliomas
Scientific Exhibit 1

Mimics of Middle Cerebral Artery Infarction: Spectrum of Diseases, Review of Misinterpreted Cases

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PURPOSE
The exhibit is to demonstrate the diseases misinterpreted as middle cerebral artery (MCA) infarction and the difference between MCA infarction and mimics.

APPROACH/METHODS
We have collected the cases misinterpreted as MCA infarction from the radiologic reports and reviewed the radiologic feature of MCA infarction and differentiating diseases.

Findings/DISCUSSION
The frequency of MCA infarction is reported to be more than 80 cases per 100,000 people in the United States. Most strokes occur in the MCA territory of cerebral circulation. In our daily practice of our clinical hospitals which have about 6000 brain MR examinations a year. We most often write the cerebral infarction in the radiologic reports. Especially, MCA infarction is written second to the lacunar infarction. We may slip in errors of diagnosing MCA infarction with ease when we see the similar radiologic findings. First of all, we review the clinical features of MCA infarction, such as etiology, distribution, symptom and complication. Secondly, we demonstrate imaging findings of MCA infarction according to phase or etiology. Finally, we will demonstrate the misinterpreted cases as MCA infarction, such as brain tumor (astrocytoma, malignant lymphoma, ganglioglioma), inflammatory disease (herpes encephalitis, non-herpetic limbic encephalitis), metabolic disease (mitochondrial myopathy, leukoencephalopathy, lactic acids and stroke-like episodes), selective neuronal necrosis with status epilepticus, compared with the MCA infarction characteristics and analyze the reason for misinterpretation.

SUMMARY/ConClusion
Becoming more acquainted with MCA infarction and mimics, we are able to differentiate them clearly.
Demyelinating Disorders of the Adult Central Nervous System: A Pictorial Review of MR Imaging

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PURPOSE
1. To highlight the wide spectrum of demyelinating disorders affecting the adult central nervous system; 2. To review MR imaging characteristics of demyelinating conditions of the adult central nervous system; and 3. To correlate with clinical and pathologic findings.

APPROACH/METHODS
We present a pictorial review of the MR imaging of adult patients with demyelinating conditions.

DISCUSSION
Central nervous system demyelinating disorders encompass a wide spectrum of syndromes affecting the integrity of myelin in the brain. T2-weighted MR imaging has become the imaging modality of choice in demyelinating disorders and plays an important role in the identification, localization and characterization of underlying white matter lesions in affected patients. We present a pictorial review of central nervous system demyelinating diseases in the adult patient giving examples of the main etiological categories: 1. Primary - multiple sclerosis and variants; 2. Ischemic - small vessel cerebro-vascular disease; 3. Infectious - progressive multifocal leukoencephalopathy, HIV encephalopathy/tumefactive demyelination, acute disseminated leukoencephalopathy; 4. Toxic and metabolic - methotrexate-induced leukoencephalopathy, Toulene syndrome; 5. Alcoholic - osmotic demyelination syndrome, Wernicke-Korsakoff syndrome, Marchiafava-Bignami disease; 6. Miscellaneous - posterior reversible encephalopathy syndrome, radiation injury. Imaging features allowing optimal differentiation of these white matter lesions will be discussed.

SUMMARY/CONCLUSION
Demyelinating disorders of the adult central nervous system encompass a wide gamut of disease. An understanding of these white matter diseases, their clinical features and parenchymal patterns of involvement is essential to permit the neuroradiologist to generate a narrow differential diagnosis which the clinician can further refine with knowledge of the patient's history and clinical examination. This educational exhibit reviews the findings of a broad spectrum of white matter lesions in the adult patient.

KEY WORDS: Demyelination

Acute Adult Hyperammonemic Encephalopathy in the Intensive Care Unit: MR Imaging Findings

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PURPOSE
In the pediatric population, acute hyperammonemic encephalopathy is well recognized with inborn errors of metabolism. In adults, this condition is encountered more commonly in ICU patients. Acute hepatic dysfunction is implicated frequently, but other etiologies include porto-systemic shunting, drugs, infections, lung transplantation. Patients are acutely encephalopathic with progressive drowsiness, seizures and coma due to primary toxic effects of ammonia on brain parenchyma. Prolonged hyperammonemia can lead to significant brain injury and intellectual impairment. Prompt recognition and treatment of hyperammonemia is essential, therefore, to avoid complications such as cerebral edema and brain herniation.

APPROACH/METHODS
We present four cases of hyperammonemic encephalopathy and describe the MR imaging findings. The four subjects were as follows: 1. 48-year-old male with fulminant hepatic failure secondary to acetaminophen ingestion on background of chronic alcoholic cirrhosis, 2. 55-year-old male with sepsis and GI bleed on background of alcoholic cirrhosis/portal hypertension, 3. 42-year-old female with dialysis line sepsis and failing liver transplant for nonalcoholic steatohepatitis and 4. 24-year-old female 6 weeks postlung transplant. All patients had reduced consciousness in the ICU and underwent cranial MR imaging. Blood ammonia levels ranged between 1.5 to 6 times normal range (0-38 micromol/L).

DISCUSSION
MR images revealed diffuse injury to the cortex with abnormal FLAIR/T2 signal and restricted diffusion; no abnormal enhancement was seen. In all cases, there was striking involvement of the cingulate gyrus and bilateral insular cortex (Figure 1). There was sparing of brainstem, cerebellum and basal ganglia. Variable involvement of the occipital, temporal, frontal and parietal cortex as well as thalami was seen. The other differential diagnoses considered in some of the cases included posterior reversible encephalopathy syndrome and diffuse hypoxic/hypotensive cortical injury.

Figure 1: Diffusion-weighted (A) and T2-weighted (B) imaging showing involvement of cingulate gyrus (closed arrows) and bilateral involvement of insular cortex (open arrows) in patient 2.
Summary/Conclusion
In our series, striking involvement of cingulate gyrus and bilateral insular cortex was seen in all cases. In ICU patients with encephalopathy, this pattern should alert the neuroradiologist to the possibility of hyperammonemic encephalopathy. Similar findings have been described in the pediatric literature (1, 2) but are recognized less well in the adult population.

References

Key Words: Hyperammonemic, encephalopathy, MR imaging

Scientific Exhibit 4

Spectrum of MR Imaging Manifestations of Sporadic Creutzfeldt-Jakob Disease as Illustrated by Three Pathologically Proved Cases

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Purpose
The spectrum of MR findings of Creutzfeldt-Jakob disease (CJD) can range from the classic finding of increased T2 and FLAIR signal and restricted diffusion in the basal ganglia to restricted diffusion only within the cortex. The various MR manifestations of CJD are illustrated through case discussion, imaging, and literature review.

Approach/Method
The clinical history, hospital course and MR imaging of three recent consecutive cases of sporadic CJD were examined. The three patients were admitted to our institution with progressive neurologic impairment between June 2006 and May 2009 and underwent MR imaging of the brain. Patient A demonstrated restricted diffusion and FLAIR hyperintensity in the basal ganglia bilaterally with diffuse supratentorial atrophy. The MR imaging of patient B showed bilateral restricted diffusion in the cortex with asymmetric restricted diffusion and FLAIR hyperintensity in the basal ganglia. The MR finding of patient C was notable only for bilateral restricted cortical diffusion with no FLAIR signal abnormality and no basal ganglia involvement. An autopsy was performed on each patient, confirming the diagnosis of CJD.

Findings/Discussion
The radiologic manifestations of sporadic CJD characteristically include bilateral and marked hyperintensity on FLAIR and T2-weighted images within the head of the caudate nucleus and the putamen when compared to the thalamus. Abnormal signal is not limited to the basal ganglia, however. Signal abnormalities within the cortical gray matter also can be seen, with ribbon-like hyperintensity on FLAIR and T2-weighted images and gyriform restricted diffusion on diffusion-weighted imaging (DWI). Diffuse parenchymal volume loss also can be noted. The majority of patients with CJD display signal abnormalities in both the cortex and the basal ganglia. However, isolated cortical abnormalities have been seen in 24% to 33% of patients with CJD and can be the only finding in the early stage of disease before the onset of myoclonus or EEG findings. Six molecular subtypes of CJD have been described, with a different disease distribution for each type. Only one case out of the three most recent histopathologically proved cases of CJD at our institution displayed the characteristic MR finding of marked, bilateral symmetric basal ganglia signal abnormalities. The predominant MR abnormality in the other two patients was restricted diffusion in the cortical gray matter, particularly within the parietal and occipital lobes.

Summary/Conclusion
Creutzfeldt-Jakob disease can produce a spectrum of findings on MR imaging of the brain, most notably on DWI and FLAIR sequences. The classic finding of hyperintense signal and diffusion restriction within the basal ganglia is not seen in all patients with CJD. Diffusion restriction limited to the cortex may be the only imaging finding. On FLAIR sequences, the basal ganglia can exhibit normal or hyperintense signal. It is imperative the radiologist is aware of the various manifestations in order to suggest the possibility of CJD in a patient with progressive neurologic impairment and prevent iatrogenic transmission of the prion by contaminated neurosurgical equipment.

Key Words: Prion, Creutzfeldt-Jakob disease

Scientific Exhibit 5

Clinical Utility of PET/MR Imaging Hybrid Fusion in Presurgical Evaluation of Intractable Epilepsy

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Purpose
Recent improvements in hybrid fusion software has improved significantly the process of multimodal coregistration and fusion. This exhibit demonstrates the clinical value of image fusion from MR imaging combined with positron emission tomography (PET) imaging, using 2-deoxy-2-[F-18]fluoro-D-glucose (FDG) in patients with intractable epilepsy.

Approach/Method
Patients with intractable epilepsy were imaged with both MR and FDG-PET. A routine MR epilepsy protocol was utilized, which included a high-resolution 3D T1-weighted gradient-echo sequence. Multimodality data sets were coregistered and fused using a PC-based postprocessing software program. Patients were selected based on the inconclusive MR and FDG PET findings.

Findings/Discussion
For the approximately one third of patients with epilepsy refractory to medical therapy, surgical resection of the epileptogenic focus is the only therapeutic option.
Presurgical localization of these lesions in many cases is a challenging endeavor, particularly in extratemporal and “non-lesional” cases, in which discordance of clinical, electrographic and imaging findings may be encountered. The key role of imaging in presurgical evaluation is increasing as progress in imaging technology advances. Recent advancements in epilepsy imaging have been towards multimodality approaches. Coregistration of MR and PET data can enhance the sensitivity and specificity of the overall presurgical evaluation by combining the sensitivity and specificity of a physiologic/metabolically-based technique such as PET with the high spatial resolution capacity of MR imaging.

**SUMMARY/CONCLUSION**
The fusion of PET and MR images can be useful in establishing the presence and location of epileptogenic foci, particularly in extratemporal and nonlesional epilepsy. This has clinical and diagnostic importance in the presurgical candidate when PET and MR imaging independently may be inconclusive for a epileptogenic focus.

**KEY WORDS:** MR imaging/PET, epilepsy, coregistration

**Scientific Exhibit 6**

**Double Inversion Recovery at 3 T: A Key Tool in the Detection of Subtle Cortical Dysplasias**

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**PURPOSE**
To provide a visual account of the benefit of a three-dimensional double inversion recovery (DIR) acquisition sequence at 3 T for the detection of subtle cortical dysplasias and heterotopia in patients with symptomatic localization-related epilepsy.

**APPROACH/METHODS**
The presurgical evaluation of patients with medically refractory epilepsy requires precise localization of any anatomical abnormality that may be potentially epileptogenic. At our institution, identification of these lesions in presurgical candidates typically leads to focused monitoring prior to surgery to confirm the area is responsible for seizure generation. This monitoring can be costly and invasive. As a result, detection and accurate localization with imaging is important to limit the need for additional monitoring and, perhaps more importantly, to accurately screen patients and detect those who might benefit from surgery who were previously felt to have nonlesional epilepsy. Double inversion recovery utilizes two inversion pulse sequences timed precisely to null the signal from not only cerebrospinal fluid, but also from white matter. This technique, which is done in a volumetric acquisition at 3 T, allows for increased conspicuity of the gray matter and abnormalities within white matter. We have been utilizing this technique for 2 years at our institution for most cases of suspected localization-related epilepsy as part of a presurgical evaluation.

**DISCUSSION**
We evaluated 14 patients with migrational anomalies with the DIR sequence. For the detection of cortical dysplasias, we have found DIR to provide increased sensitivity over conventional T1, T2, and fluid attenuated inversion recovery (FLAIR) imaging. While this has been useful in epilepsy patients with phakomatoses or more diffuse disorders of cortical migration, the true added benefit is in the patients with subtle focal cortical dysplasias that are potentially surgical candidates. The ability to detect subtle areas of focal cortical dysplasia allows for targeted monitoring and increased confidence in a positive surgical outcome in medically refractory epilepsy (Figure).

**SUMMARY/CONCLUSION**
When used at 3 T, we have found DIR to be a valuable tool in the imaging evaluation of patients with symptomatic localization-related epilepsy.

**KEY WORDS:** Cortical dysplasia, double inversion recovery, 3 T MR imaging

**Scientific Exhibit 7**

**Functional and Dysfunctional Anatomy of the Superior Longitudinal Fasciculus**

Klein, A. P. · Ulmer, J. L. · Mark, L. P. · Rohatgi, S. · Gaggl, W. · Guleria, S. · Singh, S. · Virshni, K.

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**PURPOSE**
White matter fiber tracking at Diffusion tensor imaging (DTI) is becoming increasingly important in the analysis of pathologic conditions of white matter, and commonly is used to elucidate the proximity of lesions to eloquent functional networks presurgically. A thorough understanding of the functional significance of white matter networks and the deficits induced by lesions or injury involving those networks is paramount to the translation of DTI in clinical practice. A cursory review of the topic is simply insufficient. One important fiber tract readily identified at DTI is the superior longitudinal fasciculus (SLF), a main association bundle connecting the external surface of the temporoparieto-occipital regions with the convexity of the frontal lobe.

**APPROACH/METHODS**
Detailed discussions include anatomical connections of the SLF, connectivity and cortical correlates relative to SLF networks, anatomical landmarks needed to identify the SLF on standard imaging, DTI of the SLF, and impairments associated with injuries to the SLF. Anatomical drawings, pathway diagrams, and DTI are utilized to illustrate principals underlying the function and impairments relevant to this structure.
Fibers of the SLF originate in the prefrontal and premotor gyri, including Broca’s area, and project to temporal language areas, the temporal pole, and the occipital lobe. Anatomical dissections of the SLF in nonhuman primates have identified four subcomponents. Through proposed language models and reported deficits in the literature, functions of the SLF and its subcomponents are being elucidated. Functional impairments related to the SLF include both aphasic and nonaphasic deficits.

**Summary/Conclusion**
This exhibit is designed to address functional networks relevant to the SLF, presented from a clinical imaging perspective. The overriding goal of the exhibit is to arm neuroradiologists with an understanding of anatomical and functional implications of the SLF, in a format specifically designed to provide a frame of reference useful to translating DTI into clinical imaging practice.

**Key Words:** Superior longitudinal fasciculus, DTI, anatomy

**Scientific Exhibit 8**
Integrative Approach to Presurgical Brain Mapping

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**Purpose**
White matter fiber tracking at diffusion tensor imaging (DTI) has become an important clinical tool to show the proximity of lesions to eloquent functional networks presurgically. The goals of presurgical DTI are to better define spatial relationships between lesion borders and functional brain systems, determine the resectability of a lesion, the need for intraoperative functional testing, and to guide surgical trajectory. Knowledge of critical spatial relationships at DTI enables intraoperative functional testing near vulnerable white matter tracts and may guide intraoperative white matter stimulation.

**Approach/Methods**
This exhibit presents five critical, complimentary localization techniques that should be considered in presurgical mapping, designed to translate DTI for neurosurgical applications. These localization methods include clinical presentation, functional anatomy at standard MR imaging, presurgical mapping using DTI and other complimentary techniques, intraoperative cortical mapping, and intraoperative functional assessments. This presentation elucidates the rationale underlying each localization strategy and illustrates their complimentary effect on neurosurgical outcomes through case examples and institutional data.

**Final Discussion**
Presurgical mapping with DTI has reduced complication rates for high risk lesions at our institution, and has resulted in a superior neurosurgical outcome. However, there are considerable anatomical and pathophysiologic constraints to DTI, which limit its accuracy. This includes the inability to distinguish functional pathways that are coursing in the same fiber bundle. Converging and diverging pathways also limit the ability of DTI to identify functional networks. The acuity of fiber angulations, particularly at the subcortical borders, limits the identification of cortical correlates to white matter networks. Anisotropy can be reduced by lesion infiltration, parilesional edema, and radiation induced demyelination. Lesions also may induce geometric distortion of fiber tracts. Although DTI has already had a significant impact on outcomes in neurosurgical patients, the technique is imperfect.

**Summary/Conclusion**
This exhibit presents a novel method of using DTI data intraoperatively, and outcomes data justifying its application. The exhibit is designed to provide a framework by which neuroradiologists may work jointly with neurosurgeons to apply DTI to minimize neurosurgical complications.

**Key Words:** DTI, brain mapping

**Scientific Exhibit 9**
Functional and Dysfunctional Anatomy of the Uncinate Fasciculus and Regional White Matter Pathways

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**Purpose**
White matter fiber tracking at diffusion tensor imaging (DTI) is becoming increasingly important in the analysis of pathologic conditions of white matter, and commonly is used for presurgical mapping of eloquent functional networks. A thorough understanding of the functional significance of white matter networks and the functional impairments of those networks is paramount to the interpretation of DTI in clinical practice.

**Approach/Methods**
A cursory review of the topic is simply insufficient. This detailed review will include the uncinate fasciculus (UF), which is an important association tract that provides a reciprocal cortico-cortical link between the frontal and temporal lobes, with connections from the anterior temporal lobe to the orbital and polar frontal cortices. The UF runs inferior to the inferior frontal occipital fasciculus (IFOF) before terminating in the temporal pole, uncus, hippocampal gyrus, and amygdala. This fronto-temporal circuit is thought necessary for retrieval of past information and injury to the UF may result in memory deficits. The IFOF connects the ventral, lateral, and dorso-lateral prefrontal cortex with postero-temporal cortex and the occipital lobe. Inferior frontal occipital fasciculus fibers innervate the middle and inferior temporal gyri, fusiform and lingual gyri, and occipital cortices. Impairments of both the IFOF and UF have been implicated in language deficits. Other regional pathways identified at DTI in this area include the fornix, pathways, stria terminalis, and inferior longitudinal fasciculus.


### Scientific Exhibit 10

**Corona Radiata: Functions and Dysfunctions from Anatomical Imaging Perspective**

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**Purpose**

White matter fiber tracking at diffusion tensor imaging (DTI) is becoming increasingly important in the analysis of pathologic conditions of white matter, and commonly is used to elucidate the proximity of lesions to eloquent functional networks presurgically. A thorough understanding of the functional significance of white matter networks and the deficits induced by lesions or injury involving those networks is paramount to the translation of DTI in clinical practice.

**Approach/Methods**

A cursory review of the topic is simply insufficient. One such readily identifiable fiber bundle at DTI is the corona radiata (CR), which contains corticofugal motor and thalamic-cortical sensory projections coursing through the internal capsule. The anterior limb of the internal capsule contains anterior thalamic sensory and frontopontine motor fibers. The genu contains anterior and inferior thalamic fibers and the posterior limb of the internal capsule contains superior, posterior, and inferior lateral thalamic fibers, tempoparietal-occipito-pontine fibers, optic radiation, and acoustic radiation. While corticospinal tracts are located within the posterior limb of the internal capsule, the location of corticobulbar tracts is disputed. Studies now suggest that motor fibers subserving the bulbofascial-arm-leg movement are arranged anterolateral to postero-medially in the corona radiata. The location of corticofugal fibers from each cortical motor area, particularly in the internal capsule, has been of interest for many years. The prefrontal cortical projections to midbrain have been described to pass through the anterior limb and the genu of the internal capsule in humans, though only through the anterior limb in the macaque cases. Impairments of the corona radiata and internal capsule may result in a wide variety of deficits depending on the location of the insult. These include sensorimotor, cognitive, visual, vestibular, and auditory deficits.

### Scientific Exhibit 11

**Comparison of Measurements of Fractional Anisotropy at Different Field Strengths, Directions, and Acquisitions**

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**Purpose**

Measurements of fractional anisotropy (FA) can be affected by noise; low signal-to-noise ratio (SNR) can cause an upward bias in FA. Signal-to-noise ratio is theoretically better at 3 T compared to 1.5 T and improved by increasing the gradient directions (D) and acquisitions (A). We investigated the effects on FA of different directions and acquisitions at 1.5 T compared to 3 T.

**Approach/Methods**

A single normal adult male served as a phantom. Diffusion tensor imaging parameters were identical at both field strengths: SS-EPI, 25 cmFOV, 128x128 image matrix, 2mm^3^ voxel, 9598/100 (TR/TE), b = 1000. SENSE = 2. For 6 D, A was 5, 10, and 15. For 30 D, A was 1, 2, and 3. A single 96 D sequence also was acquired at both 1.5 and 3 T. The 6 and 30 D data sets were registered to each other using affine transformation. Eddy current correction and signal averaging was using proprietary (PRIDE) software. Using PRIDE, a single observer manually placed regions of interest (ROIs) 3 times on the callosal genu (CG) and splenium (CS), PLIC, and SLF; FA for the averaged ROIs was calculated from the individual eigenvalues.
Fractional anisotropy values measured for 6 D, 5 A at 1.5 T were \( \geq 3 \) T (CG 0.82 vs 0.78; CS 0.8 vs 0.79; PLIC 0.82 vs 0.79; SLF 0.67 vs 0.64). Fractional anisotropy values for 6, 10A and 6D, 15A differed by <5% at both 1.5 T and 3 T. Fractional anisotropy values acquired using 30D, 1A and 96D, 1A were lower at 1.5 T than 3 T in the CG and PLIC. Fractional anisotropy values for 6 and 30 direction schemes are not necessarily equal despite roughly equivalent SNR. Fractional anisotropy values for 6, 10A and 96D, 1A were lower at 1.5 T than 3 T in the CG and PLIC. Fractional anisotropy values acquired using 30D, 1A and 10A and 6D, 15A differed by <5% at both 1.5 T and 3 T. Fractional anisotropy values measured for 6 D, 5 A at 1.5 T were \( \geq 3 \) T (CG 0.82 vs 0.78; CS 0.8 vs 0.79; PLIC 0.82 vs 0.79; SLF 0.67 vs 0.64). Fractional anisotropy values for 6, 10A and 6D, 15A differed by <5% at both 1.5 T and 3 T. Fractional anisotropy values acquired using 30D, 1A and 96D, 1A were lower at 1.5 T than 3 T in the CG and PLIC. Fractional anisotropy values for 6 and 30 direction schemes are not necessarily equal despite roughly equivalent SNR.

### Table I. Comparison of FA CG CSC

<table>
<thead>
<tr>
<th>Direction</th>
<th>CG 1.5T /3T</th>
<th>CG 3T /3T</th>
<th>CS 1.5T /3T</th>
<th>CS 3T /3T</th>
<th>PLIC 1.5T /3T</th>
<th>PLIC 3T /3T</th>
<th>SLF 1.5T /3T</th>
<th>SLF 3T /3T</th>
</tr>
</thead>
<tbody>
<tr>
<td>6D, 5A</td>
<td>0.82 /0.77</td>
<td>0.81 /0.79</td>
<td>0.82 /0.79</td>
<td>0.64 /0.63</td>
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<td>0.80 /0.78</td>
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<td>0.64 /0.58</td>
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<td>0.78 /0.74</td>
<td>0.73 /0.79</td>
<td>0.86 /0.65</td>
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<td>0.76 /0.77</td>
<td>0.72 /0.79</td>
<td>0.65 /0.64</td>
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<td>0.77 /0.73</td>
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### SUMMARY/CONCLUSION

Fractional anisotropy values for 6 and 30 direction schemes are not necessarily equal despite roughly equivalent SNR.

**KEY WORDS:** DTI, fractional anisotropy, reproducibility

### Scientific Exhibit 12

**Exploring the Functional and Dysfunctional Anatomy of the Anterior Cingulum**

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Medical College of Wisconsin Froedert Hospital

Milwaukee, WI

**PURPOSE**

This exhibit is designed to address functional networks relevant to the anterior cingulum (AC), presented from a clinical imaging perspective. Detailed discussions include anatomical connections of the AC, connectivity and cortical correlates relative to AC networks, anatomical landmarks needed to identify the anterior on standard imaging, diffusion tensor imaging (DTI) of the AC, and impairments associated with injuries to the AC. The overriding goal of the exhibit is to arm neuroradiologists with an understanding of anatomical and functional implications of the AC, in a format specifically designed to provide a frame of reference useful to translating DTI into clinical imaging practice.

**APPROACH/METHODS**

Anatomical drawings, pathway diagrams, and DTI are utilized to illustrate principals underlying the function and impairments relevant to this structure.

**FINAL D Nas/DISCUSSION**

The cingulum is a large white matter bundle of the limbic system coursing over the corpus callosum. It courses through the core of the cingulate and parahippocampal gyri and extends from the septal area to the uncus region in the temporal lobe. The anterior cingulate gyrus has wide spread connections with the frontal lobe, parietal lobe, amygdala, hippocampus, and brainstem motor nuclei. The anterior cingulate gyrus and anterior cingulum (AC) play a role in attention, volitional control of cognitive and motor functions, and expression of emotions. This is an area of self-awareness and a mirror of the frontal lobe functions, subserving response selection, conflict detection, error recognition, and focused problem-solving. Impairments of the anterior cingulate gyrus and AC can result in pain and consciousness, depression, decreased anxiety, reduced spontaneous behaviors and speech, executive dysfunction, attention deficits, and akinetic mutism.

**SUMMARY/CONCLUSION**

White matter fiber tracking DTI is becoming increasingly important in the analysis of pathologic conditions of white matter, and commonly is used to elucidate the proximity of lesions to eloquent functional networks presurgically. A thorough understanding of the functional significance of white matter networks and the deficits induced by lesions or injury involving those networks is paramount to the translation of DTI in clinical practice.

**KEY WORDS:** Anterior, cingulum, DTI

### Scientific Exhibit 13

**Conventional and Advanced neuroimaging of HIV: Spectrum of Imaging Characteristics in Disease Processes Associated with HIV-Seropositivity**

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Hospital of the University of Pennsylvania

Philadelphia, PA

**PURPOSE**

With the advent of effective highly active antiretroviral therapy for human immunodeficiency virus (HIV), more patients are living with HIV-seropositivity as a chronic condition. This underscores the importance of recognizing various imaging manifestations of infectious, inflammatory, and neoplastic processes associated with HIV/AIDS. The purposes of this pictorial review are to discuss the various conventional neuroradiologic findings typically seen with disease processes associated with HIV-seropositive adult patients, to highlight MR perfusional and H1-spectroscopic features of several disease processes associated with HIV, and to emphasize the importance of keeping the differential diagnosis of HIV in mind in our clinical practices.

**APPROACH/METHODS**

Our institutional PACS database was searched for patients with proven HIV-seropositivity who have had neuroradiologic imaging, including brain, spine, and head/neck imaging. Imaging studies that met the inclusion criteria then were reviewed to identify imaging characteristics consistent with disease processes associated with HIV-seropositivity. Whenever possible, final diagnoses were confirmed with biopsy, blood culture, and/or CSF analyses by searching the institutional clinical database. Most representative images of these conditions are displayed in various imaging modalities, including MR, CT, and when available MR perfusion and H-1 spectroscopy.
Disease processes associated with HIV-seropositivity identified include infectious processes such as HIV encephalitis/encephalopathy, progressive multifocal leukoencephalopathy, CMV encephalitis/myelitis, tuberculosis, cryptococcal infection, toxoplasmosis, HIV myelopathy, neoplastic processes such as CNS lymphoma, as well as benign and/or inflammatory processes such as HIV vasculitis, benign lymphoepithelial lesions, and HIV-associated cervical lymphadenopathy, etc. Conventional imaging characteristics are displayed in this pictorial essay, with emphasis on distinct imaging features. However, given that there is overlap in imaging features and further differentiation often requires correlation with clinical presentation, short discussions of symptomatology and differential considerations of these disease processes also are included. Finally, advanced imaging data with MR perfusion and/or H-1 spectroscopy may aid in narrowing the differential diagnosis. Therefore, this pictorial review also highlights MR perfusion and/or H-1 spectroscopy features of several disease processes, including HIV encephalopathy, toxoplasmosis, lymphoma, and progressive multifocal leukoencephalopathy.

**SUMMARY/CONCLUSION**
As HIV-seropositivity becomes a chronic disease, more patients are being imaged for neurologic symptoms associated with HIV/AIDS-related disease processes. This pictorial essay emphasizes the importance of familiarity with the spectrum of conventional and advanced imaging characteristics of disease processes associated with HIV-seropositivity as well as with their clinical presentations in diagnosing and caring for these patients.

**KEY WORDS:** Human immunodeficiency virus, MR perfusion, MR spectroscopy

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**Scientific Exhibit 14**

**Advanced MR Techniques in Primary Central Nervous System Lymphomas**

Ramos, A. · Hilario, A. · Salvador, E. · Gonzalez, P. · Perez-Nuñez, A. · Lagares, A.

Hospital Universitario 12 de Octubre

Madrid, SPAIN

**PURPOSE**

To assess the radiologic characteristics of primary central nervous system lymphoma using conventional and advanced MR imaging techniques (MR diffusion, MR perfusion and MR spectroscopy).

**APPROACH/METHODS**

We have conducted a retrospective review of 16 biopsy-proved cases of primary central nervous system lymphoma from our brain tumor registry since September 2004. All patients underwent MR examination including pre and post-contrast images as well as advanced MR imaging (MR spectroscopy, MR diffusion and MR perfusion and permeability).

**SUMMARY/Conglusion**

Primary central nervous system lymphomas can have variable appearance and location in the brain. About 30% of the lesions show atypical findings such as high ADC values and high cerebral blood volumes.

**KEY WORDS:** Lymphoma, neoplasm, perfusion

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**Scientific Exhibit 15**

**Dysembryoplastic neuroepithelial Tumor: Common and Unusual Findings with Pathologic Correlation**

Gomes, W. A. · Arkun, K. · Weidenheim, K. · Bello, J. A.

Montefiore Medical Center

Bronx, NY

**PURPOSE**

Dysembryoplastic neuroepithelial tumors (DNET) are among the most common pediatric brain tumors and represent a frequent cause of tumor-related epilepsy. These tumors are generally low grade and are eminently treatable - complete surgical resection is typically curative.

**APPROACH/METHODS**

Imaging findings of DNET vary widely; however, encompassing a range from benign-appearing cystic lesions to large, enhancing masses. Therefore, DNET easily may be confused with either nonneoplastic lesions or with higher-grade neoplasia.

**SUMMARY/CONCLUSION**

We review the spectrum of imaging findings in DNET, including common and uncommon variants, and present a differential diagnosis specific to each appearance. Findings on advanced imaging, including MR spectroscopy, are reviewed. Neuropathologic correlation of imaging findings is emphasized.

**KEY WORDS:** Dysembryoplastic, DNET
**Scientific Exhibit 16**

**Biological Behavior of Supratentorial Tumors**

Arbelaez, A.1,2,3 • Restrepo, F.1,2,3 • Londono, A.3 • Castillo, M.4

1CORBIC Cardio-Neuro-Vascular Institute, Medellin, COLOMBIA, 2Hospital Pablo Tobon Uribe, Medellin, COLOMBIA, 3LINK Diagnostico Digital, Medellin, COLOMBIA, 4University of North Carolina, Chapel Hill, NC

**PURPOSE**

To show in an academic exhibit the MI features of advanced imaging techniques including anatomical and functional images according to the molecular behavior of several brain tumors to improve the diagnosis, grading, extension, prognosis and response to treatment.

**APPROACH/METHODS**

We reviewed the charts and images of patients with diagnosis of intraaxial brain tumors performed during the last 2 years. Each radiologic finding was correlated with the histopathologic diagnosis and findings in molecular genetics. Our MR protocol included Scout, Axial T1, T2 and FLAIR, DWI/DTI, pMRI, axial SWI, axial, coronal and sagittal T1 post Gd, 2D or 3D CSI TE 30/144, 3D Volume T1 MPRage. Follow up after surgery, radiation or chemotherapy was done with functional techniques helping to differentiate between healing, recurrence or postradiation necrosis.

**Fluorodeoxyglucose/DISCUSSION**

Overexpression of some oncogenes and inactivation of some tumor suppressor genes leads to absence of apoptosis of genetically abnormal cells, conducting to hypercellularity, atypias, pleomorphism, mitosis, distant extension, angiogenesis and necrosis. Factors affecting tumor growth can be correlated with advanced MR techniques. Cell proliferation and invasion can be correlated with MR imaging, MRS, ADC and DTI. Ischemia, angiogenesis and hemorrhage can be correlated with MRS, pMRI and SWI. MRS, pMRI and DWI/DTI can evaluate extension beyond the borders. During follow up we found that high lactate on MRS precedes high perfusion on MR imaging and high rCVB precedes contrast enhancement. Some benign tumors may have aggressive features by pMRI, MRS, SWI, including oligodendroglioma, central neurocytoma, certain types of grades I and II astrocytomas and the dysplastic cerebellar gangliocytoma. Combined applications of MR imaging, MRS, perfusion, DWI and DTI in posttreatment patients led to evaluate the response to treatment and to differentiate between postradiation necrosis and tumor recurrence.

**SUMMARY/CONCLUSION**

Traditionally the tumor diagnosis has been base on histopathologic, ultrastructural and immunophenotypical features; however, recently the diagnostic, prognosis and follow up after treatment have been improved by molecular genetics and advanced imaging techniques.

**KEY WORDS:** Astrocytoma, MR imaging, brain tumor

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**Scientific Exhibit 17**

**Posttransplantation Lymphoproliferative Disorder of the Central Nervous System: Spectrum of Imaging and Pathologic Findings**

Kennedy, T. A. • Gentry, L. R. • Lubner, M. G. • Salamat, S. • Lake, W.

University of Wisconsin Madison Madison, WI

**PURPOSE**

Posttransplantation lymphoproliferative disorder (PTLD) is recognized as a rare complication following organ transplantation, caused by unregulated lymphoid expansion secondary to chronic immunosuppression. The distribution of PTLD is dependent on several risk factors including patient age, allograft type, and specific immunosuppressive therapeutic regimen. Posttransplantation lymphoproliferative disorder involving the central nervous system (CNS) often occurs in isolation and typically is not associated with systemic PTLD. The purpose of this scientific presentation is to review the clinical and pathologic features of CNS PTLD and to illustrate the spectrum of imaging findings of CNS PTLD with a variety of case examples.

**APPROACH/METHODS**

The histology and imaging of pathologically proved cases of PTLD involving the CNS were reviewed at a tertiary referral center with a large transplant surgical service. Representative cases were chosen to illustrate key imaging features.

**Fluorodeoxyglucose/DISCUSSION**

Posttransplantation lymphoproliferative disorder represents a heterogeneous group of diseases, ranging from polyclonal lymphoid hyperplasia to monoclonal malignant lymphoma. Central nervous system PTLD is histopathologically similar to primary CNS lymphoma typically seen in the HIV-positive population and in the elderly. The majority of CNS PTLDs are histologically monomorphic, EBV positive and of the B cell phenotype. There are several imaging patterns seen in CNS PTLD. Central nervous system PTLD most often manifest as discrete multifocal masses with a predilection for the periventricular region and perivascular spaces. Hemorrhage and necrosis are often key features. On CT, the masses are characteristically hyperdense related to the high cellularity of the tumor. On MR imaging, the lesions are hypointense on T2, isointense to hypointense on T1 with the correct diagnosis. Treatment options include a combination of one or more of the following: immunosuppressive therapy reduction, whole brain radiation, chemotherapy, surgical resection and/or antiviral therapy.

**SUMMARY/CONCLUSION**

Immunosuppression following solid organ transplant places patients at risk for a variety of postransplant complications. Posttransplantation lymphoproliferative disorder represents
a spectrum of disease, ranging from indolent lymphoid hyperplasia to aggressive lymphoma. There are several imaging patterns seen with CNS PTLD, including peripherally enhancing intraparenchymal masses and nodular leptomeningeal disease. The goals of imaging are detecting disease, guiding biopsy, and assessing treatment response.

**KEY WORDS:** Lymphoma, posttransplantation, Epstein Barr virus

**Scientific Exhibit 18**

*Neuropathology for the Neuroradiologist: A Pictorial Review with Radiologic Correlation*

Burns, J. · Arkun, K. · Erdfarb, A. · Shifteh, K. · Weidenheim, K. M. · Bello, J. A.

Montefiore Medical Center

Bronx, NY

**PURPOSE**

Despite improvements in MR imaging quality and advanced imaging techniques, final diagnosis of CNS lesions remains in the hands of experienced neuropathologists. The purpose of this review is to showcase the pathologic features commonly used by the neuropathologist for final diagnoses, and to provide radiologic correlation by highlighting findings which bridge the cellular and macroscopic features of CNS lesions.

**APPROACH/METHODS**

This educational presentation follows a didactic format. A discussion of neuropathology tools, including basic immunohistologic stains and microscopy techniques, is followed by illustrated case presentations which underscore the pathologic features of various CNS lesions. Corresponding MR and CT scans are used to provide microscopic correlation.

**FinDings/Discussion**

There are many gross and immunohistochemical means of arriving at pathologic diagnoses of CNS lesions. Developing an algorithmic approach to the pathologic diagnosis of CNS lesions involves careful evaluation of gross anatomical and ultrastructural alterations. Similarly, the neuroradiologist uses increasingly sophisticated imaging tools, coupled with an understanding of the macroscopic alterations in disease processes, to arrive at a focused differential diagnosis. A more precise understanding of the pathologic basis of CNS disease is aided by learning the complementary strategies employed by our neuropathology colleagues.

**SUMMARY/Conclusion**

Neuropathology uncoverts the underlying cellular and ultrastructural basis for CNS lesions and disease processes. Understanding the tools used and microscopic features of CNS diseases will aid the neuroradiologist in evaluating these lesions on a macroscopic scale and further our progress in imaging as we enter the molecular arena.

**KEY WORDS:** Neuropathology, neoplasm

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**Scientific Exhibit 19**

*Getting to Know Radiation-Induced Changes in the Brain: What the Clinician needs to Know*

Riascos-Castaneda, R. F. · Gonzalez, J. · Rojas, R.

1The University of Texas Medical Branch, Galveston, TX, 2Beth Israel Hospital, Boston, MA

**PURPOSE**

1. Describe the different changes that occur in the postradiated brain; 2. Learn how the findings can fit a classification based on a clinical approach; and 3. Review the pertinent findings that the clinician needs to know, and how they have an impact in the management.

**APPROACH/METHODS**

Radiation plays an important part in the treatment of primary and secondary brain tumors. External beam radiation has demonstrated to either prolong survival or palliate symptoms in most tumor affecting the brain and spine but because of its biological effects both in the neoplasms and normal brain, it also can cause significant morbidity. The identification of radiation-induced changes and their differentiation from tumor-related pathology in the brain is of utmost importance since this can change the prognosis and treatment of individual patients. Advances in imaging technology have made it possible to reliably determine whether a patient’s symptoms can be ascribed to disease progression/recurrence of treatment-related changes therefore knowing when to expect postradiation changes is essential. Radiation toxicity has been divided clinically in acute, subacute and chronic. Imaging changes follow a similar temporal distribution and the findings can be correlated with specific clinical syndromes. MR imaging is the study of choice for the detection of complications. Diffusion-weighted imaging, MR perfusion, MR spectroscopy, and PET scans can add clinically relevant information. Acute changes consisting of acute demyelination can correlate with the hypersomnolence syndrome and acute encephalopathy. Imaging findings include T2 hyperintense lesions in the deep white matter and are thought to be associated with selective oligodendrocyte apoptosis. A special form is the acute necrotizing leukencephalopathy which occurs with the concomitant use of methotrexate. The most important subacute pattern is the pseudoprogression. This phenomenon usually appears between 4 weeks and 6 months after radiation and consists of transient worsening of the MR images with the presence of abnormal enhancement and T2/FLAIR changes that mimic tumor progression. The pseudoprogression is essentially a necrotic process and must be differentiated from tumor recurrence or progression because the treatment is completely different. Chronic changes include the delayed radiation necrosis (DRN) and the chronic leukoencephalopathy. Delayed radiation necrosis can mimic tumor recurrence or progression. The use of special techniques such as perfusion and PET can be a very valuable tool in making a distinction between these two. The chronic leukoencephalopathy is caused by gliosis and appears as T2 hyperintense lesions in the white matter that can become coalescent. It usually is associated with cerebral volume loss and correlates clinically with chronic cognitive problems such as dementia.
PURPOSE
Worcester, MA
University of Massachusetts Medical School
Atherosclerotic lesions in four patients were best appreciated
resection. The morphological characteristics of intracranial
remaining patients showed no residual bA VM after surgical
detail. As on other imaging modalities, CBCT in the two
modalities, but CBCT provided substantially higher spatial
ing. Two bA VMs (1 cm) were depicted on other imaging
surgical planning as the only modality that showed the rela-
case, a subependymal micro-bA VM, CBCT was critical for

SUMMARY/Conclusion
The neuroradiologist must be aware of the multiple imaging
findings of patients that have undergone radiation of the
brain. New radiology techniques can aid in differentiating
between the postradiation changes in the brain. This can help
to avoid unnecessary surgical procedures which should
result in better patient care.

KEY WORDS: Brain tumor, radiation changes, necrotizing
leukoencephalopathy

Scientific Exhibit 20

Cone Beam CT of Intracranial Vascular Malformations,
Atherosclerosis, and Tumors: A Valuable Tool for
Diagnosis and Treatment

Patel, N. V. · Gounis, M. J. · Wakhloo, A. K.
University of Massachusetts Medical School
Worcester, MA

PURPOSE
To investigate the utility of neuroangiographic cone beam
computed tomography (CBCT) in the diagnosis and treat-
ment of a variety of cerebrovascular diseases.

APPROACH/METHODS
Cone beam computed tomography was performed using a
flat-panel detector neuroangiography system during selec-
tive common carotid or vertebral artery injections of 20% contrast, diluted in normal saline. 3D volumetric datasets
were reconstructed from 620 projection images acquired
over a 200° arc at 80 kVp and a total of 260 mAs. To maxi-
mize spatial resolution, projection images were obtained
using a 22 cm detector format. Reconstructions were per-
duced without pixel binning using a 512² matrix at fields of
view ranging from 34.44 to 69.92 mm in diameter (67 - 137
µm isotropic voxels).

RESULTS/DISCUSSION
Cone beam computed tomography data were collected in 15
patients with bAVMs (n = 7), intracranial atherosclerotic dis-
case (n = 4), IVH (n = 2), dural arteriovenous fistula (DAVF, n = 1), and meningioma (n = 1). Cone beam computed
tomography depicted micro-bAVMs not well visualized on
MDCT or MR imaging in three of seven patients. In one
case, a subependymal micro-bAVM, CBCT was critical for
surgical planning as the only modality that showed the rela-
tionship between the AVM and the fornix. In such cases,
CBCT images can be registered to systems for radiosurgery and
stereotactic guidance, enabling precise treatment target-
ing. Two bAVMs (≥1 cm) were depicted on other imaging
modalities, but CBCT provided substantially higher spatial
detail. As on other imaging modalities, CBCT in the two
remaining patients showed no residual bAVM after surgical
resection. The morphological characteristics of intracranial
atherosclerotic lesions in four patients were best appreciated
on CBCT. Unlike CTA, CBCT clearly identified circumfer-
tential calcification at a vertebral artery lesion that was
refractory to stenting. In the case of a focal M1 stenosis, the
extent of plaque was detected on CBCT as subtle irregular-
ties not seen on other imaging. In one case of intraventricu-
lar hemorrhage, CBCT allowed us to diagnose a lesion too
small to characterize using other techniques. A prominent
transmedullary vein radiating from the ependymal surface
was identified on MR imaging, which was unable to depict
the vascular lesion. Though the diagnosis remained elusive
on DSA, CBCT clearly identified the vascular structures
associated with the lesion and allowed us to distinguish this
DAV from a micro-bAVM. In the other case of IVH, no vas-
cular malformation was identified. Cone beam computed
tomography was helpful in directing preoperative emboliza-
tion and surgical resection of a tentorial meningioma. While
the vascular supply to the mass was visible on DSA, CBCT
offered the advantage of depicting the relationship between
the mass, the tentorium, the skullbase, and adjacent vascular
structures, including the anterior choroidal and posterior
communicating arteries. In the patient undergoing endovas-
cular treatment for a frontal ethmoidal DAVF, CBCT
defined visualization of the arteriovenous shunts within
the dura and the enlarged ethmoid foramina transmitting
the feeding ethmoidal branches originating from bilateral
ophthalmic arteries.

SUMMARY/Conclusion
Although invasive, the combination of superior contrast and
spatial resolution justifies the routine use of CBCT for pre-
treatment and intraoperative characterization of cerebrovas-
cular diseases. Cone beam computed tomography enables or
enhances visualization of lesions and anatomical relation-
ships beyond the capabilities of MDCT, MR imaging, and
DSA.

KEY WORDS: Cone beam computed tomography, arteriove-
nous malformations, vascular anatomy

Scientific Exhibit 21

New Application of Pixel Purity Index for Unsupervised
Classification of Brain MR Images

Chen, C. C. C. · Hsian-Min, C. · Jyh Wen, J. · Shih-Yu, C. ·
Yen-Chieh, O. · Yaw-Jiunn, C. · Ching-Wen, Y. · San-
Kan, L. · Chein-I, C.
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2National Chung Hsing University, Taichung, TAIWAN,
3University of Maryland, Baltimore County, MD

PURPOSE
Unsupervised methods generally are preferred for classifica-
tion of brain image data for the benefits of no operator inter-
vention, low intra and interoperator variability (1). However,
prior knowledge essentially required for successful unsuper-
vised classification often might not be applicable in clinical
environments. Hyperspectral imaging, an emerging tech-
ique in remote sensing, can uncover many unknown sub-
stances that cannot be resolved by multispectral images. This
paper presents a new application of using a hyperspectral
technique, i.e., pixel purity index (PPI) (2), to find training samples directly from the multispectral data for unsupervised classification of the brain MR images.

**APPROACH/METHODS**

Independent component analysis (ICA) coupled with support vector machine (SVM) has shown promise in classification of multispectral brain MR imaging (3). It requires operator intervention by selecting a small set of training data, and thus is operator dependent. Pixel purity index has been used widely for endmember extraction to specify spectral classes in hyperspectral analysis. In brain MR images, main brain tissues such as gray matter (GM), white matter (WM) and cerebral spinal fluid (CSF) can be considered endmembers, which could be extracted by PPI without operator intervention. Synthetic MR imaging of normal brain was used to evaluate the efficacy of our proposed method (4). At first, three sets of T1, T2 and proton density images were processed by ICA to generate three new statistically independent component images. Secondly, small region of interest (ROI) at each image center was extracted automatically for PPI calculation to find an appropriate set of training samples. Finally, SVM, with active learning from the appropriate training data, was used for classification of three IC images. The Tanimoto’s index was measured to statistically evaluate the results of the GM and WM volumes with the ground truth data of the synthetic brain images.

**SUMMARY/CONCLUSION**

This study presents a new approach of using a PPI endmember extraction algorithm to automatic selection of training samples directly without prior knowledge for unsupervised MR classification.

**REFERENCES**


**KEY WORDS:** Unsupervised segmentation, pixel purity index, brain MR imaging

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**Scientific Exhibit 22**

**Gemstone Spectral Imaging: Principle, Postprocessing Technique and Applications in Brain and Spine Imaging**

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University of Michigan Health System
Ann Arbor, MI

**PURPOSE**

1. To educate the reader about the principles of Gemstone Spectral Imaging (GSI) technology; 2. To provide a hands-on approach to postprocessing data obtained with GSI; and 3. To illustrate, with examples, potential applications in brain and spine imaging.

**APPROACH/METHODS**

1. The basic principle behind dual energy CT and the additional benefit of GSI will be explained. The unique nature of imaging over a spectrum of energies ranging from 80KeV to 140 KeV with the ability to reconstruct an image with over 100 user driven energy levels will be illustrated with examples; and 2. Postprocessing techniques involving monochromatic images, material density images and optimal contrast curves will be demonstrated. Material density analysis involves utilization of energy peaks of different materials such as water, iodinated contrast and calcium to create images where a particular energy peak can be selectively displayed with the others suppressed.

**SUMMARY/CONCLUSION**

The unique ability to create images with multiple user-defined virtual energy peaks provides an interactive interface where the contrast in an image virtually can be subtracted out or the contribution of various densities like calcium eliminated, all on the postprocessing workstation. This has an impact on: 1. identification of hemorrhage versus calcium; 2. reduced beam hardening artifact in the posterior fossa; 3. Better aneurysm visualization postcoiling/clipping due to metal reduction; 4. more accurate assessment of vascular stenosis in calcified vessels (where the calcium can be subtracted out); 5. better metal suppression in the spine post-surgery; and 6. increase the myelographic contrast without increasing the amount of iodinated contrast administered.

**REFERENCES**

1. The basic principle behind dual energy CT and the additional benefit of GSI will be explained. The unique nature of imaging over a spectrum of energies ranging from 80KeV to 140 KeV with the ability to reconstruct an image with over 100 user driven energy levels will be illustrated with examples; and 2. Postprocessing techniques involving monochromatic images, material density images and optimal contrast curves will be demonstrated. Material density analysis involves utilization of energy peaks of different materials such as water, iodinated contrast and calcium to create images where a particular energy peak can be selectively displayed with the others suppressed.

**KEY WORDS:** Gemstone spectral imaging, metal reduction, monochromatic
Scientific Exhibit 23

Hypoglossal Nerve: Anatomy and Pathologic Spectrum

Agarwal, A.1 · Lee, H. K.1 · Agarwal, K.2 · Chan, M.1 · Zak, I.1

1 Detroit Medical Center, Detroit, MI, 2 Detroit Medical Center, Troy, MI.

PURPOSE
The hypoglossal nerve (CN XII) is a pure motor cranial nerve and supplies the muscles of the tongue. The purpose of this exhibit is to review the pathway of CN XII from its nucleus to the tongue muscles on MR imaging by using a segmental approach and to demonstrate the spectrum of CN XII pathology.

APPROACH/METHODS
The hypoglossal nerve arises from the hypoglossal nuclei in the medulla oblongata, exits the medulla, extends through the skull base, and traverses the parapharyngeal/carotid space in the suprahyoid neck before ramifying to supply the tongue musculature. The hypoglossal nerve is divided into five segments: the medullary, cisternal, canalicular, carotid space, and lingual segments. Because each segment usually is affected by different disorders, localizing a lesion to a particular segment allows the radiologist to narrow the differential diagnosis.

DISCUSSION
Common pathologic conditions affecting each segment of the CN XII nerve are: 1. Medullary segment: demyelination, infarction, hemorrhage, neoplasms; 2. Cisternal segment: vertebro-basilar ectasia, meningiomas, schwannomas, aneurysms; 3. Canalicular segment: metastasis, nasopharyngeal carcinomas, glomus tumor, schwannoma, trauma, skull base osteomyelitis; 4. Carotid space segment: oropharyngeal carcinoma, metastatic lymphadenopathy, dissection; and 5. Lingual segment: carcinoma, trauma, postoperative. In addition, we will demonstrate denervation atrophy.

SUMMARY/CONCLUSION
Hypoglossal nerve can be affected by a wide spectrum of pathologies in its course from the medulla to the tongue. Proper understanding of anatomy of CN XII nerve using segmental approach is helpful in evaluation of its paralysis.

KEY WORDS: Hypoglossal, cranial, nerve

Scientific Exhibit 24

Differential Diagnosis of Spontaneous T1 Hyperintense Pathologies of the Brain: A Pictorial Review

Agarwal, A. · Moore, G. · Vijay, K. · Kanekar, S.

Penn State Hershey Medical Center Hershey, PA

PURPOSE
1. To elaborate the differential diagnosis of T1 hyperintense lesions on MR imaging of the brain and discuss the underlying reasons for those appearances; 2. To illustrate the imaging findings of the common T1 hyperintense pathologies of the brain.

APPROACH/METHODS
MR imaging is the preferred technique for examining intracranial pathology in the nonacute setting in most cases. The aim of this review is to demonstrate the imaging appearances on unenhanced spin-echo MR imaging of lesions that show characteristic T1 hyperintensity, which occur due to the presence of fat, cholesterol, paramagnetic substances, rapidly flowing fluids, air, cortical bone or calcification. The nature of the MR signal, together with the anatomical location of the lesion should allow the provision of a narrow differential diagnosis, before the use of intravenous contrast medium or additional imaging sequences.

DISCUSSION
In this work, the brain lesions that cause spontaneously hyperintense T1 signal on MR imaging were studied under seven categories (Table 1).

<table>
<thead>
<tr>
<th>Categories of T1-Hyperintense Brain Lesions</th>
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<tbody>
<tr>
<td>I. Hemorrhage</td>
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<tr>
<td>III. Necrosis</td>
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<tr>
<td>V. Trauma</td>
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<tr>
<td>VII. Storage disorder</td>
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</table>

The above-mentioned lesions are presented with their typical T1 hyperintense images. The underlying reasons for those appearances on MR imaging are discussed.
SUMMARY/ConCluSION
Through this exhibit, we review a comprehensive list of differentials for T1 hyperintense pathologies of the brain and further discuss the imaging appearance of the individual pathologies.

KEY WORDS: T-1 hyperintense, hemorrhage, fat

Scientific Exhibit 25
Ferromagnetic Detector Evaluation of Bullets and Other Metallic Foreign Bodies: A Step Towards Performing MR Imaging on Patients with Retained Shrapnel of Unknown Magnetic Properties?

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PURPOSE
MR imaging is presumed hazardous in patients with retained bullets and shot even though most if not nearly all are nonferrous. The purpose of this study was to test the possibility of using a commercial ferromagnetic metal detector used for routine screening for MR imaging to discriminate nonferrous bullets from comparable ferrous objects ex vivo.

APPROACH/METHODS
Test objects consisted of various metallic objects from a personal collection which included two unfired bullets, one bullet found on a street, a penny, a small steel bolt, and a paperclip. To determine ferrous properties of each object, a magnet was placed over each device and objects attracted to the magnet were considered ferrous. Testing then was performed with a FerrAlert™ (Kopp Development, Jensen Beach, FL) ferromagnetic detector which was set to a sensitivity sufficient to detect a standard small paperclip. Objects were passed through the FerrAlert™ detector in a subject’s armpit to simulate an imbedded projectile.

FINAL DISCUSSION
Data from seven objects are reported. The small paperclip and ferrous bolt were both detected by the device. All of the bullets (3/3) and the penny were nonferrous and none triggered the device.

SUMMARY/ConCluSION
The FerrAlert™ device can distinguish nonferrous bullets and equivalent as well as smaller sized ferrous objects even when not in the immediate proximity of its hall effect sensors. This device has the potential to provide additional information regarding the nature of imbedded bullets.

KEY WORDS: MR imaging, ferromagnetic, safety

Scientific Exhibit 26
MR neuroimaging Protocols at 1.5 T and 3 T: What You need to Know

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PURPOSE
To review issues arising when transitioning from 1.5 T to 3 T for neuroimaging and to provide protocols and tips for MR neuroimaging optimized for specific examinations and field strengths.

APPROACH/METHODS
Suggested protocols for neuroimaging applications (eg., whole brain, spine, neurovascular, acute stroke, IAC and cranial nerve, orbits, pituitary, and chronic epilepsy) were developed by a multi-institutional panel of expert neuroradiologists and experienced technologists. Protocols optimized for imaging at 1.5 T and 3 T and were validated clinically by one or more panel members. This exhibit presents specific suggestions for acquisition and display parameters and includes specific recommendations for essential protocol factor modifications when moving from 1.5 T to 3 T.

FINAL DISCUSSION
The main advantage to 3 T imaging is improved signal-to-noise ratios (SNR), which can translate into better spatial resolution and thus more precise anatomical delineation of brain lesions and surrounding structures, or alternatively, can be used to gain greater acquisition speed. However, many issues must be considered in adapting protocols to 3 T scanning including higher specific absorption rate (SAR), and increased chemical shift and susceptibility. T1 relaxation times are increased at 3 T, which positively impacts contrast-enhanced scanning and MRA but also results in decreased spin echo gray-white matter contrast encouraging a shift to other techniques. High relativity contrast agents provide benefits but encourage other modifications in parameters for imaging and contrast delivery and dilution. This exhibit presents neuroimaging protocols designed to leverage the
unique benefits of higher field MR imaging and suggest specific protocol changes to master the challenges of scanning at 3 T.

**SUMMARY/Conclusion**

MR imaging of the CNS at 3 T is associated with the potential for significant clinical benefit. However, an understanding of the impact of the physics of higher-field imaging is critical to leveraging the maximum gain from this technique. This exhibit discusses neuroimaging protocols designed to explore the critical issues for the neuroradiologist transition from 1.5 T to 3 T imaging.

**KEY WORDS:** 3 T, 1.5 T, protocols

**Scientific Exhibit 27**

**neuropsychiatric Imaging: The nuts and BOLDS**

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**PURPOSE**

1. To describe the major neurologic conditions that commonly present with changes in behavior, cognition, memory, or mood and for which neuroimaging is valuable in making a diagnosis. 2. To illustrate, through case examples, the characteristic neuroimaging findings in such disorders, with emphasis on their MR imaging appearance, including diffusion tensor imaging (DTI) and blood oxygenation level dependent (BOLD) functional MRI (fMRI) findings, where applicable. 3. To emphasize the critical role that the neuroradiologist can play in diagnosing neurologic disorders that mimic psychiatric illness.

**APPROACH/METHODS**

Neurologic conditions that are likely to have psychiatric presentations in association with positive neuroimaging findings were selected based upon a review of the pertinent literature as well as our experience at a major academic medical center with a high case volume in neuroradiology, neurology, and psychiatry. Case examples were drawn from our institution’s patient population based on relevant clinical history, imaging findings, and confirmatory diagnostic tests or empiric findings.

**Findings/Discussion**

Neuroimaging currently plays a limited role in diagnosing DSM-IV axis I and axis II psychiatric disorders. This is due primarily to the nonspecificity of structural imaging findings in mental illness, such as cerebral atrophy in dementia or increased ventricular size in schizophrenia. Functional MR imaging is also of limited utility in evaluating individual patients, despite demonstrable differences in activation patterns between groups of patients with and without psychiatric illness. Therefore, with few exceptions, patients presenting with abnormal behavior, cognition, memory, or mood generally are not imaged to diagnose a primary psychiatric illness. Rather, imaging typically is used to rule out an underlying, potentially urgent and treatable neurologic cause for the patient’s clinical presentation. There is a fairly wide spectrum of neurologic disorders with potential psychiatric manifestations, and establishing a reasonable differential diagnosis depends on the clinical scenario. Important considerations include the patient’s age, the time course of symptom onset, the presence of an underlying illness such as HIV infection, ingestion or inhalation of a toxin, history of drug abuse, or history of prior head trauma. In general, disorders that are important to consider in the differential diagnosis are intracranial neoplasms or vascular malformations, infectious or inflammatory meningitis, encephalitis, or cerebritis, adrenoleukodystrophy, radiation therapy, Wernicke’s or toxic encephalopathy, degenerative disorders of the basal ganglia, substance abuse, and traumatic brain injury. It is not uncommon for diseases affecting the frontal or temporal lobes to manifest with changes in cognition, mood, or memory, given the predominant functions of those regions. Seizures or sensorimotor impairment may accompany the psychiatric presentation of a particular neurologic entity. Advanced imaging methods, such as functional MR imaging and diffusion tensor imaging (DTI), can serve as helpful adjuncts in evaluating patients for neuropsychiatric illness, especially those with memory impairment.

**SUMMARY/Conclusion**

1. Neuroimaging, particularly MR imaging, plays a pivotal role in the diagnosis of neurologic disorders with psychiatric manifestations. 2. Neurologic disorders that may mimic psychiatric conditions include a wide variety of processes affecting various brain structures; clinical history is important in making the diagnosis.

**KEY WORDS:** Psychiatry, neuropsychiatry, MR imaging

**Scientific Exhibit 28**

**Headache: A Systematic and Multimodality Approach**

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**PURPOSE**

The purpose of this exhibit is to provide a systematic approach to the evaluation of headache using multiple modalities. Headache is one of the most common presenting complaints in the Emergency Department as well as outpatient clinics and various neurologic imaging studies often are utilized to find an underlying cause for this common symptom. The goal for this exhibit is provide a systematic evaluation for underlying etiologies that can manifest as headache as well as review imaging findings using multiple modalities.

**APPROACH/METHODS**

A systematic approach is provided in this exhibit for the evaluation of headache using multiple modalities. The etiologies for headache are organized by specific category as well as patient demographic or additional sign/symptoms which are unique to a certain category of etiology. Specifically, five categories are established for secondary causes of headache such as vascular, infections, inflammatory, neoplastic and posttraumatic. Through multiple modalities such as CT, MR and PET/SPECT, critical imaging findings are reviewed for each etiology. In addition, as a critical aspect of the systematic approach, distinguishing patient fea-
tures and demographics such as age, pregnancy, and immunocompetency are discussed as integral features that are characteristic of a particular category of etiology.

**Discussion**

The underlying cause for headache can be classified as primary or secondary. Although the majority of patients with headache fall into the primary classification which includes migraines, tension, and cluster headaches without neurologic abnormalities and negative imaging findings, there are multiple secondary causes for headache that are critical to identify. By systematically defining and categorizing the various secondary causes of headache and the unique patient case definitions which can apply to a specific category, an accurate diagnosis can be made more easily on multiple imaging modalities.

**Summary/Conclusion**

Headache is a common indication encountered by general radiologists as well as neuroradiologists. By providing a systematic approach to the evaluation of headache and review of critical imaging findings, accurate diagnosis of various etiologies causing headache can be made both in the context of an on-call emergency situation as well as an outpatient setting in order to streamline appropriate patient care.

**Key Words:** Headache

**Scientific Exhibit 29**

Neuroradiology Lesions that Look Alike

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**Purpose**

Primary brain tumors, metastases, postradiation lesions, infarcts, hemorrhagic conditions, infections and demyelinating plaques can look very similar. Defining the exact nature of a brain lesion is essential as this can have significant impact on the therapeutic options and prognosis. To demonstrate how to make a precise diagnosis or at least suggest a limited number of possibilities in the case of a focal brain lesion by analyzing the imaging findings on the conventional imaging sequences. The value of functional studies also will be explored.

**Approach/Methods**

We analyzed 354 MR exams evaluated between January 2001 and November 2009. Among these, 38 patients presented with a focal brain lesion that could not be characterized easily and were included in this study. Twenty-three were men and 15 women. Ages ranged between 3 and 92 years. The diagnoses were suggested by the imaging aspects and confirmed by surgery/biopsy or clinical evolution after clinical treatment.

**Discussion**

The diagnoses were: 1. Metastasis in 11; 2. Primary high-grade tumors in seven; 3. Infarcts in nine; 4. Hemorrhages in five; 5. Infection in three; 6. Demyelinating plaque in three. The detection of high choline and high perfusion within the perilesional area outside a nodule was a very useful clue to distinguish between high-grade primary brain tumors and metastases. Regarding metastases treated with radiosurgery, the finding of high cerebral blood volume (CBV) and high permeability indicated with high accuracy that the final diagnosis was metastasis. Brain infarcts could be differentiated from tumors as they were located in a vascular distribution and the morphology of the compromised gyrus was still preserved. Also the perfusion typically was reduced and the spectroscopy demonstrated elevation of lipids and lactate but not of the choline, except in the subacute and chronic stages. In regard to hemorrhagic lesions, if the hemosiderin rim was disrupted and the edema was not proportional to the size of the lesion, tumor was the best diagnosis. Also, blood within a tumor did not follow the expected temporal sequence of natural evolution. Focal infection usually presented with a very thin rim of enhancement as opposed to brain tumors that demonstrated a thicker halo of enhancement. On the T2 sequence a granuloma often demonstrated low signal intensity, as opposed to most brain tumors. The perfusion was typically low and the spectroscopy usually demonstrated elevated lipids. Finally, little edema and mass effect for the size of the lesion, small cysts within the lesion, low perfusion, an open-ring enhancement pattern and an excellent response to steroids helped diagnose a demyelinating plaque.

**Summary/Conclusion**

The ability to distinguish between different brain lesions is essential for appropriate patient care. In this regard the conventional imaging often gives many clues to the diagnosis and the experienced neuroradiologist should not make a diagnosis based upon the functional imaging findings alone. The best diagnosis is made when all the information is put together and interpreted under the lights of the clinical presentation.

**References**


**Key Words:** Differential, focal, brain


Scientific Exhibit 30
Spectrum of Imaging Findings in neurotoxicity of Substance Abuse and Intoxication

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PURPOSE
Substance abuse and intoxication is a relatively common cause of presentation to the Emergency Department. The central nervous system is one of the primary targets for injury relating to drugs of abuse and neuroimaging plays an important role in the detection of associated complications. The purpose of this exhibit is to illustrate the spectrum of neuroimaging findings in different forms of substance abuse.

APPROACH/METHODS
A retrospective review of CT and MR exams of patients presenting to our tertiary care hospital over a 2-year period with clinical features of confirmed substance abuse and intoxica-

Findings/DISCUSSION
Multifocal inflammatory demyelination in an adult following a binge of cocaine use, suspected tainted with levamisole: Multiple lesions, some with ring enhancement, are present throughout the centrum semiovale, and appear “multiple sclerosis-like”. Heroin intoxication in a known heroin abuser: Imaging revealed edema with restricted diffusion in the globus pallidi, periventricular white matter and left cerebellum, with several areas of infarction. Ecstasy toxicity in an adolescent who presented with cognitive changes and memory loss: Imaging showed the typical pattern of involvement with symmetric lesions involving the globus pallidi. Posterior reversible encephalopathy syndrome (PRES) in an opiate-dependent patient: Sudden stoppage of opiate use led to withdrawal-like symptoms, bilateral visual loss and bifrontal headache symptoms. Imaging revealed symmetric T2/FLAIR hyperintense signal changes in the parietal, occipital and frontal lobe white matter that resolved following supportive management. Polypathy overdose in a young adult presenting with decreased LOC, and with toxicology screen positive for cannabis, opiates, and ecstasy: Imaging showed asymmetric edema involving the caudate heads and anterior putamen, hippocampus and temporal lobe cortex. Methanol intoxication in a patient following suicidal attempt: Visual loss and progressive stupor leading to coma, with imaging showing the typical pattern of diffuse symmetric edema of the basal ganglia and hemorrhagic putaminal necrosis. Ethylene glycol intoxication in a patient following presumed suicidal attempt: Progressive decreased LOC: Imaging showed diffuse symmetric cerebral edema centered upon the basal ganglia and thalamus, with several small areas of cortical infarction. MR spectroscopy of the basal ganglia revealed loss of NAA and elevated lactate. Marchiafava Bignami disease in a chronic alcoholic with decreased level of consciousness. MR imaging showed edematous swelling of the corpus callosum splenium, representing acute demyelination in this clinical context. Pontine/extrapontine myelinolysis in a chronic alcoholic presenting with decreased level of consciousness and hyponatremia:

Imaging revealed T2 signal changes within the central pons with vague enhancement, as well as symmetric changes involving the putamen and external capsules.

SUMMARY/CONCLUSION
Substance abuse and intoxication continue to represent a major public health problem with significant morbidity and occasional mortality. Neuroimaging plays an important role in the early management of many cases, and can rule out surgically correctable causes of a deceased level of consciousness. Awareness of the spectrum of imaging features of such cases, including the characteristic pattern involvement caused by certain toxins, often can aid in quickly establishing a correct diagnosis and help predict early complications.

KEY WORDS: Neurotoxicity, imaging, intoxication

Scientific Exhibit 31
Neuroimaging Spectrum of Bilateral Thalamic Lesions

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PURPOSE
To present in a pictorial essay the differential diagnosis of both neoplastic and nonneoplastic bilateral thalamic lesions.

APPROACH/METHODS
The viewer will learn about the differential diagnosis of bilateral thalamic lesions as well as learn how to differentiate these lesions utilizing conventional MR imaging with supplemental neuroimaging modalities including MR spectroscopy, MR diffusion and perfusion imaging, MR venography, MR angiography, and digital angiography.

Findings/DISCUSSION
Neuroimaging of bilateral thalamic lesions will be presented. Cases of neoplastic as well as nonneoplastic bilateral thalamic lesions (infectious, inflammatory, vascular, metabolic, demyelinating) will be shown. Utilization of conventional brain MR with supplemental neuroimaging modalities can be diagnostic or aid in narrowing the differential diagnosis.

SUMMARY/CONCLUSION
Differentiation of bilateral thalamic lesions can be narrowed further using multimodality neuroimaging and clinical history.

KEY WORDS: Bilateral thalamic
Scientific Exhibit 32

Brain Stress Test: Determination of Cerebral Autoregulation

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PURPOSE
1. Discuss the relationship of cerebral autoregulation to cerebral perfusion in the traumatized brain. 2. Demonstrate methods of evaluating autoregulation.

APPROACH/METHODS
Part 1. Review the principles of cerebral perfusion and demonstrate the relationship of cerebral autoregulation to cerebral perfusion following severe traumatic brain injury (TBI, GCS<8). Part 2. Describe and compare methods of evaluating cerebral autoregulation by retrospective review of 27 patients with severe TBI.

Findings/Discussion
Reducing secondary brain injury, a main goal of treatment for severe TBI, is accomplished in part by maintaining adequate cerebral blood flow (CBF), typically by supporting cerebral perfusion pressure (CPP). Cerebral perfusion pressure is the difference between mean arterial pressure (MAP) and intracranial pressure (ICP). Cerebral autoregulation is the physiologic process by which CBF remains constant despite changes in CPP. In the absence of autoregulation, blood flow is related directly to CPP; if CPP falls, CBF declines, potentially resulting in ischemia, and if CPP increases, CBF increases, potentially leading to intracranial hypertension and cerebral edema. Disrupted autoregulation is thought to be common in patients with severe TBI, and may be an independent predictor of mortality. Evaluation of autoregulation involves assessing changes in CBF in response to physiologic challenge. Our evaluation techniques include perfusion CT (CTP) and transcranial Doppler (TCD). Transcranial Doppler evaluates the status of autoregulation by measuring cerebrovascular resistance (CVR) during changes in CPP. Autoregulation is considered intact if the percentage change in CVR/percentage change in CPP is < 0.4. Mean arterial pressure is elevated pharmacologically to assess static autoregulation, or decreased suddenly by application of a high blood pressure cuff to assess dynamic autoregulation (1). The importance of static versus dynamic autoregulation in maintaining adequate CBF is controversial. CT perfusion evaluation of cerebral autoregulation involves comparing CBF and CBV at baseline and following 20 mmHg pharmacologic increase in MAP. Patients with increased CBF and CBV after MAP elevation are considered to have impaired/absent autoregulation (2). In our population of 27 patients who underwent both CTP and static TCD, nine patients had disrupted autoregulation by CTP, and 13 had disrupted autoregulation by static TCD, indicating 78% agreement between the two methods (k = 0.56). Of 24 patients who underwent both CTP and dynamic TCD, 9 patients had disrupted autoregulation by CTP, 17 had disrupted autoregulation bilaterally by dynamic TCD and four met criteria for disrupted autoregulation only unilaterally. There was a 41-50% agreement between CTP and dynamic TCD, depending on whether patients with unilateral disruption were excluded, considered disrupted, or considered intact (k = -0.1, -0.2, 0.0, respectively).

SUMMARY/CONCLUSION
Perfusion CT and TCD can identify disruption of cerebral autoregulation and alter the management of patients with severe traumatic brain injury. Perfusion CT correlates moderately well with static TCD, but not well with dynamic TCD, suggesting these methods may evaluate different physiologic processes.

REFERENCES

KEY WORDS: Autoregulation, CT perfusion, traumatic brain injury

Scientific Exhibit 33

Aneurysmal Abnormalities on CT Angiography Performed following Craniocervical Trauma: Pseudo- or Saccular?

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PURPOSE
Many patients who present to the Emergency Department are found down by EMS and are unresponsive, often without reliable witnesses at the scene. In such settings with very little relevant history, a noncontrast CT of the head has long been the standard of care. When intracranial hemorrhage is discovered it is often presumed to be traumatic in etiology, especially if there are other signs of trauma such as facial or scalp laceration. However, with the current availability of high resolution CT angiography (CTA), a noninvasive investigation of the vascular system often is performed, especially if subarachnoid hemorrhage is extensive. Most often, these examinations are negative, but in a subset of cases, CTA detects either pseudo-aneurysms as a result of the injury, or saccular aneurysms, which either precipitated syncope and subsequent head injury, or are simply incidental. Performance of high quality CTA with careful scrutiny of source data, multiplanar, maximum intensity projection and volume rendered reconstructions is essential. In selected cases, transcatheter cerebral angiography remains necessary to clarify the diagnosis and provide definitive treatment.

APPROACH/METHODS
One hundred CTA examinations obtained following craniocervical trauma in 2009 from a busy Level I Trauma center were reviewed retrospectively in an effort to detect cervico-cerebral aneurysms or pseudoaneurysms.

Aneurysmal Abnormalities on CT Angiography
Six cases were identified which demonstrated intracranial aneurysmal abnormalities on CTA. Five of these also showed intracranial hemorrhage on standard noncontrast CT. Three cases demonstrated saccular aneurysms that were judged to almost certainly have ruptured, preceding trauma to the head. In one of these three cases, cerebral angiography was necessary to confirm the diagnosis, and in one other case a small aneurysm may have been an incidental finding. Two additional cases are included to demonstrate the contrasting appearance and location of posttraumatic pseudoaneurysms; one of these was associated with a low-flow carotid-cavernous fistula.

**SUMMARY/Concl usion**

While trauma is the most common cause of intracranial hemorrhage in the Emergency Department setting, an atypical pattern of bleeding, especially an abundance of subarachnoid hemorrhage on CT, necessitates exclusion of a ruptured aneurysm. This can be accomplished most often by high resolution CTA; transcatheter cerebral angiography is rarely necessary for primary diagnosis, but has an important and expanding role in therapeutic intervention.

**KEY WORDS:** Intracranial hemorrhage, aneurysm, trauma

### Scientific Exhibit 34

**Posttraumatic Cerebral Fat Embolism: MR Imaging Features in Four Cases**

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**PURPOSE**

The purpose of this scientific exhibit is to demonstrate the value of MR imaging in early diagnosis of posttraumatic cerebral fat embolism and see the spectrum of MR findings in four patients.

**Approach/Methods**

In the last 10 months, we radiologically evaluated four patients with clinical suspicion of fat embolism in our trauma center. All of the four patients had presented with fracture of long bones with sudden unexplained deterioration in their neurologic status a few days after the injury. Two of these patients also had simultaneous onset of respiratory problems. All of these patients underwent CT scan and MR imaging of the brain. MR protocol included T1-weighted, T2-weighted, FLAIR, diffusion-weighted imaging and gradient-echo sequences. CT pulmonary angiography also was performed in the two patients with respiratory difficulty.

**Findings/Discussion**

CT scan of the brain was normal in all four patients. MR imaging of the brain in all of the four patients showed bilateral asymmetrically distributed multiple nodular or punctate foci of high signal intensity on T2-weighted and fluid attenuated inversion recovery (FLAIR) images located in the subcortical as well as deep white matter (centrum semiovale). All the lesions showed restricted diffusion on diffusion-weighted images. One specific feature which was seen in all patients was involvement of splenium of corpus callosum which also showed significant restricted diffusion. Involvement of the brainstem and basal ganglia/thalami with similar lesions was seen in two patients each. Cerebellum involvement was seen in one patient. One patient had multiple large (> 2 cm) lesions with evidence of punctate hemorrhages within as visualized on gradient-echo images whereas the other three patients had small foci without hemorrhage. The diagnosis of cerebral fat embolism was made in all patients based upon the characteristic MR findings. The pulmonary CT angiography performed in the two patients did not reveal any pulmonary artery embolism. Both of these patients were put on ventilatory support. One patient had repeat MR imaging done 2 weeks after the initial examination which revealed significant resolution of the lesions. All four patients showed significant recovery over next 2 months and were discharged after management of their skeletal injury with minimal residual neurologic deficits. The term fat embolism syndrome encompasses a syndrome that consists of pulmonary, central nervous system, and cutaneous manifestations. The classic presentation is following a long bone fracture and a 12- to 48-hour symptom free interval followed by respiratory insufficiency, a petechial rash, and neurologic deterioration (1, 2). The abnormalities detected on MR imaging are thought to represent microinfarcts arising from fat emboli occluding cerebral arterialis.

**Summary/Conclusion**

Cerebral fat embolism is an uncommon entity which should be suspected in the right clinical setting of posttraumatic patient presenting with delayed neurologic symptoms. MR imaging of the brain with characteristic imaging findings can confirm the diagnosis.

**References**


**Key Words:** Embolism, fat, brain

### Scientific Exhibit 35

**Varied Appearance of Traumatic Cranio cervical Arterial Dissection across Multiple Modalities**

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**Purpose**

To present an educational case series exhibiting the spectrum of appearances of cranio cervical arterial dissection on unenhanced CT, CT angiography, MR imaging, MR angiography, and conventional angiography.
APPROACH/METHODS
Multiple cases of traumatic injury of the cervical spine were collected from the Barrow Neurological Institute and the University of Arizona Medical Center, both Level 1 trauma centers. Images selected highlight the varied imaging findings across multiple modalities.

DISCUSSION
The pathophysiology of arterial dissection contributes to a varied appearance on CT and MR imaging. Dissection of blood into the media can occur due to primary intimal injury and tear, or due to primary intramural hematoma. On unenhanced CT, this correlates to a hyperattenuating crescent-shaped mural lesion associated with a narrowed, eccentric lumen. Often the intramural hematoma causes overall enlargement of the external vessel diameter. CT angiography will demonstrate a narrowed arterial lumen with mural thickening that can appear isodense to muscle. On MR imaging, the appearance of this pathophysiology is highly dependent on the age of the intramural hematoma, the surrounding tissues, and MR imaging sequence. The hematoma will follow MR imaging signal intensity characteristics of blood products, appearing in the subacute stage as a bright crescentic lesion with an eccentric flow void best seen on T1 fat suppressed images. Time-of-flight and gadolinium-enhanced MRA commonly are used to demonstrate the features of dissection. On any modality, dissection may appear as an intimal flap or may manifest as complete luminal occlusion. Dissection towards the adventitia also may result in pseudoaneurysm or complete mural transection.

SUMMARY/CONCLUSION
As a relatively rare but potentially disabling complication of blunt or penetrating trauma, craniocervical dissection is a crucial diagnostic entity. Familiarity with the pathophysiology and numerous appearances across diagnostic CT and MR imaging examinations facilitates prompt diagnosis as well as prevention of morbidity and mortality.

KEY WORDS: Arterial dissection, craniocervical, trauma

Scientific Exhibit 36
CT Perfusion Evaluation of Vasospasm in the Setting of Subarachnoid Hemorrhage

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PURPOSE
The purpose of this exhibit is to demonstrate the utility of CT perfusion (CTP) in the diagnosis of intracranial vasospasm in patients with subarachnoid hemorrhage (SAH). We present six cases of known SAH evaluated by CTP, followed by digital subtraction angiogram (DSA). We demonstrate vascular territories of decreased perfusion consistent with vasospasm on CTP correlate with imaging findings of vasospasm on DSA. We also present one case of normal CTP for comparison.

APPROACH/METHODS
Vasospasm is a potential complication of SAH that may result in up to 67% increased mortality (1). The diagnosis of vasospasm is made on the basis of a new neurologic deficit in a patient with SAH; however, new deficits often are difficult to diagnose in obtunded or sedated patients. Because the
treatment of vasospasm involves the risk of hemorrhage and brain edema, diagnostic imaging is frequently utilized to establish the diagnosis of vasospasm before treatment is initiated (2). Modalities used in the evaluation of vasospasm include transcranial Doppler ultrasonography (TCD), the gold standard of digital subtraction angiogram, and CT perfusion. Transcranial Doppler ultrasonography is noninvasive but the sensitivity and specificity of the exam can vary greatly (1). Digital subtraction angiography is invasive with potential complications of embolic infarct, dissection, and possible death. CT perfusion has little to no risk of complication and provides accurate evaluation and diagnosis of intracranial vasospasm in patients with SAH (1-3). We present cases from six patients (3M 3F) with age range 36-79 years and median age of 50 years. The CTP normal is a 56-year-old female. Patients were first diagnosed with SAH on noncontrast head CT. If vasospasm was suspected clinically, a simultaneous CT angiography (CTA) and CTP exam was performed on a Siemens Somatom 128 slice Definition AS scanner, scanning from the base of the brain to the apex, using 40 mL Isovue 370 IV contrast injected at 8 mL/sec chased by a 50 mL 0.9% NaCl bolus. Postprocessing of data was performed by the CT technologist in 1 mm reconstructions. Three sets of data for CTA evaluation were sent to an independent Vitrea workstation for CTA processing. Five mm and 10 mm data sets were sent to an independent Leonardo workstation using VPCT Neuro Somaris/7 Syngo CT 2008G software package for CTP processing. CT perfusion data processing included generation and review of CBF, CBV, TTP and MTT image maps.

**Findings/Discussion**

CT perfusion data in the setting of SAH and clinically suspected intracranial vasospasm demonstrates prolongation of MTT in the vascular distribution of vasospasm. CT perfusion findings are supported by DSA findings consistent with vasospasm. Of the six patients, one demonstrated anterior cerebral artery vasospasm, four demonstrated middle cerebral artery (MCA) vasospasm, one demonstrated MCA and basilar artery vasospasm.

**Summary/Conclusion**

CT perfusion images demonstrate delayed MTT in vascular territories that correlate with vasospasm diagnosed on DSA. Our data indicate that CTP is a reliable imaging exam that can be used to diagnose intracranial vasospasm, without the subjectivity of TCD or the interventional risks of DSA.

**References**


**Key Words:** CT perfusion, subarachnoid hemorrhage, intracranial vasospasm
Scientific Exhibit 38

T2*-Weighted Gradient-Echo Type Echo Planar Imaging in Diagnosis of Ischemic Stroke

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Akita, JAPAN

PURPOSE
The purpose of this exhibit is to demonstrate T2*-weighted gradient-echo type echo-planar imaging (GRE-EPI) findings of cerebral infarction during acute to subacute period. Gradient-echo type echo-planar imaging is a useful method that can take less than a minute to acquire.

APPROACH/METHODS
The authors retrospectively reviewed GRE-EPI imaging findings of acute cerebral infarction. The MR imaging examinations were performed at 1.5 T. The MR imaging protocol included GRE-EPI, diffusion-weighted imaging, T2-weighted imaging, and 3D time-of-flight MRA. We evaluated artery susceptibility sign, enhanced venous contrast, and tissue hypointensity sign at GRE-EPI. Artery susceptibility sign was defined as the presence of hypointensity within the intracranial artery in which the diameter of hypointense signal within the vessel exceeded the diameter of adjacent vessel. Enhanced venous contrast was defined as hypointensity and enlargement of the superficial cerebral vein or deep cerebral vein. Decreased signal in ischemic parenchyma was designated tissue hypointensity sign. Tissue hypointensity sign at GRE-EPI was compared with change in oxygen extraction fraction (OEF) measured by positron emission tomography (PET) with oxygen-15. Repeated MR imaging was performed in the subacute stage.

Findings/DISCUSSION
Artery susceptibility sign was correlated with arterial occlusion at MRA, although it was difficult to detect internal carotid artery susceptibility sign due to the strong susceptibility artifact from the skullbase. Arterial susceptibility sign may be explained by severe T2-shortening at an acute embolus, representing the magnetic susceptibility variation of paramagnetic deoxyhemoglobin, which is present in high concentration in acute thromboembolism. Enhanced venous contrast was seen ipsilaterally in extensive ischemia due to embolic occlusion. Tissue hypointensity sign was detected within the vascular territory of the occluded artery. Corresponding to the decreased signal intensity areas at GRE-EPI, OEF was markedly increased using PET with oxygen-15. The increased OEF (misery perfusion) may lead to a decrease of oxyhemoglobin and a relative increase of deoxyhemoglobin concentrations in cerebral capillaries and veins within the ischemic territory. Follow-up GRE-EPI showed artery susceptibility sign alteration due to migration of acute emboli. Repeated GRE-EPI supplemented repeated MRA in evaluating arterial recanalization. Gradient-echo type echo-planar imaging allowed facile visualization of the hemorrhagic region.

SUMMARY/CONCLUSION
Gradient-echo type echo-planar imaging is a feasible method for identifying acute emboli as well as misery perfusion in acute ischemic stroke.

KEY WORDS: Cerebral infarction, gradient-echo, MR imaging

Scientific Exhibit 39

Compact White Matter Pathways: Correlation of T2-Weighted Imaging with Diffusion-Tensor Imaging Tractography

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PURPOSE
Many compact fiber pathways of the brain can be well identified on T2-weighted images due to prominent decreased signal intensity that reflects heavy myelination and high fiber density that become more obvious at 3T than at 1.5T. The purpose of this exhibit is to illustrate the anatomical features of these fibers on T2-weighted imaging and to correlate the T2-weighted white matter tract appearance with 3T diffusion-tensor imaging (DTI) tractograms.

APPROACH/METHODS
MR studies were performed at 3T (GE HDx, Philips Achieva X-series). T2-FLAIR, T2-weighted fast spin-echo, and T2 dual spin-echo images were used for demonstrating fiber pathways with short T2 relaxation times. GE Functool or Philips FiberTrak was utilized to process the DTI data for creating the tractograms.

Findings/DISCUSSION
The following fiber pathways are included in this exhibit: anterior commissure, internal capsule, external capsule, extreme capsule, corticospinal, corticopontine, thalamocortical, optic tract and radiation, fornix, mammillothalamic, superior frontooccipital fasciculus, inferior frontooccipital fasciculus, cingulum, corpus callosum (including tapetum), uncinate fasciculus, and superior and inferior longitudinal fasciculus. T2-weighted imaging fails at depicting white matter pathways (tracts) in the corona radiata to specific areas of the brain (e.g., corticospinal and thalamocortical). Fractional anisotropy images also fail at this and only tractograms can create dedicated images of these white matter pathways/tracts.

SUMMARY/CONCLUSION
This exhibit illustrates the anatomical features of fiber pathways of the brain on T2-weighted imaging with correlation to DTI tractography. The strengths and weaknesses of T2-weighted white matter imaging compared to tractography will be pointed out.

KEY WORDS: White matter pathway, T2-weighted imaging, diffusion-tensor imaging
Intracranial Vascular Anatomy and Variants in the Presence of Arteriovenous Shunts: Cross-Sectional and Angiographic Correlation

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PURPOSE
As cross-sectional neurovascular imaging becomes more common, radiologists increasingly encounter challenging neurovascular cases. The radiologist’s diagnostic accuracy requires detailed knowledge of the intracranial arterial cross-sectional appearance. This pictorial review presents high quality images of cross-sectional anatomy of normal intracranial arterial structures and variants which are visualized by the presence of arteriovenous shunts. Corresponding conventional angiographic images and illustrations help to elucidate the anatomical relationships of these vessels.

APPROACH/METHODS
Multiple examples will be presented from our vascular malformation database, depicted by digital subtraction angiography (DSA), computed tomography angiography (CTA) and magnetic resonance angiography (MRA). Simple line diagram and sketch illustrations will provide a simplified correlation. Arterial anatomy, common variants and territory of distribution will be highlighted.

Findings/Discussion
Arteries will be divided into cortical, choroidal, perforating and meningeal vessels. The arterial territories of the supratentorial and infratentorial compartment will be individualized and highlighted on cerebral angiography and cross-sectional imaging. Subtle anatomical structures like choroidal and perforating arteries will be exemplified in their normal and hypertrophied state which occurs in arteriovenous shunts. Vascularization of the meninges will be detailed in relationship to inner skull base anatomy.

Summary/Conclusion
Knowledge of detailed neurovascular anatomy is crucial to providing accurate interpretations of CTA, MRA and DSA. We present an organized approach to understanding this complex anatomy, with illustrations of various vascular structures to help the viewer understand anatomical relationships and functional roles.

KEY WORDS: Anatomy, vascular, intracranial
nerve, sublingual gland and portions of the submandibular gland and duct. The OMS lines the entire oral cavity, and has several distinct anatomical regions, including the buccal and gingival mucosa, retromolar trigone, and the mucosa over the palate. The retromolar trigone is a triangular mucosal area posterior to the third mandibular molar. Deep to this mucosa lies the pterygomandibular raphe which is a thick band of cervical fascia which extends from the medial pye-goid hamulus superiorly to the mandibular mylohyoid ridge inferiorly. The raphe serves as a point of attachment for the buccinator and superior pharyngeal constrictor.

**Summary/Conclusion**

Having a working knowledge of the complex relationships within the oral cavity is critical to understanding the pathology of this region.

**Key Words:** Oral cavity, anatomy

### Scientific Exhibit 42

**Multiplanar CT and MR Imaging of Inflammation and Infection in the Retropharyngeal Space: Is It an Abscess?**

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**Purpose**

Inflammatory collections in the retropharyngeal space (RPS) traditionally have been evaluated using axial CT images. In the era of multidetector CT and MR imaging, the use of sagittal and coronal images can be helpful in characterizing pathology and delineating the extent of disease. In this pictorial review, we present a systematic approach to evaluating RPS collections using multiplanar imaging. The purposes of this educational exhibit are: 1. To describe the anatomy of the retropharyngeal space (RPS) and its appearance on multiplanar imaging; 2. To define an algorithmic approach to evaluating inflammatory collections in the RPS using multiplanar imaging; and 3. To describe and illustrate the imaging findings of abscess and nonabscess fluid in the RPS.

**Approach/Methods**

A. Normal anatomy: Boundaries and contents; The danger space. B. Collections in the RPS: Is it abscess or nonabscess fluid? a) Imaging approach to a RPS collection; b) Imaging findings: • RPS abscess, suppurative adenitis and cellulitis; • RPS edema and causes. c) Pitfalls: Mimics of a RPS collection.

**Discussion**

An imaging approach to a RPS collection includes evaluation of 1) location and extent in the RPS, 2) configuration of the collection, 3) degree of mass effect, 4) wall thickening and enhancement, and 5) ancillary findings outside the RPS. A suppurated RPS node appears as a unilateral RPS mass. Extranasal collections fill the RPS from side to side. A suppurated lymph node in the suprathyroid RPS can rupture and spread bilaterally and inferiorly as cellulitis/phlegmon before forming an abscess. A RPS abscess has rim enhance-

### Summary/Conclusion

When evaluating inflammatory collections in the RPS, it is critical for radiologists to distinguish between abscess and nonabscess fluid collections, because this differentiation determines whether the patient is an appropriate candidate for surgery. In this exhibit, we describe the key findings that are useful in differentiating between abscess and nonabscess fluid in the RPS, and determining the etiology of the collection.

**Key Words:** Retropharyngeal space, abscess, multiplanar imaging

### Scientific Exhibit 43

**Multiplanar CT and MR Imaging of Masses in the Retropharyngeal Space**

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**Purpose**

Masses in the retropharyngeal space (RPS) traditionally have been evaluated using axial CT images. In the era of multidetector CT and MR imaging, the use of sagittal and coronal images can be helpful in characterizing pathology and delineating the extent of disease. In this pictorial review, we present a systematic approach to evaluating RPS masses using multiplanar imaging. The purposes of this educational exhibit are: 1. To describe the anatomy of the retropharyngeal space (RPS) and its appearance on multiplanar imaging; 2. To categorize the potential etiologies of a mass in the RPS, and define an imaging approach to these lesions; 3. To identify lesions that can mimic RPS masses.

**Approach/Methods**

A. Normal anatomy: Boundaries; Contents; Criteria for normal lymph nodes. B. Masses in the RPS: i) Imaging approach to a RPS mass; ii) Imaging findings. Malignant neoplasms: • Lymph node; • metastasis; • Non-Hodgkin’s lymphoma; • Pharyngeal carcinomas invading into RPS. Benign neoplasms: • Lipoma; • Nerve sheath tumor; • Parathyroid adenoma; • Goiter extending into RPS. Vascular malformations: • Venous malformations; • Lymphangioma. iii) Pitfalls and mimics; • Tortuous medialized ICA; • Submucosal lesions; • Prevertebral space mass.

**Discussion**

When categorizing RPS masses, the radiologist should evaluate 1) the size and extent of the lesion within and outside the RPS, 2) the intrinsic density/signal and enhancement characteristics of the lesion, and 3) ancillary findings outside the RPS. Sagittal images are helpful in delineating the extent
of a mass and confirming the location within the RPS. Primary tumors of the RPS are usually elliptical and conform to the shape of the RPS. When RPS lymph node metastases are suspected, surveillance of primary sites includes pharynx (especially the nasopharynx), skull base, larynx, thyroid, and paranasal sinuses.

**SUMMARY/Conclusion**
The differential diagnosis for a RPS mass includes benign and malignant neoplasms arising from tissues in the RPS in addition to masses extending into the RPS. A systematic approach to lesions of the RPS allows radiologists to construct a logical and clinically useful differential diagnostic approach.

**KEY WORDS:** Retropharyngeal space, lymph node metastasis, multiplanar imaging

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**Scientific Exhibit 44**

**Retromolar Trigone: What Is It, Where Is It, and Why Should I Care?**

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**PURPOSE**

Retromolar trigone (RMT) tumors account for 7 percent of tumors affecting the oral cavity. The unique location of the RMT at the junction of the oropharynx and oral cavity permits complex patterns of tumor spread. Beneath the mucosal surface of the RMT is the pterygomandibular raphe, extending from the hamulus of the medial pterygoid plate superiorly, to the mylohyoid line of the mandible inferiorly. The buccinator and superior pharyngeal constrictor muscles arise from this raphe and provide common routes of tumor spread: 1. Superiorly, spread to the pterygoid plates allows access to the pterygopalatine fossa from which tumor may spread cephalad to the skull base and cavernous sinus; 2. Involvement of the pterygoid muscles in the masticator space may lead to perineural spread along the mandibular nerve and proximally to the skull base. This exhibit explores the complex anatomy of the RMT and pathologies that occur in this location. Emphasis is placed on demonstrating the routes of tumor spread from the RMT.

**APPROACH/METHODS**
The normal anatomy of the RMT is demonstrated using schematic illustrations, CT and MR images. We retrospectively reviewed 125 cases of RMT pathology evaluated at three institutions over the past 5 years. Histopathology of these lesions was obtained. CT, MR, and PET images were analyzed for tumor extent including mandibular invasion, perineural spread, and regional lymph node involvement.

**FinDiGS/DIscussion**
The majority, 97 patients, were found to have squamous cell carcinoma of the retromolar trigone primarily or via direct extension from adjacent structures. The remaining patients demonstrated a variety of pathologies: 10 odontogenic abscesses, three mucoepidermoid carcinomas, three adenoid cystic carcinomas, two sarcomas, two ameloblastomas, one facial nerve schwannoma, one acinic cell adenocarcinoma, and one odontogenic keratocyst.

**SUMMARY/Conclusion**
The RMT is an important subsite of the oral cavity in which the majority of lesions are tumors. Imaging facilitates assessment of tumor volume, perineural invasion, bone marrow invasion, and lymph node involvement—factors which influence the staging, treatment, and prognosis. Schematic illustrations and cases of pathology (common and uncommon) are used to demonstrate the anatomy and routes of tumor spread.

**KEY WORDS:** Retromolar trigone, oral cavity

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**Scientific Exhibit 45**

**Perineural Spread of Head and Neck Malignancy: A Pictorial Review**

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**PURPOSE**

Perineural spread (PNS) of head and neck malignancy is one of the most important factors influencing prognosis and therapeutic management. Symptoms of PNS may be insidious which results in delay in diagnosis and early treatment. Timely and correct diagnosis of PNS is crucial as continued neurotropic spread may make treatment difficult and improper diagnosis may result in suboptimal treatment. MR imaging is the modality of choice in detection of perineural extension of tumor. Understanding of cranial nerve anatomy, mode of perineural spread and its radiologic appearance is essential in meeting this diagnostic challenge.

**APPROACH/METHODS**

1. Discuss optimal CT and MR protocol for detection of perineural spread;
2. Describe relevant topographic landmarks, skull base and cranial nerve anatomy; and
3. Image-based pictorial review of wide spectrum of head and neck malignancies associated with perineural extension. Direct and indirect signs of cranial nerve involvement and potential pitfalls will be discussed.

**FinDiGS/DIscussion**
The most common head and neck tumors to spread perineurally are squamous cell carcinomas (SCC) of the skin and adenoid cystic carcinoma. Perineural tumor extension also is seen in mucosal SCC, melanoma, lymphoma, rhabdomyosarcoma and malignant nerve sheath tumors. Perineural spread can be antegrade or retrograde in relation to the brain, and can present as contiguous or skip lesions. The trigeminal and facial nerve branches are involved most commonly. Enlargement and enhancement of the nerve, obliteration of perineural fat, widening and erosion of neural foramina, denervation atrophy of muscle are the imaging signs aiding in detection of perineural extension.
Key Words: Perineural, cranial nerve, MR imaging

Scientific Exhibit 46

MR Findings in Thoracic Outlet Syndrome

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Purpose
We discussed MR techniques and findings in thoracic outlet syndrome (TOS) based on 23 cases.

Approach/Methods
A total of 46 neurovascular bundles of 23 symptomatic cases were evaluated in the cervicothoracophracial region. To exclude neurogenic abnormality, from C4 to T2 with arms alongside of the body (neutral), sagittal and axial T2-weighted for radiculopathy and spinal cord lesions, and pre- and fat-saturated postcontrast axial and coronal (parallel to the long axis of C4-C7 vertebrae) T1-weighted and coronal fat-saturated T2-weighted for brachial plexus were obtained. To exclude compression/impingement on the neurovascular bundle, in abduction and neutral positions, sagittal T1-weighted images were obtained vertical to the longitudinal axis of brachial plexus from spinal cord to the medial part of the humerus. To exclude vascular TOS, MR angiography (MRA) and venography (MRV) of subclavian artery (SA) and vein (SV) in abduction were obtained. If there is compression upon the vessels, MRA and MRV of SA and SV were repeated in neutral.

Findings/Discussion
Seventeen of 46 neurovascular bundles were normal (12 cases). Twenty-nine neurovascular bundles were abnormal. In four cases, there were bilateral congenital variational bone abnormalities causing TOS such as long C7 transverse process, cervical rib, cervical rib-first thoracal rib articulation. In 7/29, arterial-venous-neurogenic TOS was noted in costoclavicular space. In 4/7, additionally neurogenic TOS was noted in interscalene triangle due to congenital variational bone abnormalities. In 10/29, neurogenic TOS was noted. Two of nine were in costoclavicular space due to accessory or hypertrophied muscle. Four of nine were in interscalene triangle due to congenital variational bone abnormalities with one observed at both interscalene triangle and costoclavicular space. Four of nine were in costoclavicular space probably secondary to position. In 7/29 venous TOS was noted in costoclavicular space with one observed in retropectoralis minor space additionally. In 1/29, arterial TOS was noted at lateral border of interscalene triangle possibly secondary to compression of anterior scalene muscle or because of piercing of the SA through the anterior or middle scalene muscles. In 4/29, 2/4 were arterial-venous TOS in costoclavicular and retropectoralis minor spaces. One of four was arterial-neurogenic TOS in costoclavicular space and 1/4 was venous-neurogenic TOS in costoclavicular space. The most common compression/impingement was observed in costoclavicular space. Long transverse process and short cervical rib cause compression/impingement in interscalene triangle. A cervical rib, if it is long enough, may cause compression/impingement in both interscalene triangle and costoclavicular space. Neurovascular bundle very rarely are compressed/impinged in retropectoralis minor space.

Summary/Conclusion
For evaluation of subjects presenting with TOS, visualization of brachial plexus with dynamic evaluation of neurovascular bundle in cervicothoracophracial region is mandatory.

Key Words: Thoracic outlet syndrome, brachial plexus, subclavian artery and vein

Scientific Exhibit 47

Effective Strategies in Reducing Radiation Dose in Head and Neck Imaging

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Purpose
This exhibit outlines the principles of radiation dose in computed tomography (CT) imaging and the effective strategies in reducing the radiation dose in head and neck imaging.

Approach/Methods
There are multiple parameters that contribute to the radiation dose in CT imaging which includes tube current, peak voltage, tube rotation time, pitch, and collimation. Changing the acquisition parameters forms the basic strategy in reducing the radiation dose. Typically, when one of the imaging parameters is decreased, another needs to be increased to maintain the image quality.

Findings/Discussion
Automatic tube current modulation (ATCM) is an innovative technique that helps in reducing radiation dose. An optimal diagnostic image can be acquired with the aid of ATCM system while reducing radiation dose. A proper centering of the patient in the tube proved to be a valuable factor in improving image noise and optimizing the value of ATCM and hence minimizing the radiation dose while maintaining a good image quality. Adaptive statistical iterative reconstruction (ASIR) is a reconstruction technique that reduces image noise and radiation dose while maintaining the quality of the CT image.

Summary/Conclusion
It is essential to understand the imaging parameters in order to optimize the CT image quality while achieving the lowest possible radiation dose. Automatic tube current modulation system along with good patient centering and ASIR are valuable tools in minimizing radiation dose.

Key Words: Radiation dose, head and neck
Scientific Exhibit 48

“Finding a needle in a Haystack”: Review of Imaging to Identify Parathyroid Adenomas

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PURPOSE
Primary hyperparathyroidism is the most common cause of primary hypercalcemia. This typically is caused by parathyroid adenomas which can be difficult to localize given the small size and occasional ectopic location. The purpose of this educational exhibit is to review parathyroid imaging to diagnose and localize adenomas with various modalities. We aim to review embryology, imaging, anatomy and different imaging techniques helpful in diagnosing parathyroid adenomas.

APPROACH/METHODS
Retrospective review of patients with biochemically and pathologically proved parathyroid adenomas was performed at a tertiary referral center. The imaging modalities included ultrasound, nuclear medicine imaging including sestamibi scan, CT including dynamic contrast-enhanced 4D CT, and magnetic resonance (MR) imaging. Through example illustrations, we review the imaging characteristics of parathyroid adenomas as demonstrated in different imaging modalities with particular emphasis on efficacy and limitations of each modality.

Findings/DISCUSSION
The embryology and anatomy of the parathyroid glands are reviewed. Ultrasound and nuclear medicine study, particularly sestamibi scan are used most commonly for localization as the first line modality. Ultrasound is noninvasive and cost-effective; however, may have difficulty identifying ectopic adenomas. Sestamibi scan is effective but less sensitive to smaller lesions due to poor spatial resolution. MR imaging is useful and free from radiation, but not cost-effective and often degraded by motion. CT provides higher spatial resolution and dynamic contrast-enhanced CT provides functional information, which is helpful for tissue characterization and shows promise as a technique for identifying small adenomas in ectopic locations. However, radiation dose from multiple scan (4D) technique is not ideal, particularly for young patients.

SUMMARY/CONCLUSION
Localization of parathyroid adenomas is important for planning surgical exploration to decrease operating time and surgical complications. Radiologists have an important role, and must be familiar with embryology, anatomy and imaging characteristics of parathyroid adenomas, as well as efficacy and limitations of each modality.

REFERENCES

KEY WORDS: Parathyroid adenoma, 4D CT

Scientific Exhibit 49

Rhabdomyosarcoma in Children and Adolescents: Imaging, Clinical, and Pathologic Assessment

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PURPOSE
To demonstrate the clinical, imaging, and pathologic findings of rhabdomyosarcoma in children and adolescents.

APPROACH/METHODS
We evaluated 30 cases of rhabdomyosarcoma (RMS) in two to 20-year-old patients from the Massachusetts General Hospital (MGH) and the Massachusetts Eye and Ear Infirmary (MEEI). All cases were studied with CT and/or MR imaging, and PET-CT was available in some cases. Representative cases of RMS in different locations will be selected and illustrated along with extension of these tumors. Pertinent differential diagnosis will be presented at the conclusion of the case presentations.

Findings/DISCUSSION
On CT the densities were homogeneous showing only slight enhancement. The MR findings revealed low signal intensities relative to muscle on T1-weighted, increased signal intensities on T2-weighted, and marked enhancement on postgadolinium images. PET-CT was helpful in determining the activity of residual tumor after therapy and local and distant metastases. Tumor necrosis was not a prominent feature. The location of RMS was as follows: orbit (8), parapharyngeal space (PPS) (5), nasopharynx (NP) (4), oral cavity/oropharynx (4), paranasal sinuses/nasal cavity including nasal bones (4), temporal bone (2), neck (2), and temporal fossa (1). Intracranial extension occurred most commonly in RMS arising in the PPS, NP, and temporal bone. Rhabdomyosarcoma is the most common soft tissue sarcoma in the first two decades of life representing over 50% of all pediatric soft tissue sarcomas and 15% of all pediatric solid tumors with 35% of RMSs occurring in the head and neck. The male/female ratio is about 2:1 with a mean age at diagnosis of 5-8 years. The embryonal subtype is the most frequent (70%) followed by the alveolar RMS. The head and neck is the most common site of the disease, followed by the genitourinary tract and limbs. The overall survival at 10 years is about 70%. Rhabdomyosarcoma arises from embryonal mesenchyme. The patients are treated with a combination of surgery, chemotherapy and radiation.
Rhabdomyosarcoma in the head and neck site can be divided into orbital, cranial parameningeal, and nonorbital-non-parameningeal. The predominant specific sites in our series are the orbit, nasopharynx and parapharyngeal space, with paranasal sinuses, ear, intraoral cavity, neck, and parotid next in frequency. Rhabdomyosarcoma in the orbit has the best cure rate while parameningeal involvement is associated with the poorest prognosis. Differential diagnosis includes: Ewings sarcoma, chondrosarcoma, osteosarcoma, synovial sarcoma, undifferentiated sarcoma, leiomyosarcoma, malignant fibrous histiocytoma, angiosarcoma, alveolar soft-part sarcoma, granulocytic sarcoma.

SUMMARY/CONCLUSION
We present the imaging findings of 30 cases of RMS in children and adolescents that were seen at MGH and MEEI in the last 10 years. The imaging modalities consisted of CT, MR imaging and in some cases PET-CT. We evaluated these tumors for size, shape, margins, location, extent, bony erosion, multiplicity and local and distant metastases. In addition, we characterized the tumor matrix as to pattern and degree of enhancement, necrosis, signal intensities on MR imaging, and hyper-hypometabolism on PET-CT.

REFERENCES

KEY WORDS: Rhabdomyosarcoma, head and neck, children

Scientific Exhibit 50
Oral Cavity Cancer: A Review of Patterns of Spread

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PURPOSE
CT and MR imaging play an important adjunctive role to clinical examination in the evaluation of patients with oral cavity cancer because they provide critical information about submucosal spread of tumor, mandible and maxillary involvement, deep tumor spread along extrinsic tongue muscles, and perineural tumor spread, all of which frequently are underestimated by clinical exam alone. Knowing the common patterns of spread for oral cavity tumors helps the radiologist identify these important but sometimes subtle findings.

APPROACH/METHODS
This exhibit will review the major patterns of oral cavity cancer spread with use of CT, MR, clinical photographs, pathologic specimens and diagrams to illustrate these patterns.

FINAL DRAFT/DISCUSSION
Tumors of the oral cavity originate in five major locations: oral tongue, floor of mouth, buccal mucosa, retromolar trigone (RMT) and the palate. Perimucosal and perineural spread are the most important mechanisms of tumor extension. Most tumors arising from the oral tongue begin on its lateral or ventral surface. Tumors may stay confined to the oral tongue until large. Tumors may spread to the floor of the mouth along the hyoglossus laterally or genioglossus medially. Posterior oral tongue lesions have early access to the mylohyoid and palatoglossus muscles, which can provide pathways to the parapharyngeal space, skull base and oropharynx. Perineural spread of tumor is less common in oral tongue lesions. The vast majority of tumors originating from the floor of the mouth arise in the anterior medial floor of the mouth. The lingual septum is a porous barrier to tumor spread, and submucosal/deep tumor spread is common, and greatly affects treatment decisions. Tumors in the floor of mouth commonly are adherent to the periosteum of the mandible, with less frequent frank mandibular invasion, which more commonly occurs from tumor that reaches the alveolar ridge. Tumors can spread out of the floor of the mouth via perineural/vascular spread along the lingual neurovascular bundle, directly into the parapharyngeal and submandibular space posteriorly, or into the tongue along the extrinsic tongue musculature. Buccal cancers most commonly arise from the lateral buccal mucosa. They have ready access to the underlying buccinator muscle, allowing buccal cancers a pathway to the maxilla, mandible and pterygomandibular raphe relatively early. The RMT is a small mucosal region posterior to the third molars that overlies the maxillary turbosisty and pterygomandibular raphe. Because of this anatomical positioning, tumors arising in the RMT easily spread to the oropharynx, skull base, and buccal space. Cancers arising from the hard palate are more commonly minor salivary tumors. They have a tendency to spread perineurally along the greater and lesser palatine nerves and may reach the pterygopalatine fossa giving it access to multiple additional areas including the orbit, the nasopharynx, the maxilla, the infratemporal fossa and the intracranial space. Extension to the soft palate and anterior tonsillar pillar also may occur.

SUMMARY/CONCLUSION
Knowing the typical patterns of spread of oral cavity cancer assists the radiologist in providing the most complete imaging information possible for pretreatment planning.

KEY WORDS: Cancer

Scientific Exhibit 51
Imaging of Nontraumatic Emergencies of the Head and Neck

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PURPOSE
Imaging plays a crucial role in the management of patients with nontraumatic emergencies of the head and neck. By providing an accurate diagnosis and guiding appropriate management the radiologist can do much to optimize the clinical outcome. However, nontraumatic emergencies of the head and neck represent only a small percentage of cases
seen in a typical emergency department. The purpose of this exhibit is to familiarize the radiologist with the imaging features of 10 such emergencies.

**APPROACH/METHODS**

A retrospective review was undertaken of imaging done for patients presenting to our tertiary care hospital with nontraumatic emergencies of the head and neck over the past year.

**Flint/GS/DISCUSSION**

1) Postinfectious carotid pseudoaneurysm: is a potentially fatal complication of deep neck infections. A contrast-enhanced CT scan of the neck will demonstrate the pseudoaneurysm as well as an associated abscess. 2) Lemierre's syndrome: is septic thrombophlebitis of the internal jugular vein (IJV) following an oropharyngeal infection, with bacteremia, septic emboli, and disseminated abscesses. A contrast-enhanced CT scan of the neck and chest in a bacteremic patient will demonstrate IJV thrombosis with coexistent (septic) pulmonary emboli. 3) Angiotensin-converting enzyme (ACE) inhibitor angioedema: occurs in about 0.1-0.7% of patients using ACE inhibitors. CT imaging of the neck will show generalized edema and swelling of the pharyngeal and glottic soft tissues resulting in a compromised airway. 4) Chondroradionecrosis of the larynx: is a rare complication of radiotherapy to the neck. CT findings of chondroradionecrosis include sloughing and fragmentation of the thyroid, arytenoid, and cricoid cartilages, with gas bubbles in and around the cartilages. 5) Post bone marrow transplant mucositis: results in diffuse pharyngeal mucosal edema and swelling and potential airway compromise. CT imaging can rule out abscess formation and assess for airway obstruction. 6) Ludwig's angina: is an infectious cellulitis of the floor of mouth with the potential for abscess formation and spread to the deep spaces of the neck and mediastinum. CT evaluation demonstrates extensive soft tissue edema and fluid/gas collections within the floor of the mouth, and can assess for mediastinal spread. 7) Pott's puffy tumor: is frontal sinusitis with frontal osteomyelitis and subgaleal abscess. Gadolinium-enhanced MR imaging can identify associated intracranial or intraorbital abscesses. 8) Cavernous sinus thrombosis: is a serious and potentially life-threatening condition. Contrast-enhanced CT or MR imaging will identify filling defects of the cavernous sinus as well as secondary intracranial and intraorbital complications. 9) Acute mastoiditis: can produce intracranial complications such as septic sigmoid sinus thrombosis and epidural abscess. High-resolution CT will show bone destruction and gadolinium-enhanced MR imaging will show dural sinus thrombosis and intracranial abscess. 10) Subperiosteal orbital abscesses: can be a complication of ethmoid sinusitis. It usually involves the medial orbit and is seen as a peripherally enhancing gas and fluid collection with mass effect on the medial rectus muscle.

**SUMMARY/CONCLUSION**

Awareness of the imaging findings seen in nontraumatic emergencies of the head and neck will allow the radiologist to provide an accurate diagnosis and thereby guide appropriate management in these rare but serious conditions.

**KEY WORDS:** Nontraumatic, imaging, emergencies

**Scientific Exhibit 52**

**Metastatic Cystic Lymph nodes in HPV Positive Head and Neck Cancer**

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**PURPOSE**

To present pathologic and imaging review, illustrating the role of human papilloma virus (HPV) in head and neck cancer with cystic metastatic lymph nodes.

**APPROACH/METHODS**

Review of current literature on HPV, its detection methods, cystic lymph nodes in head and neck cancer and head and neck cancer with unknown primaries.

**Flint/GS/DISCUSSION**

There is a high incidence of HPV positivity in oropharyngeal cancer (tonsils and base of tongue). Two major detection methods currently are used: 1) In situ hybridization (ISH) and 2) Polymerase chain reaction (PCR). Like cervical cancer, HPV16 is the most common HPV found in oropharyngeal head and neck squamous cell cancer (OPHNSCC) in addition to p16 expression, a surrogate marker of HPV. Histopathologically, HPV-positive tumors tend to have a poorly differentiated and frequently basaloid histology. There is a higher incidence of metastatic cystic lymph nodes in HPV positive cancers. Even before the role of HPV was evident, cystic lymph nodes were known to be associated with primaries in the Waldeyer's ring. Generally, it is difficult to differentiate cystic from necrotic lymph nodes on imaging. The cystic lymph nodes can be simple or complex cystic (including matted cystic lymph nodes). A cystic lymph node can mimic branchial cleft cyst on imaging. Human papilloma virus detection not only help in the diagnosis but also suggest the origin of unknown primary in oropharynx.

**SUMMARY/CONCLUSION**

Human papilloma virus positive head and neck cancers have a high incidence of metastatic cystic lymph nodes, the known and unknown primary is present most likely in the oropharynx.

**KEY WORDS:** Papillomavirus, tonsils, cystic

**Scientific Exhibit 53**

**Value of PET/CT Molecular Imaging in the Management of Thyroid Carcinoma**

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**PURPOSE**

1) To review the genetic markers and the molecular targets in thyroid cancer; 2) To illustrate the utility of fluoro-2-deoxy-D-glucose with fluorine (18F-FDG-PET/CT) in the management of patients with differentiated, medullary and anaplastic thyroid cancer; 3) To identify the appropriate types of
patients with thyroid cancer who will benefit from 18F-FDG-PET/CT imaging; and 4) To review the current guidelines for the management and long-term follow up of thyroid cancer.

**APPROACH/METHODS**

1) Most thyroid cancer patients have an excellent outcome with the standard therapies which are dependent on the tumor exhibiting a differentiated phenotype similar to normal thyrocytes consisting of responsiveness to the growth factor TSH via the presence of the TSH receptor and expression of the sodium-iodide symporter (NIS); 2) Surveillance for these patients typically consists of a combination of anatomical imaging such as neck ultrasound, radiiodine whole body scans, and serum measurement of the thyroid-specific protein thyroglobulin with anti-thyroglobulin antibody levels; 3) Dedifferentiation of thyroid cancer may consist of loss of expression of the TSH receptor, NIS, and loss of thyroglobulin production. In the process of a tumor losing NIS expression, the clinician loses the ability to use radiiodine for monitoring and treatment. However these subsets of tumors frequently become visible with 18F-FDG-PET/CT.

**INSIGHTS/DISCUSSION**

1) The major role of FDG PET/CT in thyroid cancer is in the setting of a rising serum thyroglobulin level with a negative radiiodine scan following cancer treatment. The extent of FDG PET/CT uptake can be used as a prognostic factor in the outcome of these patients. 2) Recent 2009 American Thyroid Association (ATA) Revised Guidelines for the management of thyroid nodules and cancer now recommend that initial staging and follow up of high-risk patients unlikely to concentrate radioactive iodine (RAI) such as hurthle cell, poorly differentiated, anaplastic and medullary thyroid cancers should include 18F-FDG-PET/CT imaging. RAI scanning and conventional imaging will miss metastatic disease in these patients. 3) As a powerful prognostic tool for identifying which patients with known distant metastases are at highest risk for disease-specific mortality. 4) As a selection tool to identify those patients unlikely to respond to additional RAI therapy. 5) As a tool of posttreatment response following external beam irradiation, surgical resection, embolization, or systemic therapy.

**SUMMARY/CONCLUSION**

This educational exhibit will review genetic markers and molecular targets in thyroid cancer, the role of 18F-FDG PET/CT in the management of patients with differentiated, medullary and anaplastic thyroid cancer and the updated treatment guidelines of the American Thyroid Association 2009.

**KEY WORDS:** FDG PET/CT, thyroid carcinoma

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**Scientific Exhibit 54**

**Clival Chordoma: The Great Mimic**

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**PURPOSE**

Clival chordoma has a classic MR appearance that is well described in the literature. Unfortunately, a minority of chordomas actually have this appearance. Most chordomas are atypical in MR appearance, and chordomas frequently mimic other pathologic entities. In this exhibit, we show examples of clival chordoma that have atypical MR features, and compare these MR findings with the MR findings of the lesions that chordoma may mimic.

**APPROACH/METHODS**

Two CAQ-certified neuroradiologists with 9 and 5 years of experience in skull base imaging reviewed a series of MR examinations from 36 patients with clival chordomas collected between 1997 and 2008 at a single academic institution. The percentage of chordomas with typical MR findings was calculated. For educational purposes, the atypical chordomas were compared with typical examples of other entities for which the chordoma could be mistaken.

**INSIGHTS/DISCUSSION**

The classic appearance of chordoma (uniform high T2 signal in a centrally located erosive clival lesion, with mixed T1 signal and strong enhancement after contrast administration) is encountered in only 10% of clival chordomas. Examples of chordoma were collected in which the MR findings were more suggestive of malignancies such as chondrosarcoma, nasopharyngeal carcinoma, soft tissue sarcoma, and lymphoma. Some chordomas mimicked benign neoplasms such as pituitary adenoma, craniopharyngioma, trigeminal schwannoma, and meningioma. Other chordomas had findings that might be mistaken for nonneoplastic masses such as Meckel’s cave meningocoele, arachnoid cyst, enlarged arachnoid granulation, and epidermoid tumor. Atypical findings were generally the result of an unusual location of the lesion, or unusual signal intensities. Lack of contrast enhancement also was encountered. We propose that the variable signal characteristics of chordomas may be related to their variable histologic components, particularly myxoid content.

**SUMMARY/CONCLUSION**

Clival chordomas frequently exhibit an atypical imaging appearance that may mimic other pathologic lesions. Thus, chordoma should be considered in the differential diagnosis of many central skull base lesions.

**KEY WORDS:** Skull base neoplasms, chordoma, MR imaging
Scientific Exhibit 55

CT Surgical Anatomy of Paranasal Sinuses for Functional Endoscopic Sinus Surgery; Pre and Postoperative Findings

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PURPOSE
Surgical therapy for the treatment of rhinosinusitis has existed since George Walter Caldwell described the procedure in 1893 and Henry Luc in 1897. The Caldwell-Luc procedure is the fenestration of the anterior wall of the maxillary sinus and the surgical drainage of this sinus into the nose via an antrostomy. Subsequent advances lead to intranasal middle meatus antrostomy in the late 1960s and 1970s. Functional endoscopic sinus surgery (FESS) is based on the surgical approach performed by Messerklinger and Wigand in Europe via the ostiomeatal complex. Functional endoscopic sinus surgery has become the standard surgical treatment for chronic maxillary sinusitis. Functional endoscopic sinus surgery involves the resection of the uncinate process, a portion of ethmoid bulla, antrostomy, turbinectomy, and enlarging the maxillary sinus ostium and frontal recess. This exhibit documents CT surgical anatomy of the paranasal sinuses related to FESS and the postsurgical changes.

APPROACH/METHODS
We use axial and 2D CT images of the paranasal sinuses to demonstrate the surgical anatomy and postoperative changes of the paranasal sinuses. Postoperative CT images of the various FESS procedures such as uncinate process resection, antrostomy, ethmoidectomy, turbinectomy, and frontal recess resection are presented with appropriate digital photographs where available. (Fig 1A and B).

Fig 1A. Coronal CT through uncinate process showing normal right uncinate process (arrow) and atelectactic left uncinate process (double arrows).

Fig 1B. Operative photo of left maxillary sinus antrostomy (arrow) in same patient. Left middle turbinate (star) is on left.

Findings/Discussion
This exhibit presents CT surgical anatomy of the paranasal sinuses along with postoperative changes.

SUMMARY/CONCLUSION
Educational benefits derivable from this exhibit include: 1. Familiarity with the anatomical structures involved in inflammatory processes of the paranasal sinuses relevant to FESS; 2. Understanding the surgical procedures for treatment of rhinosinusitis; and 3. Ability to identify these surgical procedures at CT.

KEY WORDS: Paranasal sinuses, CT anatomy, functional endoscopic sinus surgery changes

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Scientific Exhibit 56

Dural Arteriovenous Fistulas: Review of Imaging Findings and Endovascular Treatment Strategies

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PURPOSE
Dural arteriovenous fistulas are challenging lesions, often associated with diagnostic confusion and therapeutic frustration. Intracranial dural arteriovenous fistulas account for approximately 10% to 15% of all intracranial vascular malformations and are defined as abnormal vascular connections between a dural venous sinus (or a leptomeningeal vein) and an arterial feeding vessel. Spinal dural arteriovenous fistulas account for approximately 70% of all spinal vascular malformations and consist of abnormal vascular connections between a radiculomeningeal artery and a radicular vein, typically centered within the dura mater adjacent
to a spinal nerve root. While subtle findings on noninvasive imaging studies may suggest the presence of a dural arteriovenous fistula, invasive digital subtraction angiography commonly is required for definitive diagnosis and treatment planning. The subtlety of the imaging findings, coupled with frequent nonspecific clinical symptoms, highlights the neuroradiologist’s integral role in treatment of these lesions. Additionally, current endovascular therapy allows curative treatment in many cases, moving catheter-based paradigms to the forefront of fistula treatment. Our purpose is to review the characteristic imaging findings in patients with dural arteriovenous fistulas and to illustrate the various endovascular approaches to treatment.

**APPROACH/METHODS**
We performed literature review and reviewed the imaging findings in 50 patients harboring documented intracranial or spinal dural arteriovenous fistulas confirmed by catheter-based angiography that were referred to our institution and treated via an endovascular approach from 2003 through the end of 2009. The diagnostic imaging studies reviewed include magnetic resonance (MR) imaging, computed tomographic (CT) imaging and digital subtraction catheter-based diagnostic angiographic (DSA) studies. Illustrative cases are included to highlight the various diagnostic findings and to demonstrate the various endovascular strategies for treatment.

**FlgDblgs/DIscussIOn**
The clinical presentation, imaging evaluation and endovascular treatment of dural arteriovenous fistulas is discussed, through literature review and case examples. Imaging findings on noninvasive studies most commonly include hemorrhage, dilated venous structures or indirect effects upon the brain or spinal cord parenchyma secondary to elevated venous pressure. Cerebral or spinal angiography definitively demonstrates the arteriovenous shunts in the sinus or wall of the vein, allows categorization for risk stratification purposes and defines potential routes of endovascular treatment. The endovascular therapy administered for intracranial dural arteriovenous fistulas included transarterial administration of liquid embolic agents or particulate embolic material, the transvenous deployment of detachable coils, stent placement within the dural venous sinus or a combination of strategies. For the treatment of spinal dural arteriovenous fistulas, the endovascular therapy consisted exclusively of transarterial liquid embolic administration performed as monotherapy or for preoperative devascularization.

**SUMMARY/ConclUsIon**
Dural arteriovenous fistulas are complex lesions frequently producing nonspecific clinical symptoms, and an accurate diagnosis requires a high degree of suspicion coupled with awareness of specific subtle findings on noninvasive imaging studies. The endovascular treatment of dural arteriovenous fistulas has evolved rapidly over the last few decades, with curative treatment being possible in many cases.

**Key Words:** Fistula, arteriovenous, dural

### Scientific Exhibit 58

**Cervicofacial Cutaneous Vascular Malformations with Associated Anomalies of the Brain and/or Skull**

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**PURPOSE**
We present a series of eight patients with cervicofacial cutaneous vascular malformations who were found on MR imaging and/or MR angiography to have malformations or anomalies of the brain and/or skull.

**APPROACH/METHODS**
We include their radiologic scans and photographic images. These patients’ cutaneous anomalies include facial and truncal hemihypertrophy (3 patients), vascular malformations on the base of the tongue (2 patients), Klippel Trenaunay syndrome and a systemic AV malformation syndrome.

**FlgDblgs/DIscussIOn**
MR findings are varied and unusual. Some of the arteriopathies resemble those seen in patients with PHACES, which is associated with segmental cutaneous hemangiomas, not cutaneous vascular malformations, including hemimegacephaly, cerebellar abnormalities, Chiari malformation and coarctation of the aorta.

**SUMMARY/ConclUsIon**
Our purpose is to raise the index of suspicion for patients who present with cervicofacial vascular malformations, as even small cutaneous findings may have associated malformations in the brain and/or major cranial arteries. If radiologic abnormalities are identified, close clinical, neurodevelopmental, and radiologic follow-up is warranted.

**Key Words:** Vascular anomalies

### Scientific Exhibit 59

**Challenges of Craniosynostosis Imaging: From Diagnosis through the Reconstruction Process**

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**PURPOSE**
Imaging plays a critical role in the diagnosis and management of craniosynostosis. The purpose of this exhibit is to present a concise pictorial reference of the imaging features of the major primary craniosynostoses, emphasizing diagnostic criteria, operative repair, and postoperative follow-up imaging.
**APPROACH/METHODS**

The imaging system of a referral center with an active craniofacial team was queried to find images that best represent the classic imaging findings in metopic, sagittal, (unilateral and bilateral) coronal and lambdoid craniosynostosis. Two- and three-dimensional computed tomographic images of preoperative, postoperative and delayed follow up were selected. A review of the craniofacial imaging literature was performed to extract normative data for sutural closure and imaging features relevant to the craniofacial team.

**Findings/DISCUSSION**

Craniosynostosis is a disorder of skull development involving premature fusion of one or more sutures of the cranial bones. Craniosynostosis occurs in one in 2500 live births and may be due to mechanical, metabolic, or genetic factors. Symptoms resulting from craniosynostosis are either directly caused by pathological growth pattern or indirectly because of increased intracranial pressure. Children with craniosynostosis who undergo surgical correction before 3 months of age have a more favorable outcome than do children who undergo surgery at an older age. Through numerous images, this exhibit concisely presents the imaging features relevant to the craniofacial team caring for the craniosynostosis patient. Imaging protocols are provided. Criteria for diagnosis, including normative data for sutural closure are summarized. And, systematic evaluation of craniosynostosis imaging in the pre and postop period is emphasized.

**SUMMARY/DISCUSSION**

Primary craniosynostosis imaging is critical to the diagnosis and exclusion of craniosynostosis in the patient with abnormal calvarial shape. In the perioperative and long-term follow up of these patients, imagers are relied upon to detect complications and guide further interventions.

**REFERENCES**


**KEY WORDS:** Craniosynostosis, 3D computed tomography

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**Scientific Exhibit 60**

**Operative Integration of Multimodality Neuroimaging: Practical Applications**

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**PURPOSE**

Modern neuroimaging techniques are critical for neurosurgical planning. Multiple imaging modalities commonly are used for evaluation of these complex patients. With the advent of modern frameless stereotactic guidance systems, radiologists and neurosurgeons can utilize many imaging modalities to localize brain lesions and identify safe and effective corridors for surgical treatment. In this exhibit we present our recent experience with multimodality neuroimaging integration in a wide variety of neurosurgical patients.

**APPROACH/METHODS**

Illustrative case material is presented from a consecutive series of adult and pediatric patients undergoing multimodality neuroimaging for purposes of operative planning and intraoperative guidance. Imaging modalities integrated included MR imaging (MRI), functional MR imaging (fMRI), DTI tractography (DTI), positron emission tomography (PET), (CT), CTA, MRA, magnetoencephalography (MEG), and subtraction ictal SPECT coregistered to MRI (SISCOM). DICOM data from these modalities were fused with anatomical imaging (MRI and CT) in an advanced neuronavigation system and an integrated operative plan produced for preoperative assessment and intraoperative use.

**Findings/DISCUSSION**

Multimodality image fusion and integration into a single operative plan was performed in patients with intractable epilepsy, brain tumors, vascular malformations, and spinal tumors and was highly useful to the neurosurgeon. A team approach using data from multiple neuroimaging specialists is essential. The process of multimodality image fusion, and clinically significant region identification from anatomical imaging, fMRI, DTI, PET, SISCOM, and MEG data to form a single operative plan is reviewed. The utility of a single processing environment for fMRI and DTI is demonstrated. Operative correlation with fMRI, DTI, and other modalities is discussed. The significant role of the radiologist in producing and interpreting the integrated imaging datasets is stressed.
Figure demonstrates the use of CT (calcified tuber), PET hypometabolism (SPM analysis), SISCOM, MEG, and segmented subdural grids (CT) to guide surgery in a 3 year old with tuberous sclerosis, intractable epilepsy and multiple tubers. Epileptogenic tuber was identified with aid from multimodality image fusion, and an operative plan made for resection using neuronavigation.

SUMMARY/Conclusion
Operative integration of multimodality neuroimaging is feasible and highly useful in neurosurgical patients. Radiologists can play a lead role in coordinating and creating novel treatment plans in these patients.

KEY WORDS: Multimodality imaging, functional MR imaging, neuronavigation

Scientific Exhibit 61
Pediatric Head and Neck Infections

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PURPOSE
Purpose is to describe imaging anatomy of the neck spaces and describe imaging characteristics of head and neck infections in pediatric age group.

APPROACH/METHODS
1. Detailed description and pictorial demonstration of deep neck spaces. 2. Exceptional teaching cases of head and neck infection selected from extensive pediatric neuroradiology database of a tertiary care pediatric hospital. 3. Display cases of pediatric head and neck infections to illustrate important imaging characteristics of various pediatric neck infections.

Findings/DISCUSSION
Diagnosis and treatment of head and neck infections is a challenge to both radiologists and physicians because of the complex anatomy and anatomical proximity to vital structures such as airway and carotid system. Intercommunication with other anatomical spaces outside the neck such as superior mediastinum can cause significant morbidity and mortality. Timely and accurate imaging diagnosis is important in treatment as airway and vascular compromise is more imminent in children due to their small caliber and pliability. Head and deep neck infections can spread quickly to vital neck spaces and follow predictable pathway. Hence, sound knowledge of the compartmental anatomy of the neck is vital to determine the extent of infectious processes. Although the clinical history and physical manifestations are important factors in the evaluation of neck infections, imaging has significant role in the treatment planning. The exhibit demonstrates the anatomy within the head and neck as it relates to pediatric infections. The exhibit illustrates CT, MR, and ultrasound images of various abscesses including orbital, nasal septal, subperiosteal, periaxial, periodontal, peritonsillar, parotid, submandibular, thyroid, and deep facial abscesses. The differential diagnosis of these abscesses and other pediatric head and neck infections such as infected frontal sinus fracture with intracranial extension, orbital cellulitis, adenitis, jugular vein thrombophlebitis, Lemierre’s syndrome, otitis media, mastoiditis, ranula, sialocele, parotitis, sinusitis and Pott’s puffy tumor also are discussed. Consideration of congenital anomalies also must be assessed when evaluating pediatric head and neck infections. Dacrocystocele, branchial sinus/cleft, and dural sinus tracts can become infected.

SUMMARY/Conclusion
Pediatric head and neck infections have characteristic presentations and imaging appearances. A detailed radiologic imaging report can help guide the clinicians in treatment.

KEY WORDS: Pediatric head and neck infections, neck infections

Scientific Exhibit 62
Neonatal Brain Ultrasound: A Pictorial Review of the Basic and Advanced Techniques Including Common Pathology

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PURPOSE
It is the intent of this scientific exhibit to review the neonatal brain ultrasound. By exploiting the anterior fontanelle of the newborn, a window into the inner-workings of the brain is obtained. With the relatively low cost, lack of ionizing radiation, portable nature of the machine and absence of sedation, ultrasound has many advantages over conventional CT and MR imaging. Additionally, ultrasound may be obtained serially in the premature population to evaluate the evolution of intracranial hemorrhage.

APPROACH/METHODS
The basic ultrasound study takes approximately 15 minutes and the portable machine may be used for the convenience of the NICU patients. Scanning begins through the anterior fontanelle, acquiring images sequentially in the coronal and parasagittal planes. Transmastoid imaging also may be employed.
**Summary/Conclusion**

With the progression of ultrasound, more advanced techniques have become available to elucidate neurologic abnormalities. At many institutions, high-resolution images are obtained through linear high-frequency transducers. Additionally, duplex doppler evaluation of the anterior cerebral arteries and determination of the resistive indices allows for a greater understanding of neuropathology.

**Key Words:** Neonatal, ultrasound, brain

**Scientific Exhibit 63**

**Practical Clinical Neuroimaging in the Newborn ICU: A Case-Based Illustration**

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**Purpose**

Neuroimaging can provide important additional clinically relevant information for several neonatal neurologic conditions such as cerebral infarction, infectious processes, white matter disorders, vascular and congenital malformations. The purpose of this exhibit is to illustrate examples that depict the spectrum of neurologic conditions encountered in the neonatal ICU (NICU), and familiarize the radiologist and radiology resident as to their common imaging features. The purpose of this exhibit is to illustrate examples that depict the spectrum of neurologic conditions encountered in the newborn ICU (NICU), and familiarize the radiologist and radiology resident as to their common imaging features.

**Approach/Methods**

A retrospective review was undertaken of imaging done for newborns presenting to our NICU with neurological symptoms during the past 1 year.

**Findings/Discussion**

Discussion will include germinal matrix hemorrhage and its staging, in addition to choroid plexus hemorrhage. Congenital abnormalities including agenesis of the corpus callosum and Chiari malformations also will be reviewed. Demonstration of vascular malformations, such as vein of Galen malformation will be made. Periventricular leukomalacia and hypoxic ischemic injury also will be covered.

**Key Words:** Neonatal, ultrasound, brain
Atypical Teratoid/Rhabdoid Tumor: Imaging Features along the Neural Axis

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PURPOSE

APPROACH/METHODS
Retrospective case review yielded five primary intracranial and two primary spine tumors (M/F ratio 5/2, ages 4-23 months). All cases were proved pathologically to be atypical teratoid/rhabdoid tumor. Tumors were characterized on the basis of location, signal characteristics, enhancement properties, metastatic spread, peritumoral edema, hydrocephalus, cystic components, hemorrhage, and calcification. Imaging features were compared with those described in published case reports.

Discussion
Of the five intracranial ATRT, three were supratentorial, one arose within the vermis, and one arose in the brainstem. Three were characterized by mixed cystic/solid components while two were predominantly solid. All had mixed signal characteristics and heterogeneous enhancement. The two spinal ATRT were intradural, extramedullary tumors with extradural extension through the neural foramina. They were predominantly solid masses with homogeneous intermediate intensity signal and diffuse, slightly heterogeneous enhancement. Imaging studies documenting metastases were available for six of seven cases. Regardless of the primary tumor site, CSF dissemination was the main mechanism for metastasis. Spinal leptomeningeal metastases developed in two of three cases with a supratentorial primary. For the third supratentorial tumor, no follow-up imaging was available. Ascending leptomeningeal metastases developed in four of four cases with a posterior fossa or spinal primary. “Drop” metastases are thus capable of traveling in both ascending and descending directions.

SUMMARY/CONCLUSION
1. Primary ATRT may occur anywhere along the neural axis. 2. Imaging features of spinal tumors may differ from the intracranial ones. 3. Drop metastases are multidirectional, mandating imaging of entire neural axis at all times.

KEY WORDS: ATRT, MR imaging, brain

Imaging of Pediatric Hearing Loss

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PURPOSE
The purpose of this exhibit is to review the multiple causes of hearing loss in the pediatric population. Diagnostic imaging including modalities such as CT and MR can play an essential role in the evaluation and management of pediatric hearing loss. This exhibit will review the key anatomy and pathology involved with conductive and sensorineural hearing loss in children from an imaging perspective.

APPROACH/METHODS
An anatomical-based imaging approach is provided for the causes of hearing loss in the pediatric population. Hearing loss is divided into conductive and sensorineural causes based on pathology of the outer, middle, and inner ear. Pathology causing hearing loss, either conductive or sensorineural, is correlated with the specific anatomical region of the ear and is further categorized into three large subdivisions of various etiologies including congenital, neoplastic, and infectious/inflammatory. Through modalities such as CT and MR imaging, multiple etiologies for each category are reviewed.

Discussion
Hearing loss in children is a prevalent disability, affecting one in 1000 newborns and greater than 10 percent of school-aged children. Imaging plays a key role in the evaluation of conductive and sensorineural hearing loss using multiple modalities such as CT and MR imaging. The causes include both osseous and nonosseous abnormalities which can be categorized into congenital, neoplastic and infectious/inflammatory etiologies. By understanding the anatomy of the outer, middle and inner ear, the pathology causing hearing loss is better understood and identified on imaging.

SUMMARY/CONCLUSION
Imaging plays a key role in understanding the underlying cause for pediatric hearing loss. By reviewing the anatomy and etiologies found in conductive and sensorineural hearing loss through an imaging approach, the radiologist can essentially play a key role in the diagnosis and overall evaluation of pediatric hearing loss.

KEY WORDS: Hearing loss
**Scientific Exhibit 66**

**Sellar/Suprasellar Lesions in Children: A Pictorial Review**

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**PURPOSE**
To demonstrate the wide spectrum of pediatric sellar/suprasellar lesions, including normal anatomical and physiological variants.

**APPROACH/METHODS**
At our institution, MR imaging of the sella is performed either on a 1.5 or 3.0 T magnet. Our protocols include T1- and T2-weighted, postcontrast thin sections through the sella region in orthogonal planes, and diffusion-weighted imaging in specific cases. Examples of different pathologies and normal variants are selected from a total of 400 cases of pituitary examinations. Patients referred for examination of the pituitary gland have had worrisome clinical findings of presumable hypophyseal disorders or incidental imaging abnormalities of the sella on MR or CT examinations performed for other indications.

**Findings/Discussion**
Common and unusual imaging appearance of sellar/suprasellar pathology in children is depicted. Lesions that constitute the majority of sellar pathology are described in the following categories: A. Normal anatomical and physiological variants; B. Cystic and solid mass lesions, such as Rathke’s cleft cysts, craniopharyngiomas, hypothalamic gliomas, hypothalamic hamartomas, pituitary adenomas, germ cell tumors, epidermoids, arachnoid cysts; C. Systemic diseases, such as Langerhans cell histiocytosis, metastatic dissemination, tuberculosis; D. Vascular lesions, such as aneurysms; E. Miscellaneous pathology, such as ectopic neurohypophysis, septo-optic dysplasia, empty sella, as a manifestation of pseudotumor cerebri, suprasellar cavernoma.

**SUMMARY/Conclusion**
Familiarity with common and unusual imaging appearance of the variety of pituitary gland and surrounding sellar/parasellar disorders is important for precise and timely diagnosis of numerous endocrine, developmental and many other pediatric conditions.

**KEY WORDS:** Pediatric, pituitary gland

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**Scientific Exhibit 67**

**Unexplained Childhood Stroke: What Is the Role of Varicella Zoster Infection?**

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**PURPOSE**
Childhood arterial ischemic stroke (AIS) has been associated with various medical conditions. Still, in a significant percentage, the reason of stroke remains unexplained. In recent years, varicella zoster infection (VZI) has been cited as a possible cause of stroke in otherwise healthy children. Arterial luminal narrowing has been hypothesized as the possible pathophysiologic mechanism. In this presentation the characteristic radiologic features of AIS caused by VZI are highlighted.

**APPROACH/METHODS**
The database of children with stroke who were referred to our institution was screened. Imaging studies of previously healthy individuals without any documented risk factor for stroke, but with a recent history of VZI, were reviewed.

**Findings/Discussion**
Noncontrast CT is the initial modality used in the work up. It characteristically shows a circumscribed hypodens area in the brain parenchyma with various amounts of perilesional edema. Diffusion-weighted MR imaging is the modality of choice for confirmation of stroke, classically showing an area of diffusion restriction. MR imaging is also an excellent tool to differentiate true stroke from possible stroke mimickers. Finally, the arterial origin of stroke is demonstrated by catheter angiography, showing luminal narrowing at the level of the circle of Willis or its feeders.

**SUMMARY/Conclusion**
Arterial luminal narrowing following VZI can be a cause of childhood stroke. Because of the high incidence of VZI in the pediatric population the radiologist must be familiar with the key imaging features of this entity. In this presentation we illustrated the characteristic signs on noncontrast CT, diffusion-weighted MR imaging and catheter angiography.

**KEY WORDS:** Arteriopathy, stroke, varicella
Scientific Exhibit 69

MR Imaging Contributions to the Differential Diagnosis of Hypertrophic Mono and Polyneuropathies

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PURPOSE
Due to similar clinical and radiologic features, the differential diagnosis between intraneural perineuriomas, plexiform neurofibromas and hypertrophic neuropathies [chronic inflammatory demyelinating polyradiculoneuropathy (CIDP) or hereditary motor-sensory neuropathies (HMSN)] of Charcot-Marie-Tooth/Dejerine-Sottas] may be challenging. In this scientific exhibit, we want to highlight the MR imaging contributions to the differential diagnoses of these hypertrophic neuropathies.

APPROACH/METHODS
Clinicopathologic and imaging features of intraneural perineurioma, plexiform neurofibroma, CIDP and HMSN are discussed through reviews of the literature and illustrated by images obtained in our own institution. In particular, we evaluate the role of MR imaging in the differential diagnosis of these entities.

Findings/Discussion
In patients presenting with an idiopathic, localized mononeuropathy, electromyography (EMG) and nerve conduction studies (NCS) can localize readily and define the severity of a mononeuropathy. MR imaging is an excellent tool for providing additional information about the size and location of an abnormal segment. In case of hypertrophic mononeuropathy, the differential diagnosis includes schwannoma, neurofibroma, intraneural perineurioma and HMSN. Genetic consultation is imperative in the diagnostic workup for HMSN. Intraneural perineuriomas may show polymorphic presentation. Differentiation of intraneural perineurioma, schwannoma, neurofibroma and HMSN only can be made reliably with biopsy. Fascicular biopsy is an effective mode of diagnosis with limited risk of increased deficit, showing for HMSN true onion-bulbs from Schwann cells positively staining for S-100. Histologic examination of intraneural perineuriomas shows a replacement of the normal nerve architecture by concentric whirls of perineurial cells superficially resembling onion-bulbs (pseudoonion-bulbs) and positively reacting with epithelial membrane antigen (EMA). In the differential diagnosis of hypertrophic polynepheopathies, one should consider the possibility of a plexiform neurofibroma, CIDP or HMSN. In all of these entities, the affected nerve segments show a T2 hyperintense enlargement and a variable, mild to moderate contrast enhancement on T1-weighted images.

SUMMARY/Conclusion
MR imaging, in conjunction with careful neurologic examination and detailed electrodiagnostic studies, is a valuable tool for identifying and precise localization of hypertrophic nerve segments, thereby improving the accuracy of targeted fascicular biopsies for definitive differentiation. The morphology and contrast uptake are the most useful criteria for MR imaging differential diagnosis of these neuropathies.

Key words: Hypertrophic neuropathy, CIDP, intraneural perineurioma

Scientific Exhibit 70

Cauda Equina Syndrome: An Overview

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PURPOSE
Cauda equina syndrome is a serious condition that has a variety of etiologies. The etiologies range from narrowing and compression of the nerve roots of the spinal canal to mass effect in the conus terminalis from tumors or vascular malformations. As cauda equina syndrome represents a surgical emergency, it is critical that the condition be suspected early and the etiology of the condition be diagnosed promptly. Often if the patient has suffered a recent trauma, CT imaging may be used for a rapid diagnosis of fractures compressing the nerve roots or conus. Increasingly, MR imaging is available at most institutions on an urgent or emergent basis when the diagnosis of cauda equina syndrome is clinically suspected. We will present seven cases to highlight the range of conditions that cause cauda equina and present key imaging features.

APPROACH/METHODS
Multiple CT as well as 1.5 and 3 T MR images were reviewed over the past 5 years from multiple institutions.

Findings/Discussion
There is a large spectrum of disease processes that can manifest as cauda equina syndrome such as: arteriovenous malformation of the conus, epidural lipomatosis, extruded disk, osteomyleitis, metastasis in the thecal sac, inflammatory conditions such as sarcoidosis, and lymphoma. We present multiple proved cases of cauda equina syndrome, and the various imaging characteristics seen on CT as well as 1.5 and 3 T MR imaging.

SUMMARY/Conclusion
There are a variety of conditions known to cause cauda equina syndrome. We hope to provide a comprehensive overview of cauda equina syndrome, and the various conditions that cause it. It is essential for both the radiologist and the clinician to have a thorough understanding of this disease process and its imaging characteristics. We hope that by
showing the various entities that can cause this condition, a greater insight and understanding of this disease process will be obtained.

**Key Words:** Cauda equina syndrome, imaging spectrum, MR imaging

**Scientific Exhibit 71**

**HEALSME: A Differential Diagnosis for Intramedullary Spinal Cord Lesions**

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**Purpose**
To illustrate and review the differential diagnosis for intramedullary spinal cord lesions and discuss their distinguishing imaging features and clinical presentations.

**Approach/Methods**
This exhibit is based on a retrospective search for intramedullary lesions identified on MR imaging. Images of representative entities will be presented and any distinguishing imaging features, diagnostic imaging pearls, patient demographics, and prognosis will be discussed.

**Discussion**
Our population had a variety of intramedullary spinal cord lesions, including, but not limited to hemangioblastoma, ependymoma, astrocytoma, lymphoma, syrinx, metastasis, multiple sclerosis, and edema. We developed the mnemonic HEALSME to help with recalling the intramedullary differential diagnosis.

**Summary/Conclusion**
There is a broad differential for intramedullary spinal cord lesions. The mnemonic HEALSME can help in recalling an initial location-based differential diagnosis that includes the majority of intramedullary pathologies. Distinguishing these lesions by location, signal characteristics, and patient age significantly narrows the differential diagnosis.

**Key Words:** Intramedullary

**Scientific Exhibit 72**

**Trauma Pearls for the Cervical Spine: CT and Radiographic Findings of Occult Ligamentous and Spinal Cord Injury with MR Imaging Correlation**

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**Purpose**
To present an educational case series reviewing traumatic hyperextension, flexion, and distraction injuries to the cervical spine, with emphasis on subtle conventional radiograph and CT findings indicative of clinically significant ligamentous and spinal cord injury.

**Approach/Methods**
Multiple cases of traumatic injury of the cervical spine were collected and reviewed at the University of Arizona Medical Center, a Level 1 trauma center. Images were chosen for presentation that elucidate various radiographic and CT findings of occult ligamentous and/or spinal cord injury with MR imaging correlation.

**Discussion**
As detailed extensively in the literature, a spectrum of osseous and soft tissue injuries occur as a result of biomechanical forces on the cervical spine. Predictable fracture patterns have been identified involving both direct impact and noncontact (whiplash) mechanisms. The widespread use of helical, multidetector CT in the setting of trauma results in comprehensive and rapid evaluation of the cervical spine, providing a more sensitive and specific modality than conventional radiography for detection of fracture. While ligamentous injury often is suspected in the setting of identified fracture, certain patterns of injury can result in severe soft tissue and cord injury with subtle or no osseous abnormality. In such cases, secondary signs on CT or radiograph can be key to making the diagnosis, and can include splaying of the spinous processes, widening of the anterior disk space, and prevertebral soft tissue swelling.
SUMMARY/CONCLUSION
While a comprehensive understanding of observed fracture patterns of the cervical spine is essential, the subtle findings of ligamentous injury may be the only diagnostic clues of an occult unstable injury. It is imperative to recognize these subtle findings in order to prevent diagnostic delay or nondiagnosis of these severe injuries.

KEY WORDS: Cervical spine, trauma, ligamentous injury

Scientific Exhibit 73
Imaging Spectrum of Cervical Spine Injury

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PURPOSE
We present the imaging spectrum of various patterns of injury to the cervical spine. We also emphasize the role of various imaging modalities in recognizing and characterizing these injuries.

APPROACH/METHODS
Patients with suspected cervical spine injury were imaged on Siemens 6 slice CT scanner (Emotion)/128 slice CT scanner (Definition AS). Multiplanar reformats and 3D volumetric reconstructions also were obtained. In patients with suspected neurologic damage, MR imaging also was performed using Siemens 1.5 T MR (Sonata, Erlangen, Germany) in addition to MDCT.

SUMMARY/CONCLUSION
The most common causes of spinal injury are motor vehicle accidents, acts of violence, falls and sports injuries. Amongst spinal injury, cervical spine is the most common level for spinal cord injury, representing 55% of all spinal cord injuries (1). Injuries to cervical spine can be categorized according to anatomical location, presumed mechanism of injury, and presence or absence of instability. According to the location, the injuries of the cervical spine can be occipitoatlantoaxial or lower cervical (C3 to C7). It is appropriate to classify them separately as their biomechanics as well as pathophysiology of injury differ. The common classification groups for lower cervical spine injury include compressive flexion, vertical compression, distraction flexion, compressive extension, distraction extension and lateral flexion (2). These mechanisms lead to specific patterns of injury that may be characterized radiologically. The stability of the injury also needs to be determined for institution of appropriate and prompt therapy. As the cervical spine injury is common and devastating, prompt and accurate diagnosis is essential to prevent irreversible spinal cord injury and permanent neurologic damage. A significant number of cervical spine fractures are missed on routine radiographs. Obtunded, obese and uncooperative patients pose additional diagnostic challenges. The use of multidetector CT has gained widespread acceptance and it is being used increasingly as the initial screening modality in evaluation of polytrauma victims. Cross-sectional imaging also facilitates the simultaneous evaluation of vascular structures of neck in cases of trauma. MR imaging is a powerful diagnostic tool and is warranted in the evaluation of patients who demonstrate clinical neurologic deficits as well as in those patients with negative CT scans but a high clinical suspicion for injury. It is an essential diagnostic modality in cases of spinal cord injury without radiologic abnormality (SCIWORA). It provides excellent visualization of soft tissue injury such as acute traumatic disk herniations and epidural hematomas that often are difficult to resolve on conventional radiographs and CT.

REFERENCES
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KEY WORDS: Spine, trauma, imaging
Electronic Scientific Exhibits (eSE’s) 1–119
Exhibition Hall C

Monday, May 17, 6:30 AM through Thursday, May 20, 3:00 PM

Note: A missing Scientific Exhibit number indicates an abstract has been withdrawn.

Electronic Scientific Exhibit 1
Retrospective Blinded Comparison of the Radiographic Diagnosis of Acute Central Nervous System Injury on a Portable Handheld Device and O-cyrix to Traditional High-Resolution LCD Monitors

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Miami Beach, FL

PURPOSE
Acute central nervous system (CNS) injuries are urgent and common indications for emergency room visits with many different etiologies and presentations. Acute CNS injuries are a spectrum of diseases that mainly can be classified as acute ischemic events, acute hemorrhagic events, and compressive events. Delay of diagnosis can significantly increase morbidity and mortality. Symptoms also can vary based on etiology ranging from subtle headaches and back pain to obvious hemiplegia.

APPROACH/METHODS
Currently the diagnosis of acute central nervous system injuries is performed with a combination of both clinical and radiographic evaluation. The current standard of care is to evaluate the central nervous system with a full neurologic examination followed by a CT scan or MR imaging with special dedicated sequences to exclude acute processes. These images then are interpreted by a radiologist on high-resolution LCD monitors in the proper ambience.

FINDINGS/DISCUSSION
Signs of acute central nervous system injury on CT include direct visualization of hemorrhage within the brain parenchyma and ischemia via elevated mean transit time of blood on CT perfusion scans. On MR imaging, restricted diffusion and inversion recovery images are the gold standard for the diagnosis of acute ischemia and acute anatomical CNS injury. Advantages of these specialized sequences on both CT and MR imaging include its superior ability to rule out injury, ready availability, noninvasiveness, and the potential to reveal alternative diagnoses.

SUMMARY/CONCLUSION
The current mode of practice is to view these specialized sequences on high-resolution monitors in a room with minimal light. However, there has been the development of newer software that can enable the interpretation of radiologic studies on newer software, O-cyrix, and remotely on the portable hand-held devices. This is a retrospective study that will compare the accuracy of these newer modalities to that of the traditional high-resolution LCD monitors.

Different radiologists will interpret the same sequences on all three different modalities of 100 patients who have already had these tests performed on them over the past 6 months. The results will be compared to determine the accuracy of the portable hand-held devices and O-Cyrix when compared to high-resolution LCD monitors.

KEY WORDS: CNS injury

Electronic Scientific Exhibit 2
Signs and Symptom of Stroke: A Clinical Neuroanatomy Primer for the Neuroradiologist

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PURPOSE
While oftentimes it is the lack of appropriate history that ranks neuroradiologists in their interpretation of stroke imaging, an apt conveyance of symptoms requires the imager to have a thorough knowledge of clinical neuroanatomy. This exhibit will seek to provide a useful clinical primer for the neuroradiologist regarding the common and uncommon clinical presentations of stroke.

APPROACH/METHODS
Cases will be interactive and will take advantage of the unique didactic medium of Powerpoint. Clinical presentation will be provided and correlative imaging of patients will be shown, with examples of strokes localizing to the different cerebral vascular territories. Emphasis will be on their unique clinical identifying characteristics.
**FINDINGS/DISCUSSION**
Examples will be drawn from the aphasias, the major cortical territories - both arterial and venous, the distinctive brainstem syndromes, injuries to the cranial nerve nuclei, among others. Equipped with this clinical knowledge, the neuroradiologist will have a deeper appreciation of how an accurate patient clinical presentation can be useful in evaluating stroke patients.

**SUMMARY/CONCLUSION**
It is our hope that upon completion of this exhibit, the reader will be able to keenly scrutinize the appropriate anatomical structures based on given the neurologic exam, so as to provide the highest level of care to referring physicians and patients. In addition, we hope this will develop a renewed and deeper appreciation of the clinico-radiologic correlation of ischemic brain imaging.

**KEY WORDS:** Stroke, signs, symptoms

**Electronic Scientific Exhibit 3**
**Current Advances in the Prediction of Stroke**

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**PURPOSE**
Stroke, brain attack, ischemic event and infarction are all terms used to describe the second most common cause of death in the U.S. in people over the age of 60 and the fifth leading cause of death in people aged 15 to 59 years. Imaging plays a pivotal role not only in the detection of infarction and intracranial hemorrhage, but also may have a role in determining the type of treatment and predicting tissue fate and ultimately clinical outcome.

**APPROACH/METHODS**
A review of the current advances in stroke imaging was performed.

**FINDINGS/DISCUSSION**
There have been many recent advances in the imaging of acute stroke. The identification of stroke on noncontrast CT has improved by identifying early ischemic signs and systematically assessing for stroke by using the Alberta Stroke Program Early CT Score or ASPECTS. Sensitivity and specificity further improve by using CT angiography - source images (CTA-SI) and CT perfusion (CTP) data to identify the presence of infarction. In the unselected patient, thrombolytic therapy with tissue plasminogen activator (TPA) improves clinical outcomes up to 4.5 hours after symptom onset. It remains to be shown whether the selected patient with an identifiable ischemic penumbra may benefit beyond this current treatment time window. Hemorrhagic conversion risk can be predicted by assessing the blood-brain barrier using a two phase CTP acquisition and acquiring permeability-surface area product (PS) maps. In cases of primary intracerebral hemorrhage, hematoma expansion can be predicted by using the CTA “Spot Sign” and the finding of post contrast leakage. Assessing the extent of clot burden and degree of collateral blood supply can aid in the prediction of clinical outcomes, and help select patients who may benefit from more aggressive thrombolytic therapies such as intraarterial TPA or mechanical thrombectomy. Cerebral blood flow (CBF) thresholds for both gray (25mL/100g/min) and white matter (14mL/100g/min) have been identified that can predict the final volume of infarction in the absence of recanalization. Using the interactions between CBF and cerebral blood volume (CBV) data allow accurate determinations of the ischemic penumbra and salvageable brain tissue if recanalization occurs.

**SUMMARY/CONCLUSION**
Acute stroke imaging assessment now offers a wealth of information to the clinician by identifying the presence and extent of infarction, predicting hemorrhagic transformation and hematoma expansion, the ability to select patients for more aggressive thrombolysis, identify the presence of the ischemic penumbra and ultimately predict clinical outcomes. This information will help individualize stroke therapy and possibly allow the selection of patients with persisting penumbra and a vessel occlusion who may benefit from thrombolytic therapy well beyond the 4.5 hour time window.

**KEY WORDS:** Stroke, CT perfusion, ischemic penumbra

**Electronic Scientific Exhibit 4**
**Brainstem and Thalamic Vascular Syndromes: A Topographic Review**

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**PURPOSE**
To present an illustrated review of brainstem and thalamic vascular syndromes, in an anatomical imaging topographic format.

**APPROACH/METHODS**
The literature on the correlative anatomy of diencephalic and brainstem vascular syndromes. Anatomical schematic generation with corresponding axial diffusion trace and T2 images.

**FINDINGS/DISCUSSION**

**SUMMARY/CONCLUSION**
Familiarity with the complex anatomy of the nuclei and tracts in the brainstem and thalamus is essential in correlating imaging findings with clinical diagnosis.

**KEY WORDS:** Brainstem, thalamic, syndromes

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PURPOSE
Disability resulting from MS correlates poorly with white matter disease burden. It is postulated that cortical gray matter involvement may correlate better. Gray matter lesion demonstration is a challenge utilizing conventional MR sequences such as T2 FLAIR while white matter lesions are readily apparent by T2 FLAIR. Double inversion recovery (DIR) is a relatively new imaging sequence that may have utility in MS plaque imaging particularly in the demonstration of gray matter lesions. Comparison of 3D double inversion recovery versus T2 FLAIR imaging sequences at 3 T in the evaluation of multiple sclerosis (MS) involving both white and gray matter of the brain.

APPROACH/METHODS
A short bore 3 T system combined with a 32-channel head coil was utilized. Typical MS protocol at our institution include T1 3D space, T1 Flair, T2, 2D T2 Flair, 3D DIR, diffusion-weighted imaging, susceptibility-weighted imaging, and gadolinium DTPA. Two independent ABR board-certified MR readers retrospectively evaluated DIR and Flair axial images in 30 MS cases. Conspicuity and number of lesions on both sequences were scored and compared in all cases. Cases evaluated in this study include a variety of lesion locations and configurations including inactive, active, tumefactive, and chronic plaques.

FINDINGS/DISCUSSION
In our series, all cortical gray matter lesions were better demonstrated by DIR. Almost all white matter lesions were better visualized on T2 FLAIR sequences. In the minority of cases demonstrating subcortical U-fiber involvement, DIR performed better. Performance of either sequence depended on plaque location and character of the lesion. Signal-to-noise ratio was consistently better on T2 FLAIR images in all cases.

SUMMARY/CONCLUSION
Our initial experience indicates both T2 Flair and DIR at 3 T are useful sequences which compliment each other with either sequence outperforming the other or occasionally performing equally well depending on lesion location and morphology. Follow-up investigation of DIR is needed to further elucidate its utility in MS imaging of the brain.

KEY WORDS: MR imaging, brain, multiple sclerosis

MR Imaging of Parkinson's Disease

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PURPOSE
To describe the pathophysiology of idiopathic Parkinson's disease (IPD). To illustrate the different pulse sequences used in diagnosis of IPD. To demonstrate the MR appearance of IPD with different pulse sequences such as DWI, MRS. To differentiates IPD from other causes of movement disorders. To demonstrate the role of MR imaging in monitoring patient after treatment.

APPROACH/METHODS
Different MR pulse sequences have been used for diagnosis of Parkinson's disease. Parameters of MR imaging correlated well with clinical scoring as well as with disease progression.

FINDINGS/DISCUSSION
MR imaging has been used for the differentiation from simulating disease such as multisystem atrophy. MR imaging has been used for preoperative localization before thalamotomy. MR imaging has been used to detect the response of levodopa as well as after surgical intervention.

SUMMARY/CONCLUSION
We concluded that different pulse sequence MR imaging helps in the diagnosis of IPD, differentiating from simulating lesions as well as in monitoring patients after treatment.

KEY WORDS: Parkinson’s disease

Typical Multiple Sclerosis Lesions on Conventional MR Imaging

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PURPOSE
To define the most useful MR features for establishing a precise differential diagnosis between multiple sclerosis (MS) and other focal white matter disorders.

APPROACH/METHODS
Review of the full range of MR imaging abnormalities that should be taken into consideration to increase the specificity of MR imaging in the diagnosis of MS.

FINDINGS/DISCUSSION
Conventional MR techniques, such as T2-weighted and gadolinium-enhanced T1-weighted sequences, which are highly sensitive for detecting demyelinating plaques, are recognized as the most important paraclinical tool for diagnosing MS. However, the changes seen on MR imaging in
patients with MS are not disease-specific. Other disorders can cause white matter lesions with similar imaging characteristics. Nevertheless, the MR imaging pattern of brain MS is usually relatively specific when age, clinical information, and the full range of MR abnormalities are taken into consideration. Multiple sclerosis lesions tend to affect specific regions of the brain, including the periventricular white matter, and the callosal-septal interface along the inferior surface of the corpus callosum. Juxtacortical lesions involving the “U” fibers are present in two thirds of patients with MS. Posterior fossa lesions preferentially involve the floor of the fourth ventricle, the middle cerebellar peduncles, and the brainstem. Most brainstem lesions are contiguous with the cisternal or ventricular cerebrospinal fluid spaces, and range from large confluent patches to solitary, well delineated paramedian lesions or discrete “linings” of the cerebrospinal fluid border zones. These areas are a key feature that helps to identify MS plaques and differentiate them from focal areas of ischemic demyelination and infarction, which preferentially involve the central pontine white matter. Multiple sclerosis lesions of the spinal cord resemble those in the brain. On sagittal scans, the lesions characteristically have a cigar shape and rarely exceed two vertebral segments in length. On cross-section they occupy the lateral and posterior white matter columns, extend to involve the central gray matter, and rarely occupy more than one half of the cross-sectional area of the cord. The prevalence of cord abnormalities is as high as 92% in established MS. MR identification of subclinical spinal cord lesions in patients with non-specific brain findings, particularly those >50 years old, can increase the diagnostic certainty because these lesions are relatively frequent in MS, but rare in other white matter diseases. Longitudinal and cross-sectional MR studies have shown that formation of new MS plaques often is associated with contrast enhancement. Incomplete ring enhancement on T1-weighted gadolinium-enhanced images, with the open border facing the gray matter of the cortex or basal ganglia is a common finding in active MS plaques and is a helpful feature for distinguishing between inflammatory-demyelinating lesions and other focal lesions such as tumors or abscesses.

SUMMARY/CONCLUSION
Knowledge of the full range of MR imaging abnormalities that characterize MS lesions increases the diagnostic specificity of MR imaging. This is particularly important, as MR imaging is now integrated in the overall diagnostic scheme of the disease, and in guiding therapeutic decisions.

KEY WORDS: Multiple sclerosis, MR imaging

Therapeutic Effects on Brain White Matter

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PURPOSE
To describe the different types of therapeutic effects on brain white matter.

APPROACH/METHODS
Review of the full range of neuroradiologic imaging abnormalities related to radiation- and chemotherapy-induced neurotoxicity.

FINDINGS/DISCUSSION
Treatment strategies (radiation and chemotherapy) designed to target cancer cells commonly are associated with deleterious effects to the central nervous system. Radiation encephalopathy has been classically divided into three stages according to its timing after radiotherapy: early, early-delayed, and late-delayed reactions. MR finding in early reactions occurring during course of treatment are nonspecific. MR imaging may be normal or demonstrate poorly defined multifocal lesions in both hemispheres that usually disappear spontaneously. MR imaging in early-delayed reactions also may show signal changes involving not only the hemispheric white matter but also the basal ganglia and the cerebral peduncles, which resolve completely without treatment. Late-delayed reactions can be subdivided into diffuse leukoencephalopathy and focal radiation-necrosis injury. The diffuse form is characterized by a progressive and irreversible periventricular and subcortical leukoencephalopathy usually without contrast uptake. Focal radiation-necrosis usually present as a ring-like or irregular enhancing mass lesion located in the white matter, which may become hemorhagic. When appear after radiation therapy of high-grade brain tumors, focal radiation-necrosis may be quite difficult to differentiate from tumor recurrence. The use of advanced MR techniques, such as DWI, PWI and MRS, or PET scan can offer additional information that may substantially improve the ability to differentiate between the two entities. Imaging studies have provided evidence that structural and functional CNS changes also occur in a significant number of patients treated with chemotherapy. Some agents, such as methotrexate or Carmustine, are well known to cause a leukoencephalopathy syndrome, especially when administered at a high dose, intrathecally, or in combination with cranial radiotherapy. Nonenhancing, confluent, periventricular white matter lesions, necrosis, ventriculomegaly, and cortical atrophy characterize this syndrome. White matter abnormalities following high-dose chemotherapy have been detected in up to 70% of treated individuals and usually have a delayed onset of several months. A delayed leukoencephalopathy syndrome with distinct diffusion-weighted imaging abnormalities on MR imaging indicative of cytotoxic edema within cerebral white matter has been described recently. This syndrome appeared to mimic a stroke-like syndrome and has been seen mainly in patients receiving methotrexate, 5-fluorouracil (5-FU), Carmofur, and Capecitabine. Although most cases of posterior reversible leukoencephalopathy syndrome (PRES) occur in association with hypertension, the use of various drugs, such as immunosuppressive agents also may produce this syndrome. Toxic levels of these drugs are not required for the development of PRES, and patients can become symptomatic after several months of exposure to a drug. Most patients, but not all, have some degree of hypertension, but blood pressure levels are usually lower than those typically encountered.

SUMMARY/CONCLUSION
Standard oncologic therapies, such as chemotherapy and cranial radiotherapy, frequently result in a spectrum of clinical and neuroradiologic abnormalities. Early recognition of
these treatment-related neurologic complications is critically important, in order to prevent or at least minimize irreversible CNS injury.

**KEY WORDS:** Radiotherapy, chemotherapy, white matter

### Electronic Scientific Exhibit 9

**Diffusion Tensor Imaging Demonstration of White Matter Abnormalities in Autism**

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East Meadow, NY

**PURPOSE**

Autism and autism spectrum disorder (ASD) are complex entities defined clinically by impairments in social interaction and communication skills. The incidence of ASD continues to rise and multidisciplinary research into the disease’s pathogenesis and pathology is ongoing. Given its clinical manifestations various authors have postulated that there exists abnormal functional white matter connectivity between regions of the brain that have been implicated in processing of language and emotion. Through diffusion tensor imaging (DTI) we are able to assess fractional anisotropy (FA) in specific white matter tracts, thereby enabling global comparisons of FA, as a proxy for neuronal connectivity, between individuals with autism and controls.

**APPROACH/METHODS**

We performed a literature search on Google Scholar, which includes the PubMed database, for the keywords “autism” and “diffusion tensor imaging”. Studies then were chosen from this list that employed DTI as an imaging modality comparing FA in individuals with ASD and controls. Exclusion criteria included poster presentations and studies that lack published coordinate data of identified regions of interest in either the Montreal Neurological Institute (MNI) or Talairach spaces. Data recorded included the number of study subjects and controls, p-values (with or without correction for multiple comparisons), MNI or Talairach coordinates of regions-of-interest and whether these regions demonstrated reduced or increased FA, and the number of voxels in each region. Twenty-two composite regions-of-interest then were mapped simultaneously on a reference brain using a novel technique in which data are weighted by large-volume regions-of-interest have been identified with both increased and decreased FA, not repeatable between study populations and of questionable clinical significance. Via our novel visualization method we attempt to present these data in a manner that reflects the level of their statistical certainty. We discuss the functional significance of regions connected by white matter tracts, including foremost the corpus callosum and limbic system, that have been implicated as being abnormal in ASD.

**SUMMARY/CONCLUSION**

Autism is a clinically significant behavioral disorder in which exist demonstrable abnormalities of intra and interhemispheric connectivity. Measurement of FA using DTI offers researchers an elegant method of demonstrating these differences. We describe a novel visualization method of previously identified regions of decreased FA that may lend new insight to researchers and clinicians.

**KEY WORDS:** Autism, fractional anisotropy, DTI

### Electronic Scientific Exhibit 10

**How to Make a Diagnosis of Nonlesional Patients with Intractable Epilepsy**

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**PURPOSE**

Epilepsy is a progressive disorder and affects 10% of the world population. About 10-15% of the patients showing no lesion in the brain on MR imaging are considered nonlesional. The purpose of this exhibit is to demonstrate the multimodality approach to bring these patients to surgery.

**APPROACH/METHODS**

Twenty nonlesional cases were reviewed retrospectively. All patients first showed no obvious lesion on MR imaging with epilepsy protocol. EEG telemetry and MR, FDG PET studies were reviewed and PET-MR fusion was obtained. Eighteen patients had MEG study and 15 patients had depth or grid placement. fMRI-EEG coregistration also was performed in three patients. Two patients had ictal SPECT scan also.

**FINDINGS/DISCUSSION**

Eleven patients had cortical dysplasia. Six patients showed gliosis. Three patients found no abnormality. When the lesion showed cortical dysplasia with dysmorphic neurons, MEG demonstrated clustered spikes. Subtle dysplasia in extratemporal lesion showed scattered multifocal spikes in MEG and invasive depth study was needed. PET-MR fusion was helpful to demonstrate the abnormality.

**SUMMARY/CONCLUSION**

Multimodality approach is important when MR imaging shows no lesion in epilepsy cases. PET, MEG, fMRI and SPECT will help localizing the lesion and should be considered before the invasive depth or grid placement.

**KEY WORDS:** Epilepsy, nonlesional, multimodality
**PURPOSE**
Differentiation of nonneoplastic condition from tumors in the brain is sometimes difficult by conventional MR imaging alone. Advanced MR techniques, such as perfusion-weighted image (PWI) and proton MR spectroscopy (MRS) can give additional information to conventional imaging. Our purpose is to review PWI/MRS results in various tumor-mimicking conditions in the brain and to understand usefulness of PWI/MRS in differentiating between tumors and nonneoplastic conditions.

**APPROACH/METHODS**
Basic principles and techniques of PWI/MRS in the application for brain tumors and tumor-mimicking conditions will be presented. Perfusion was evaluated by relative cerebral blood volume (rCBV) normalized by that of contralateral region. MR spectroscopy was assessed by choline/creatine ratio (Cho/Cr). Perfusion-weighted imaging/MRS results in various nonneoplastic conditions such as infarctions, demyelinating diseases, inflammatory diseases, infectious diseases, hematomas, cortical dysplasias will be presented based on our 47 cases of nonneoplastic conditions and compared to the results from the literature. Comparison of PWI/MRS results between tumors and nonneoplastic conditions will be presented. Limitations of PWI/MRS in the differentiation between tumors and nonneoplastic conditions will be discussed.

**FINDINGS/DISCUSSION**
Mean rCBV and mean Cho/Cr ratio of the nonneoplastic condition were 1.02 and 1.74, respectively and they are significantly lower than those of tumors. It is important to differentiate tumors and nonneoplastic conditions in the brain. Reliable differentiation of these two conditions by noninvasive technique may be helpful to avoid unnecessary biopsies. Advanced MRI techniques, such as PWI/MRS can give important physiologic and metabolic information complementing morphologic findings from conventional imaging. Our results and review of the literature indicates that PWI/MRS is useful to differentiate between the two conditions.

**SUMMARY/CONCLUSION**
We present PWI/MRS findings of various nonneoplastic conditions in the brain and the results were compared to those of the tumors. Perfusion MR/MR spectroscopy are useful for differentiation between tumors and tumor-mimicking conditions in the brain. Nonneoplastic conditions reveal lower level of rCBV and Cho/Cr ratio compared to brain tumors. However, there are significant overlaps in rCBV and Cho/Cr values between nonneoplasms and tumors and cautious interpretation combined with conventional MR imaging is strongly indicated.

**KEY WORDS:** MR, perfusion, MR spectroscopy, brain, nonneoplastic diseases

**PURPOSE**
To propose multivoxel MRS as a reliable technique to differentiate primary tumors (glial or lymphatic origin) from metastases, stressing the evaluation of the peritumoral region.

**APPROACH/METHODS**
Twenty cases were studied with a 1.5 T MR unit. The patients presented with solitary or multiple brain tumors: glioblastomas (8) anaplastic astrocytomas (3) lymphoma (4) and metastasis (5). We performed conventional-enhanced MR imaging and multivoxel MR spectroscopy with short and intermediate echo times. The VOI was placed on the enhancing portion of the lesion and also included the adjacent regions. Results were compared with those of the pathologic anatomy.

**FINDINGS/DISCUSSION**
Primary high-grade tumors and metastases may show similar conventional MR findings. The analysis of the spectra of the peritumoral area can be of great utility in these situations. The main findings for differentiating primary tumors from metastases were an elevated peak of choline that was observed in primary tumors, both glial and lymphatic origins, which was not present in the cases of metastases, reducing infiltration pattern. Both conventional MR images and the spectra from the enhancing portions were not conclusive to differentiate primary high-grade gliomas from secondary tumors. Space-occupying lesions showed variable contrast enhancement, and an inversion of the choline/NAA ratio with peaks of lactate and lipids in most cases.

**SUMMARY/CONCLUSION**
MR spectroscopy is a reliable technique to differentiate primary from secondary tumors in the CNS in the peritumoral area. Important modifications of other diagnostic procedures such as corporal PET and of therapeutic strategies may ensue.

**KEY WORDS:** Primary brain tumors, metastasis, MRS
Neuroradiology of the Criminal Mind: Insights, Controversies and Ramifications

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PURPOSE
To provide a historical context of the numerous attempts to understand the criminal mind culminating in modern neuroimaging techniques. We investigate how changes induced by brain injuries and organic processes can adversely affect behavior and we illustrate pertinent anatomical pathways and a wide diversity of pathologic conditions. We also discuss the ethical and legal ramifications of the radiologist’s assessment.

APPROACH/METHODS
Our exploration of behavioral changes and neuroimaging entailed a thorough literature search, with diverse sources drawn from the realm of biocriminology. These references included not only radiology, but also cognitive neuroscience, bioethics and psychiatry. We graphically display with normal CT and MR orthogonal images and 3D reconstructions those regions of the brain which, if injured, have been implicated in producing impaired mental states. Also included are detailed descriptions of the associated functional derangements. Cases from our Level I trauma center are presented to illustrate those varied causative factors, both organic (e.g., neoplasms, dementias, infarctions) and posttraumatic, which may lead to sociopathic behavior. We highlight modern imaging techniques, including PET, SPECT and fMRI, which advances this analysis from the purely anatomical and structural to the functional realm. Finally, we discuss various medicolegal ramifications, with examples of actual legal cases where neuroimaging played a crucial role.

FINDINGS/DISCUSSION
An interest in the ability to predetermine and explain criminal behavior dates back nearly 200 years, evolving from the practice of phrenology to the current subspecialties within biocriminology. Although behavior is dependent on a complex interaction of multiple factors, modern neuroimaging techniques have helped elucidate brain regions associated with particular cognitive, behavioral and emotional changes. Specific clinical syndromes involving behavioral derangements include those of the frontal lobe (especially the prefrontal cortex), related to loss of judgment and inhibition, the limbic system, involved in aggressive and instinctual behavior, and the temporal lobe, linked to affective emotional disturbance. In the late 1990s, PET scanning revolutionized the field when the brains of convicted murderers were evaluated and showed visible changes. Recently, PET and SPECT have been overshadowed by fMRI, which can demonstrate activation of multiple cognitive functions, permitting evaluation of more highly complex behaviors. In the legal domain, neuroimaging findings increasingly have made the leap from hospital to courtroom. Notable court cases where brain scans were admissible as evidence include that of John Hinckley’s assassination attempt of Reagan (CT, 1982) and that of an executive who strangled his wife (PET scan, 1992). In 2005, a precedence was set when fMRI was introduced as evidence in the trial of a minor who threw 17 women off a bridge. Recently, fMRI evidence also was used in the government’s argument that a relationship exists between playing violent video games and aggressive behavior in children.

SUMMARY/CONCLUSION
Developments in imaging have furthered significantly our understanding of the neurologic basis of criminally deviant behavior. The neuroradiologist may play a crucial role not only in discerning an underlying pathologic process, but also may be an influential determinant of the patient’s judicial fate.

KEY WORDS: Medicolegal radiology, biocriminology, fMRI

Conventional and Advanced Imaging in Glioblastoma with Pathologic and Cytogenetic Correlation

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PURPOSE
To describe the common and uncommon imaging findings of common and rare variants of glioblastoma multiforme (GBM) on MR imaging, including diffusion, perfusion and spectroscopy findings.

APPROACH/METHODS
Glioblastoma multiforme are most common intraaxial tumors in the adult brain. We have collected close to 100 cases of GBM with advanced imaging (diffusion, perfusion, spectroscopy). These cases include common and uncommon variants of GBM.

FINDINGS/DISCUSSION
There are multiple variants of GBM like classical, small cell, giant cell and sarcomatoid. Newer imaging (diffusion, perfusion, spectroscopy) can help to differentiate the subtypes of GBM. There are also cytogenetic markers, like endodermal growth factor receptor, which can be used to assess the prognosis. There are imaging markers like contrast enhancement, necrosis, permeability, apparent diffusion coefficient (ADC), Choline/creatine ratio and relative cerebral blood volume which have been used in determining the prognosis and survival.

SUMMARY/CONCLUSION
Glioblastoma multiforme has varied appearances on conventional and advanced imaging. The uncommon variants of GBM can be difficult to differentiate on conventional imaging, but with advanced imaging we can not only suggest the diagnosis but also can provide more insight in the nature of neoplasm which could be helpful in determining the prognosis. This educational exhibit will describe imaging findings with correlation to pathologic and cytogenetic findings.

KEY WORDS: Glioblastoma, MR perfusion, MR spectroscopy
Electronic Scientific Exhibit 15
Susceptibility-Weighted MR Imaging in HIV-Related Central Nervous System Infections: A Pictorial Review
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PURPOSE
To review susceptibility-weighted MR phase imaging (SWI) in central nervous system HIV-related infections.

APPROACH/METHODS
Susceptibility-weighted MR phase imaging is high-resolution 3D gradient-echo sequence that uses magnitude and filtered-phase information, both separately and in combination with each other, to create new sources of contrast. Susceptibility-weighted imaging offers information about any tissue that has a different susceptibility than its surrounding structures such as deoxygenated blood, hemosiderin, ferritin, and calcium. This relatively new technique may offer new information on patterns of HIV brain infections. A retrospective review was performed on our data bank, and 54 AIDS patients with confirmed central nervous system infection were studied. In addition to the conventional MR imaging protocol, we acquired SWI in all cases. We retrospectively reviewed the patterns of signal abnormalities on SWI in all the cases and correlated with the final diagnosis.

FINDINGS/DISCUSSION
Susceptibility-weighted imaging is more sensitive than T2* to detect microbleeding and small amounts of calcium. We hypothesized that SWI could potentially help in the differential diagnosis of HIV-related brain infections. We evaluated 54 brain MR studies from the most prevalent HIV-related conditions (AIDS dementia complex, progressive multifocal leukoencephalopathy, toxoplasmosis, cryptococcus infection, tuberculosis). Most of these infections are associated with some degree of bleeding; however, there are different patterns of bleeding and different times of bleeding in the disease evolution. Toxoplasmosis is frequently associated with early and significant foci of hemorrhage. Tuberculosis and cryptococcus infection may present with some degree of early bleeding. PML almost never presents with bleedings. AIDS dementia complex alone was not associated with foci of hemorrhage.

SUMMARY/CONCLUSION
Susceptibility-weighted imaging can help narrowing the differential diagnosis of HIV-related central nervous system infections. The imaging features described in this review may improve imaging specificity; however, further good quality research is required for proper validation of the technique.

KEY WORDS: SWI, HIV, infections

Electronic Scientific Exhibit 16
Conventional and Advanced MR Imaging Features of Neurologic Immune Reconstitution Inflammatory Syndrome in Patients with AIDS
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PURPOSE
The aim of this study is to evaluate the clinical findings, the conventional and advanced MR imaging features in AIDS patients with neurologic immune reconstitution inflammatory syndrome (IRIS).

APPROACH/METHODS
We have reviewed cases at our institution regarding MR imaging features of neurologic IRIS in patients with AIDS. We present five cases, two of them with histopathologic evaluation. All patients underwent MR imaging examinations including axial T1 pre and postcontrast, T2, FLAIR, diffusion tensor imaging and susceptibility-weighted MR phase images. The laboratory data, such as plasma HIV RNA viral load and CD4 T-lymphocytes, and the clinical data, such as clinical presentation, follow up and antiretroviral therapy, also were evaluated.

FINDINGS/DISCUSSION
A paradoxical worsening or onset of systemic clinical signs and symptoms among patients with HIV/AIDS has been reported. This occurs after the initiation of HAART, particularly in those with profound immune suppression, termed IRIS, which occurs with or without a concurrent opportunistic infection. Conventional and advanced MR imaging techniques are useful in evaluating these phenomena. Typical MR imaging patterns of some infections can be modified during IRIS. The most frequent findings are a paradoxical increase in the size, number of lesions, perilesional edema and greater lesional enhancement in T1 postcontrast. A combination of clinical, laboratory and MR imaging findings with follow-up studies should be recommended in these patients.

SUMMARY/CONCLUSION
This exhibit reviews the main MR imaging features in AIDS patients with IRIS. The use of MR imaging in association with the clinical and laboratory data can reduce the number of unnecessary cerebral biopsies in some clinical scenarios.

KEY WORDS: IRIS, AIDS, MRI
Electronic Scientific Exhibit 17

Welcome to the Masquerade Ball: Central Nervous System Mimickers of Infections, Inflammatory Processes, and Neoplasms

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PURPOSE
In the central nervous system (CNS), infections, neoplasms, and inflammatory processes can be confused with each other. The aim of this exhibit is to present various challenging CNS cases, in which the latter occurred, in order to avoid falling victim to these CNS mimickers.

APPROACH/METHODS
The cases will be presented in quiz format with key radiologic features discussed for each case. Some of the cases to be presented are: 1. Cerebral schistosomiasis simulating a brain glioma; 2. Cerebral tuberculosis thought to represent cystercerosis; 3. Herpes simplex virus infection vs neoplasm; 4. Atypical diffuse brain metastasis simulating cystercerosis; and 5. Langerhans cell histiocytosis vs neuroblastoma metastases.

FINDINGS/DISCUSSION
Central nervous system neoplasms, infections, and inflammatory processes can have similar radiologic appearances that can lead to reader confusion and misdiagnosis, many times altering patient care. Central nervous system infection/inflammation can simulate a neoplasm, and conversely neoplastic processes can simulate infection/inflammation.

SUMMARY/CONCLUSION
In the exhibit we present various examples of these CNS mimickers, and give clues that help the reader avoid being tricked by these sneaky players, ultimately making the correct diagnosis.

KEY WORDS: Infection, tumors, neoplasm

Electronic Scientific Exhibit 18

Neuroradiologic Spectrum of HIV and AIDS: Revisiting an Old Foe

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PURPOSE
To review the diverse and overlapping neuroradiologic spectrum of HIV-related diseases, including those conditions affecting the intracranial contents (brain and meninges), head and neck, and spine. The viewer of this exhibit will be challenged with an interactive quiz format of look-alike entities, aimed at honing one’s diagnostic acumen. Instruction is provided on formulating relevant clinical questions and producing a tailored protocol. Recognizing the distinguishing radiologic features and gaining knowledge of the latest arsenal of specialized imaging techniques will aid in the detection, diagnosis and treatment of this debilitating disease.

APPROACH/METHODS
We retrospectively reviewed the clinical histories and radiologic studies of patients with HIV or AIDS who presented through the emergency department, neurology and infectious disease clinics of our Level I trauma and county medical facility during the past 5 years. Imaging modalities included CT, MR (e.g., spectroscopy, DWI, perfusion), cerebral angiography and nuclear medicine studies. We organized lesions according to location, morphology and contrast patterns. A wide array of both typical and atypical entities and mimics is presented.

FINDINGS/DISCUSSION
Diffuse patchy white matter abnormalities may be seen with HIV encephalopathy, PML, herpes and CMV encephalitis. Focal/multifocal masses include opportunistic and bacterial infections, such as toxoplasmosis, cryptococcomas, tuberculosis and abscesses, as well as neoplasms, primarily lymphoma. SPECT, PET, perfusion MR and MR spectroscopy can all assist in differentiating toxoplasmosis from lymphoma. CMV and lymphoma commonly have a periventricular predilection. Meningeal involvement is commonly due to tuberculosis, cryptococcus, and CMV. One should be careful to search for associated parenchymal lesions, which may provide important diagnostic clues. Vascular manifestations include ischemic changes which may be secondary to vasculitis or embolic phenomena, as well as hemorrhage secondary to infectious aneurysms and infarcts. Syphilis has many presentations, which may include meningitis, vasculitis, and parenchymal disease. Head and neck entities often involve the otologic structures (HIV labyrinthitis, otomastoiditis, facial neuropathy), oral cavity and pharynx (lymphoma), larynx, parotid glands (lymphoepithelial cysts) and paranasal sinuses. Aggressive fungal sinus diseases (aspergillosis, mucormycosis) can result in both intraorbital and intracranial invasion. Various conditions are associated with lymphadenopathy, including opportunistic infections and lymphoma. Spinal pathologies are categorized by location. Conditions involving the vertebral column include HIV-related bone marrow abnormalities and osteomyelitis/diskitis. Intrathecal extramedullary processes frequently include leptomeningeal lymphoma and nerve root enhancement (e.g., CMV). Intramedullary lesions include HIV vacuolar myelopathy and viral myelitis (herpes, CMV and varicella-zoster). Pediatric AIDS, less common than the adult version, may present with diffuse calcifications, atrophy, encephalitis, and microcephaly.

SUMMARY/CONCLUSION
Nearly 30 years after its discovery, treatment and cure of HIV and AIDS remain as elusive as ever despite continued advancements and research. Radiology plays a key role in the detection, diagnosis and surveillance of the numerous manifestations of this illness, which include primary HIV-associated disease, opportunistic infections and neoplasms. Differential dilemmas confronting and confounding the radiologist are heightened by the multiplicity of pathologies and convergence of imaging findings. A systematic clinical and roentgenologic approach can expedite diagnosis and facilitate treatment.

KEY WORDS: HIV, AIDS
Autoimmune-Mediated Encephalopathies: Classification, Diagnostic Evaluation, and Case-Based Pictorial Essay

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PURPOSE
There has been increasing awareness of autoimmune-mediated disorders that lead to cognitive impairment and behavioral changes. These neurologic disorders can be distinguished by their association with auto-antibodies, often directed against the central nervous system, and the pattern of MR imaging abnormalities. The purpose of this exhibit is to review the classification, clinical features, and MR manifestations of the autoimmune-mediated encephalopathies (AME). As many of these conditions are reversible, familiarity with the clinical and imaging features may allow radiologists to recognize them, facilitating the clinical work up and treatment.

APPROACH/METHODS
We retrospectively evaluated select patients presenting to our institution over the past 10 years with acute and subacute encephalopathy, who subsequently were diagnosed with an AME. The clinical presentation, MR abnormalities, systematic diagnostic work up, and treatment of several representative AMEs are discussed in a case-based format with reference to the scientific literature.

FINDINGS/DISCUSSION
MR findings in our patients included limbic encephalitis, brainstem encephalitis, cerebellar degeneration, and multifocal white matter disease. We classified these autoimmune encephalopathies into the paraneoplastic autoimmune-mediated encephalopathies and the nonparaneoplastic autoimmune-mediated encephalopathies. Several disorders presented include: 1) Paraneoplastic AME disorders: anti-Hu, anti-CV2, anti-Yo, and anti-N-methyl-d-aspartate (NMDA) receptor associated antibody syndromes; 2) Nonparaneoplastic AME disorders: anti-voltage gated potassium channel associated (VGKC) encephalopathy, antinovel cell membrane antigen (nCMAg) encephalopathy, Hashimoto’s encephalopathy, antilgal encephalopathy, and antiglutamic acid decarboxylase (GAD) antibody syndrome. Further diagnostic work up for a suspected AME disorder include electroencephalography, cerebrospinal fluid (CSF) analysis (for protein, glucose, cell count, IgG index, and oligoclonal bands), and serum and CSF auto-antibody panel testing. Patients may be screened for occult malignancy with whole-body computed tomography (CT) and 18F-fluorodeoxyglucose positron emission tomography (FDG-PET). Patients also should be evaluated for systemic autoimmune diseases and infectious processes (such as herpes simplex virus and Creutzfeldt-Jakob disease), which are potential clinical and imaging mimickers. As opposed to many vascular and neurodegenerative causes of encephalopathy, many AMEs are potentially reversible with appropriate intervention including immunomodulatory therapy or in the cases of the paraneoplastic syndromes, treatment of the underlying malignancy. Autoimmune-mediated encephalopathies associated with cell-membrane antigens (including VGKC and nCMAg) are typically more responsive to treatment than those associated with intracellular antigens (including Hu and Ma2).

SUMMARY/CONCLUSION
It is important to recognize the MR appearance of the AMEs as these disorders typically require urgent diagnosis and treatment with immunosuppressants or of the underlying etiology. These disorders can mimic neoplastic, infectious, or neurodegenerative processes; however, by recognizing the possibility of a paraneoplastic or nonparaneoplastic autoimmune condition, the radiologist can help direct the referring physician to the appropriate systematic work up for prompt diagnosis and treatment.

KEY WORDS: Autoimmune, paraneoplastic, encephalopathy

Infectious Stroke: Spectrum of Intracranial Pathogens and Imaging Findings

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PURPOSE
The purpose of this exhibit will be to discuss various categories of pathogens, their common routes of spread and also illustrate the spectrum of imaging findings that commonly are seen in infectious cerebral conditions, particularly as these findings pertain to stroke and their concurrent clinical management.

APPROACH/METHODS
We will show examples of various viral, bacterial, fungal and parasitic causes of infectious stroke from our teaching files and demonstrate imaging features using cross-sectional imaging as well as show examples of angiograms (digital subtraction angiography, CT and MR angiography) to enhance the illustrations. These imaging features will be illustrated in the adult population.

FINDINGS/DISCUSSION
Stroke as a clinical entity, worldwide is one of the leading causes of death in both developing and industrialized countries. Infections cause a significant proportion of stroke particularly more in developing nations and also are becoming increasingly more common even in the U.S. Infectious stroke can be subdivided into hemorrhagic and ischemic. Furthermore, this can be either arterial or venous in etiology. Lastly, infectious stroke can be a result of either direct or hematogenous spread of the organism. Each of these subdivisions of stroke and its etiologies are pivotal in understanding the spectrum of imaging findings seen with infectious stroke.

SUMMARY/CONCLUSION
Infectious etiologies of stroke range from viral, bacterial, fungal, and parasitic. The findings of stroke itself are typically a direct result of the degree of vascular involvement in the regions in question. Infections can involve vessels of any
size and caliber ranging from large vessels to arterioles. However, the type of vessels involved commonly depends upon the pathogen and the route of spread. Depending on the burden of infection, vascular involvement could vary from vessel irregularity, to beading, narrowing, and ultimately frank occlusion and thrombosis. Rarely infectious spread can even lead to mycotic aneurysm formation. This spectrum of vascular irregularity and rarely occlusion has been observed in both the arterial and venous systems. Furthermore, in the setting of cerebral infection, parenchymal changes secondary to vascular changes could lead to infarction, cerebritis/encephalitis and finally frank abscess formation. Uncommonly, infectious vasculitis also could present with hemorrhagic stroke. Finally, the route of infection often will demonstrate a distinct imaging appearance which can be indicative of the origin of the infection and possible further complications which can occur. Many of these imaging findings can be utilized to guide clinical as well as surgical management.

**KEY WORDS:** Infectious, stroke

### Electronic Scientific Exhibit 21

**Spectrum of Neuroradiology Findings in Erdheim-Chester Disease**

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**PURPOSE**

To delineate and describe the neuroradiographic imaging findings in Erdheim-Chester disease.

**APPROACH/METHODS**

After IRB approval, a retrospective review was performed of all patients with a diagnosis of Erdheim-Chester disease at our institution over the last 15 years (total 36 patients). All available imaging modalities, including CT, MR imaging, and PET, were reviewed with specific attention to the neuraxis.

**FINDINGS/DISCUSSION**

In this largest single-center case series, we found neuroradiographic abnormalities in 33% (12 of 36 patients) of Erdheim-Chester patients. MR imaging of the head and/or spine were available for 21 out of 36 patients. Twenty-nine out of 36 had CT scans available consisting of combined head (10), spine (1), and body (27) scans. Five out of 36 patients had PET scans. Neuroradiographic findings included enhancing and nonenhancing infiltrative T2 hyperintense lesions within the brainstem and cerebellum (n = 5). Dural-based T2 hypointense, homogeneously enhancing lesions were noted both intracranially (n = 3) and within the spinal canal (n = 2). Among this group of patients, there was increased metabolic activity on FDG PET scans in the extraaxial lesions (n = 2). These lesions were shown to be iso to hyperdense on CT in all regions of the neuraxis. Additional findings included thickening of the pituitary infundibulum (n = 3), and intracanal infiltrative orbital masses (n = 3). Radiographic findings of Erdheim-Chester disease outside of the neuraxis included more classic findings of diaphyseal sclerosis of the long bones, retroperitoneal or mesenteric fibrotic changes, and soft tissue encasement of the aorta.

**SUMMARY/CONCLUSION**

The non-Langerhans Cell Histiocytes (non-LCH) are a group of disorders defined by the accumulation of phenotypically distinct histiocytes. Although rare, Erdheim-Chester disease represents a specific entity of non-LCH which has a significantly worse prognosis. Since nearly 30% of patients have neuroradiographic abnormalities, the neuroradiologist should be aware of these findings as they may be the first person to suggest the diagnosis by correlating the clinical, radiographic, and pathologic findings.

**KEY WORDS:** Erdheim-Chester disease, brain, spine

### Electronic Scientific Exhibit 22

**Brain Infectious Diseases in Patients with AIDS: A Review of the Conventional and Advanced MR Imaging Findings**

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**PURPOSE**

To review the spectrum of conventional and advanced MR imaging findings in the most common central nervous system (CNS) infections in patients with AIDS.

**APPROACH/METHODS**

We identified patients having been diagnosed with neuroAIDS over the last 2 years from our institution and retrospectively reviewed their MR imaging studies, clinical presentation, diagnostic work up, and any follow-up studies available. All patients underwent MR imaging examinations including axial T1 pre and postcontrast, T2, FLAIR, diffusion tensor imaging and susceptibility-weighted MR phase.
images. Most of the patients also had dynamic susceptibility-weighted contrast-enhanced perfusion study, postcontrast FLAIR and MR spectroscopy (using TE = 30 and 135 ms)

**FINDINGS/DISCUSSION**
The HIV is a retrovirus that infects cells of the immune system, destroying or impairing their function. HIV invades the brain at the time of primary infection and induces an immunologic process in the central nervous system, causing damage. Beside the lesions provoked by the HIV itself, there are many other opportunistic agents that can cause CNS infections. Presenting symptoms and clinical course varied widely in patients with CNS infections. We review MR findings of the most common infectious diseases that affect the CNS: AIDS dementia complex, progressive multifocal leukoencephalopathy (PML), toxoplasmosis, CMV infection, cryptococcus infection, aspergillosis, tuberculosis, neurosyphilis, bacterial infections and differential diagnosis with immune reconstitution inflammatory syndrome (IRIS).

**SUMMARY/CONCLUSION**
The diagnosis of AIDS-related CNS infections is often a challenge. Brain biopsy is the gold standard, but usually is not the first step in the diagnostic work up. Neuroimaging plays a fundamental role in the early diagnosis, along with serological tests and laboratory analysis. The advanced MR imaging techniques improves the accuracy of the noninvasive diagnosis in these patients.

**KEY WORDS:** AIDS, infections, MR imaging

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**Electronic Scientific Exhibit 23**

**Advanced MR Imaging of Primary Lymphoma of the Central Nervous System**

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**PURPOSE**
To illustrate the advanced MR imaging (MRI) of primary lymphoma of the central nervous system (PCNSL).

**APPROACH/METHODS**
Based on MRI data of 20 consecutive patients with histologically proved PCNSL who performed advanced MRI, including diffusion-weighted imaging (DWI), perfusion-weighted imaging (PWI), susceptibility-weighted imaging (SWI), and MR spectroscopy (MRS), the role of advanced MRI in differentiating primary CNS lymphoma from other malignant brain tumors was evaluated. Advanced MRI data of 20 glioblastomas and 20 metastasis with similar conventional MR imaging appearances were used for comparison.

**FINDINGS/DISCUSSION**
The presence of a markedly elevated lipid signal on MRS, areas of reduced diffusion on DWI, low cerebral blood volume (CBV) value on PWI, and absence of intratumoral susceptibility signal on SWI are the characteristic advanced MR findings in patients with PCNSL. These advanced MR findings could discriminate PCNSL from glioblastomas or metastatic tumors with a high specificity and diagnostic accuracy.

**SUMMARY/CONCLUSION**
Advanced MRI is very useful in differentiating PCNSL from glioblastoma or metastasis.

**KEY WORDS:** Lymphoma

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**Electronic Scientific Exhibit 24**

**Neuronal-Glial Tumors of the Central Nervous System**

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**PURPOSE**
1. To illustrate the typical and atypical MR imaging features of various pure neuronal and mixed neuro-glial tumors of central nervous system. 2. To correlate between the imaging findings (CT, MR) with histopathology features.

**APPROACH/METHODS**
We retrospectively reviewed the imaging studies from our PACS system of 22 patients surgically or biopsy-proved cases of neuroglial tumors. Besides routine MR imaging, all of the patients also had high-resolution T2 and MPR and postcontrast T1-weighted sequence through the whole brain.

**FINDINGS/DISCUSSION**
We classified these lesions using WHO brain tumor classification into: 1) Gangliocytoma, 2) Dysplastic gangliocytoma of cerebellum (Lhermitte-Duclos), 3) Ganglioglioma, 4) Anaplastic (malignant) ganglioglioma, 5) Desmoplastic infantile ganglioglioma, 6) Central neurocytoma, 7) Dysembryoplastic neuroepithelial tumor, and 8) Olfactory neuroblastoma (esthesioneuroblastoma).

**SUMMARY/CONCLUSION**
In this exhibit we review the clinical and pathologic characteristics of the various neuronal-glial tumors of the central nervous system and demonstrate representative characteristic imaging findings.

**KEY WORDS:** Neuronal-glial tumors, epilepsy

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**Electronic Scientific Exhibit 25**

**Molecular Medicine and the Neuroradiologist: Why the PI3K/AKT/mTOR Pathway Is Important for Us to Understand**

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**PURPOSE**
Molecularly targeted therapies promise to transform the treatment of patients with glioblastoma, the most common malignant brain tumor. The phosphatidylinositol-3-kinase (PI3K)/AKT/mTOR (mammalian target of rapamycin) pathway is an attractive target because it plays a central role in tumor survival, proliferation, angiogenesis and resistance to
therapies. We summarize the PI3K/AKT/mTOR pathway, illustrate targeted small molecular inhibitor and antibody therapies being tested in phase I-II clinical trials, and explore some of the current limitations of neuroimaging in the setting of these newer treatments.

**APPROACH/METHODS**

The binding of growth factors such as vascular endothelial growth factor (VEGF) and platelet derived growth factor to tyrosine kinase receptors results in the activation of PI3K, which in turn activates mTOR through the intermediate enzyme AKT. mTOR activation results in the phosphorylation of proteins that are active in glioma survival, proliferation, and angiogenesis. We summarize targeted agents that inhibit various components of this pathway: Vascular endothelial growth factor inhibitors (e.g., bevacizumab, anti-VEGF-A monoclonal antibody), multitargeted tyrosine kinase inhibitors (e.g., pazopanib, sunitinib, sorafenib, and vandetanib), PI3K inhibitors (XL765, which also inhibits mTOR), AKT inhibitors (e.g., perifosine), and mTOR inhibitors (e.g., sirolimus, temsirolimus).

**FINDINGS/DISCUSSION**

The entry of these new agents into clinical practice has made tumor response assessment increasingly complicated. Many of these agents have direct effects on the tumor vasculature that abscond traditional MR response criteria, which usually are based on changes in size of the enhancing tumor. This has serious implications on patient care and on clinical trials, nearly 75% of which rely on surrogate imaging end-points rather than patient survival. Advanced MR techniques such as perfusion and spectroscopy may play a role in the treatment decision process. New PET radiotracers also may become important, such as 18F-FACBC, an amino acid whose cell entry is facilitated by an L-type amino acid transporter regulated by the PI3K/AKT/mTOR pathway, and 18F-ML-10, an apoptosis agent.

**SUMMARY/CONCLUSION**

Understanding the mechanisms of action of molecular pathways and targeted therapies is important for the neuroradiologist to accurately interpret imaging manifestations of response and progression, imaging limitations, and remain a crucial player on the neurooncology team. More work is necessary to evaluate the role of advanced MR imaging and/or PET imaging to determine their role in disease monitoring.

**KEY WORDS:** Glioblastoma, chemotherapy

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**Electronic Scientific Exhibit 26**

**Nonenhancing Leptomeningeal Metastases**

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**PURPOSE**

To describe a small series of unusual cases of pathologically proved leptomeningeal metastases that did not enhance after contrast administration.

**APPROACH/METHODS**

We reviewed the radiology database from January 2008 to December 2009 to search for cases of nonenhancing leptomeningeal metastases that were pathologically proved.

**FINDINGS/DISCUSSION**

Leptomeningeal metastases portend a poor prognosis in most patients and are a significant cause of morbidity and mortality. Although sampling the CSF multiple times can establish the presence of leptomeningeal metastases, brain and spine MR imaging are valuable tools to make this diagnosis in patients with known primary neoplasms. Leptomeningeal metastases nearly always enhance after gadolinium administration, but we observed five unusual instances with nonenhancing leptomeningeal metastases. This exhibit will present the imaging findings, explain how the diagnosis was made, and review the relevant literature.

**SUMMARY/CONCLUSION**

The presence of nonenhancing leptomeningeal metastases is uncommon, but may become more problematic with new chemotherapeutic agents that have direct effects on tumor vasculature. A high degree of suspicion and keen understanding of this phenomenon is essential for the radiologist to make this diagnosis and help initiate the appropriate treatment.

**KEY WORDS:** Leptomeningeal, metastases
Electronic Scientific Exhibit 27

Interactive Orbit Teaching Tool

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PURPOSE
An interactive electronic exhibit that will provide examples of common orbital lesions based on anatomical location.

APPROACH/METHODS
The navigation tool is an interactive anatomical drawing based in powerpoint. A simple click on each image leads to a differential diagnosis list; a subsequent click on each diagnosis provides links to illustrative examples and a brief overview of the disease processes. The following compartments of the orbit will be covered (with several examples of diseases to be discussed): 1. Optic nerve/sheath: neuritis, glioma, meningioma, pseudotumor cerebri, dilated optic nerve sheath; 2. Intracanal without optic nerve involvement (cavernous hemangioma, orbital varix, lymphangioma pseudotumor, lymphoma, metastases, cavernous carotid fistula); 3. Muscle Cone: thyroid opthalmopathy, pseudotumor, orbital cellulitis, lymphoma; 4. Globe: retinoblastoma, melanoma, coloboma, staphyloma, persistent hyperplastic primary vitreous, coat's disease, Sturge-Weber, NF-1; 5. Lacrimal Fossa: dacrocystocele, dermoid cyst, sarcoid, plemorphic adenoma; 6. Extrapalcal: dermoid, lymphoma, pseudotumor; and 7. Bony orbit: fibrous dysplasia, metastases, NOF.

FINDINGS/DISCUSSION
There are numerous intraorbital diseases that can be categorized successfully by anatomical location, which when presented in an electronic format can aid in learning/ reviewing these many pathologic processes. Our navigation tool allows the user an approach to orbital lesions both by anatomical location and common clinical and radiologic presentation.

SUMMARY/CONCLUSION
We introduce an efficient, interactive computer-based tool that will review the differential diagnoses for intraorbital lesions based on their anatomical location.

KEY WORDS: Orbit, neoplasm

Electronic Scientific Exhibit 28

Neurooncology SPECT: Know Your Glioma Imaging

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PURPOSE
To improve the reader's diagnostic accuracy, cases of patients requiring SPECT for glioma are demonstrated. On completion the reader will: 1. Understand the indications; 2. Discuss SPECT analogues (\textsuperscript{201}TI, \textsuperscript{99m}Tc-MIBI, \textsuperscript{111}In-penetetreotide); 3. Describe the scintigraphy of gliomas; and 4. Evaluate grades and prognosis.

APPROACH/METHODS
Interesting cases will be presented in an illustrated quiz format. Key differential diagnostic points will be highlighted in each case.

FINDINGS/DISCUSSION
Included in this part is: 1. Discussion of the interface with conventional MR imaging, and indications; 2. Description of glioma scintigraphy: protocol and reasons for tracer uptake; 3. Implications of a normal scan: Radionecrosis and postsurgical change; and 4. Evaluation of low-grade versus high-grade glioma and prognosis.

SUMMARY/CONCLUSION
1. The main indication is in the posttherapeutic setting to determine whether enhancement on MR imaging is residual glioma; 2. \textsuperscript{201}TI protocol is 2-4mCi dose with early imaging (5-10 mins); 3. Functional imaging defines blood flow and integrity of the blood-brain barrier, as well as mitochondrial density (\textsuperscript{99m}Tc-MIBI), Na/K pump expression (\textsuperscript{201}TI) and somatostatin receptor expression (\textsuperscript{111}In-penetetreotide); 4. \textsuperscript{111}In-penetetreotide is limited if no blood-brain-barrier breakdown and \textsuperscript{99m}Tc-MIBI is limited by choroid uptake; 5. \textsuperscript{111}In-penetetreotide can direct Y\textsuperscript{90} somatostatin therapy; and 6. Uptake correlates with grade and is an independent prognostic marker.

KEY WORDS: Glioma, SPECT, scintigraphy

Electronic Scientific Exhibit 29

Glioma Treatment Planning and Response: Quantitative Imaging Biomarkers

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PURPOSE
On completion the reader will be able to: 1. Understand how quantitative imaging differs from conventional imaging; 2. Describe quantitative glioma MR imaging techniques; and 3. Discuss important and characteristic glioma findings to aid treatment planning and evaluate response. In particular regarding: Dynamic susceptibility contrast MR imaging (DSC- MRI); Apparent diffusion coefficient (ADC); Magnetic resonance spectroscopy (MRS); Positron emission tomography (PET); and Functional magnetic resonance imaging (fMRI).

APPROACH/METHODS
Interesting cases will be presented in an illustrated quiz format. Key differential diagnostic points will be highlighted in each case.
**SUMMARY/CONCLUSION**

- Knowledge of anatomical extent of tumour infiltration into functionally eloquent brain regions is essential to surgical and radiotherapy planning.
- Conventional MR imaging provides limited detail: enhancing components reflect only deficient blood brain barrier, and T2*-dependent signal abnormality is biologically nonspecific.
- All motor studies localize 96-100% of fMRI activated areas within 2 cm of cortical stimulation.
- Studies of quantitative MRI-guided radiotherapy are preliminary, and no outcome data on survival or patterns of recurrence are available.
- There is increasing interest in noninvasive imaging biomarkers of therapy and surrogate endpoints in clinical trials.
- Measuring treatment response with metrics is limited. Pseudoprogression and pseudoprogression are problematic.

**KEY WORDS:** Glioma, functional, quantitative

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**Electronic Scientific Exhibit 30**

**Differentiating Pseudoprogression and True Disease Progression: Utility of Advanced MR Perfusion and Permeability Imaging in the Surveillance of High-Grade Gliomas**

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**PURPOSE**

Current treatment for high-grade gliomas includes radiotherapy and temozolomide with response to therapy monitored using periodic contrast-enhanced MR imaging. Frequently, progressively enhancing lesions may be encountered, particularly at the end of therapy, which do not represent true progression of disease, but are a treatment-related effect termed “pseudoprogression”. Our purpose is to describe the clinical characteristics, pathology, and MR findings of pseudoprogression using conventional contrast-enhanced structural imaging methods, as well as permeability and perfusion imaging and MR spectroscopy (when available) to better understand this phenomenon and help differentiate it from true disease progression.

**APPROACH/METHODS**

We retrospectively reviewed the records and MR imaging studies in patients who underwent surgery for progressive disease as seen on MR imaging following chemoradiotherapy for which pathology revealed findings that were not consistent with disease progression (pseudoprogression), including cases that demonstrated disease improvement on follow-up MR imaging. We describe the changes noted on contrast-enhanced imaging as well as on perfusion and permeability imaging. We compare these MR imaging findings to those in patients with known disease progression. Pathologic correlation is provided as well as a discussion of changes in the treatment regimen of those found to have pseudoprogression.

**FINDINGS/DISCUSSION**

Pseudoprogression has been described in 10-15% of patients undergoing surveillance imaging during the first 6 months following temozolomide chemoradiotherapy. Pathology specimens in our patients with pseudoprogression demonstrated bland necrosis. The underlying mechanism is unknown, though it is felt to represent a continuum between radiation changes treatment-related necrosis. Pseudoprogression may be differentiated from true disease on MR perfusion imaging by noting diminished relative cerebral blood volume (rCBV) with pseudoprogression. In contrast, true disease progression demonstrates elevated cerebral blood volume. The contrast enhancement kinetics on permeability imaging demonstrate elevated vascular permeability in both cases, due to blood brain barrier breakdown. However, a steep enhancement curve with plateau is suggestive of viable high-grade tumor, while progressive linear enhancement may represent treatment-related changes.

**SUMMARY/CONCLUSION**

Changes on MR imaging during tumor surveillance must be interpreted with caution following the course of chemoradiotherapy. Differentiation of pseudoprogression from true disease progression has important implications for further treatment planning. Evaluating perfusion parameters, such as rCBV, and enhancement kinetics through vascular permeability imaging can be useful in making this important differentiation.

**KEY WORDS:** Pseudoprogression, high-grade glioma, surveillance imaging
**Imaging Features of Oligodendroglioma and Its Variants with Review of their Clinical and Neuropathologic Manifestations**

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**PURPOSE**

To identify the distinguishing imaging features of oligodendroglioma and its variants with review of their epidemiologic, clinical, and neuropathologic manifestations.

**APPROACH/METHODS**

Oligodendroglioma is the third most common glial neoplasm, and has a more indolent clinical history and prolonged survival compared with astrocytic tumors of the same grade. Current histopathologic classification schemes recognize four main types of tumors: low-grade oligodendroglioma, anaplastic oligodendroglioma, low-grade oligoastrocytoma, and anaplastic oligoastrocytoma. The development of malignant oligodendroglioma can originate from the tissue of benign tumor; also, a primary tumor can be malignant from the beginning. For clinical decision-making it is important to establish the grade of oligodendrogliomas, because therapeutic management and prognosis depend on the tumor grade. Tumor grade of oligodendrogliomas is the single most important prognostic variable that is most strongly associated with survival. We present and review various imaging features of oligodendroglioma and its variants with review of their epidemiologic, clinical, and neuropathologic manifestations.

**FINDINGS/DISCUSSION**

At neuroimaging, a fronto-temporal location, involvement including superficial cortex, and intrinsic calcification are characteristic of oligodendrogliomas. Several possible factors in determining the malignancy of oligodendrogliomas, include marked contrast enhancement, especially nodular-like enhancement, growing of tumor heterogeneity due to cystic change, necrosis and hemorrhage, and increased perifocal edema and brain dislocation. There are no unique features at neuroimaging that allow distinction of a mixed oligoastrocytoma from an oligodendroglioma. While calcification is not as common as seen in pure oligodendrogliomas, enhancement following intravenous contrast material administration is more common. Tumors that contain deletions of genetic material on 1p and 19q are found more commonly in the frontal lobe with ill-defined margins, frequently with bilateral extension, are more likely to have calcification, and are more likely to respond to chemotherapy. Advanced MR imaging techniques and metabolic imaging play increasingly important roles in both pre and postoperative assessment of these complex neoplasms.

**SUMMARY/CONCLUSION**

Understanding of this exhibition presents information that facilitates the recognition of these tumors at neuroimaging.

**KEY WORDS:** Oligodendroglioma, MR imaging

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**Electronic Scientific Exhibit 32**

**Solving the Enigma: MR Imaging Spectrum of Radiation Necrosis and Recurrent Tumor in Adults**

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**PURPOSE**

1. To illustrate the multisquence MR imaging manifestations of recurrent tumor compared to radiation necrosis in patients treated for high-grade tumors such as glioblastoma, anaplastic astrocytoma and metastases. 2. To provide imaging-pathologic correlation in cases of recurrent tumor and radiation necrosis. 3. To describe the role of advanced imaging techniques such as MR perfusion, permeability and spectroscopy in the differentiation of these two entities.

**APPROACH/METHODS**

1. Review the MR imaging spectrum of recurrent tumor and radiation necrosis with MR imaging including sequences such as diffusion-weighted imaging, perfusion, permeability and spectroscopy. 2. Review subtle conventional and advanced imaging characteristics that help in the differentiation of these entities. 3. Display imaging pathologic correlation after biopsy or surgical resection.

**FINDINGS/DISCUSSION**

High relative cerebral blood volume (rCBV) and high Choline/Creatine ratio are imaging markers of recurrent tumor. Enhancing lesions developing in a nonenhancing tumor after treatment, lack of mass effect for the degree of enhancement and edema, enhancing focus distant from the primary tumor and characteristic "soap bubble" or "swiss cheese" pattern of enhancement are MR markers of radiation necrosis.

**SUMMARY/CONCLUSION**

Imaging findings that help in differentiating recurrent glioma from radiation necrosis can be subtle or marked depending on the time of imaging. Earlier in treatment the distinction between these two entities is clinically more pertinent since treatment can be altered by modulating the radiation dose.

**KEY WORDS:** Brain tumor, radiation necrosis, recurrent glioma
**High-Grade Gliomas: Early Appearance on MR Imaging**

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**PURPOSE**
Astrocytic tumor is the most common primary cerebral neoplasm in adults. The clinical management and prognosis of these tumors depends on their histologic grade; hence, accurate and early diagnosis is essential. High-grade astrocytic tumors show typical characteristics on MR imaging, such as heterogeneous signal intensity and irregular contrast uptake, but in early stages their appearance can be nonspecific, making the diagnosis challenging. We describe the MR findings of 5 patients who had minimal cortical signal changes in brain MR scans performed a few days after symptoms onset, and who showed a marked lesion size increase within a short period of time, suggesting the diagnosis of high-grade glioma.

**APPROACH/METHODS**
We retrospectively reviewed the initial MR findings of five patients, three men and two women, aged 33 to 75 years (mean age 49 years), who presented with new-onset seizures (four cases) and a focal neurologic deficit (one case). The initial brain MR scan demonstrated a small cortical lesion. All MR studies included fast T2/Flair images and contrast-enhanced T1-weighted sequences. In three patients perfusion-weighted sequences also were obtained. All patients underwent follow-up clinical and MR assessment within 6 months.

**FINDINGS/DISCUSSION**
Initial MR scans were obtained within 6 days after symptoms onset. All patients had small hyperintense cortical lesions on T2-weighted images with mild to moderate contrast uptake. In the three patients who underwent perfusion-weighted imaging, the lesion showed an increase in CBV or CBF values compared to surrounding gray matter. Three lesions were located in the temporal lobes and two in the frontal lobes. The initial clinical-radiologic diagnoses included acute ischemic stroke, postictal changes, or brain tumor. In all patients, a surveillance MR examination was performed at 1 to 6 months (mean 83 days). Recurrent symptoms during the interval occurred in only one patient. The follow-up MR scans revealed marked progression in tumor size (>100%) in all patients and development of typical imaging features of high-grade glioma in four. All patients underwent surgical resection of the lesion and histopathologic analysis established a final diagnosis of high-grade glioma (glioblastoma multiforme in four patients and anaplastic oligoastrocytoma in one).

**SUMMARY/CONCLUSION**
High-grade cortical gliomas in patients presenting with new-onset seizures or focal neurologic deficits may show atypical features on MR imaging, mimicking low-grade tumors or nonneoplastic conditions. MR identification of small cortical lesions that show contrast uptake and increased CBV or CBF in these clinical situations should raise the suspicion of high-grade glioma, which requires imaging follow up at a short interval (within 1 month). This short interval surveillance is essential to identify tumor progression as early as possible, since it will have a clear impact on treatment decisions and likely on clinical outcome.

**KEY WORDS:** Brain tumors, MR imaging, high-grade glioma

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**Going beyond McDonald Criteria: Role of Newer Imaging Techniques in Follow Up of Brain Tumors**

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**PURPOSE**
Treatment response in brain tumors usually has been assessed by various methods of tumor measurements on contrast-enhanced MR imaging. There is, however, now an increasing awareness of false interpretation of tumor increase on contrast-enhanced T1-weighted images after radiotherapy or chemo/radiotherapy. This increase in tumor volume also may be associated with worsening clinical symptoms and thus be interpreted as tumor progression which may result in the withdrawal of an effective drug or even needless surgery. Our goal in this exhibit is to make radiologists aware about the limitation of size-based criteria and application of newer techniques in follow up of brain tumors.

**APPROACH/METHODS**
We have reviewed cases at our institution regarding the performance of anatominical and functional imaging in follow up of brain tumors.

**FINDINGS/DISCUSSION**
1. To know about various size-based criteria in diagnosing progression and nonprogression of tumors and to explain their limitations; 2. Elaborate role of advanced MR techniques like diffusion, MR spectroscopy and MR perfusion, since these techniques have evolved over time and promise to be very important imaging tools which have been explored as imaging biomarkers to evaluate the disease response; 3. Discuss role of imaging technique in treatment planning and predicting the survival; and 4. Explain various limitations associated with individual techniques.

**SUMMARY/CONCLUSION**
This exhibit will be a pictorial essay with review of literature regarding various MR imaging techniques for follow up of patients treated for brain tumor. This exhibit describe the role of size-based criteria, diffusion, spectroscopy and MR perfusion in follow up of brain tumors in describing the treatment effect, tumor recurrence, radiation necrosis and therapy-related complications.

**KEY WORDS:** Brain tumor, McDonald criteria, advanced imaging of brain
Mimickers of Meningiomas: A Pictorial Review

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**PURPOSE**

1. To discuss the typical and atypical features of the meningiomas; 2. To illustrate the various other mass lesions that can mimic meningioma; and 3. To review the differentiating features between the meningioma and other lesions to get an accurate diagnosis.

**APPROACH/METHODS**

The teaching files were reviewed for a period of 3 years for extraaxial mass lesions which simulated meningioma. The cases with further imaging, follow up and/or histology were selected to discuss in this exhibit.

**FINDINGS/DISCUSSION**

Meningiomas are the most common extraaxial mass lesions in the head. Their diagnosis is usually straightforward in majority of instances. However there are many other lesions like sarcoidosis, lymphoma, metastases, hemangiopericytoma, neurogenic tumors, paraganglioma and aneurysms that can mimic meningioma and can lead to erroneous diagnosis.

**SUMMARY/CONCLUSION**

We will review the imaging features of each of these lesions and discuss the salient differentiating features between them.

**KEY WORDS:** Extraaxial, head, meningioma

Intracranial Growth of Plasmacytomas and Multiple Myeloma: A Pictorial Essay

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**PURPOSE**

Intracranial involvement of plasmacytomas and multiple myeloma generally results from extramedullary tumor masses arising from bone lesions in cranial vault, skull base, nose, or paranasal sinuses. Primary dural and leptomeningeal involvement are rare. The purpose of this pictorial essay is to increase awareness of clinical presentation and neuroradiologic findings at both diagnosis and follow up of plasmacytomas and multiple myeloma with intracranial growth.

**APPROACH/METHODS**

This pictorial essay reviews clinical and neuroradiologic features in 11 patients (7 women, 4 men; age range at diagnosis: 41-82 years), with plasmacytoma (n = 2), and multiple myeloma (n = 9). Neuroradiology included CT, MR imaging, DWI with ADC maps, MR spectroscopy, MR perfusion, and DSA. Clinical presentation included headache associat-
**Electronic Scientific Exhibit 37**

**“Cyst-with-Mural-Nodule” Tumors of the CNS: A Pictorial Review**

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**PURPOSE**

1. The purpose of this study was to attempt to increase the diagnostic accuracy when dealing with intra-axial neoplastic processes of the central nervous system when they appear as cystic lesions with mural nodules. 2. To highlight the radiologic-pathologic correlation to aid in the diagnosis of these lesions.

**APPROACH/METHODS**

Relevant cases were obtained by taking advantage of the Department of Radiology’s data warehouse which contains every diagnostic report produced by department radiologists since 1995. Using search tools developed in the division, cases were retrieved using multiple search term strategies. We found 125 patients with a “cyst-with-mural-nodule” tumor that had proved pathologic diagnosis. Pathologic processes included: 1. Pilocytic astrocytoma; 2. Hemangioblastoma; 3. Ganglioglioma; 4. Pleomorphic xanthoastrocytoma; 5. Intraparenchymal schwannoma; 6. Desmoplastic infantile ganglioglioma; and 7. Cystic metastasis.

**FINDINGS/DISCUSSION**

Precise diagnosis is essential to enable the surgeon to plan the best treatment possible. Although “cyst-with-mural-nodule” appearance in CNS tumors usually is associated with a well defined differential diagnosis, no well established features are described in order to differentiate the various histotypes. We present a thorough illustrated review of various typical and atypical appearances with different features, namely supra vs infratentorial location, cortical vs deep location, thickness of the cyst capsule, enhancement of the cyst capsule, nodule/cyst volume ratio, homogeneity of the nodule intensity, intensity of the cyst compared to CSF and compared them to pathologic findings.

**SUMMARY/CONCLUSION**

This study provides a comprehensive teaching module for the diagnostic evaluation of various “cyst-with-mural-nodule” CNS tumors.

**KEY WORDS:** CNS tumor, cyst, nodule

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**Electronic Scientific Exhibit 38**

**Many Faces of Central Nervous System Lymphoma**

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**PURPOSE**

The clinical and imaging manifestations of many central nervous system (CNS) diseases may be indistinguishable. Primary CNS lymphomas (PCNSL) share radiologic, clinical, and laboratory similarities with many other diseases of the CNS. It is very important to be familiar with the protean imaging findings of lymphoma because unlike glial tumors, chemotherapy with or without radiation therapy rather than surgery is the mainstay of the lymphoma treatment. The purpose of this exhibit is to familiarize the viewer with the different imaging appearances of CNS lymphoma.

**APPROACH/METHODS**

We retrospectively reviewed all of the CNS lymphoma cases in our institution from 2004-2008.

**FINDINGS/DISCUSSION**

A typical lymphoma in an immunocompetent patient is located in deep white matter, appears hyperdense on non-contrast CT scan due to high nuclear to cytoplasmic ratio, and demonstrates moderate to intense enhancement on contrast-enhanced CT scan. On MR imaging, a typical lymphoma appears iso to hypointense to gray matter on T1-weighted images and typically hypo to isointense (to gray matter) on T2-weighted images. Another characteristic MR feature is diffusion restriction on DWI. Usually lymphoma is associated with low relative cerebral blood volume on MR perfusion imaging. However, PCNSL often has atypical imaging appearances on both CT and MR imaging, making it difficult to correctly diagnose. Central nervous system lymphoma in immunosuppressed patients has atypical imaging features and mimics other AIDS-associated pathologies. Extraaxial lymphomas also have different imaging appearances. The best diagnostic approach may include considerations of lesion location and patient immune status. We will organize our exhibit according to the schema described below. Under each subtype, we will demonstrate different imaging appearances. Immunocompetent: Intraaxial: Parenchymal mass, Along white matter tracts (Axonopetal tumor), Lymphomatosis cerebri, Ependymal/subependymal, Spinal cord. Extraaxial: Dural, Cranial nerves, Cavernous sinus, Orbital. Immunosuppressed: Cystic with heterogenous enhancement, Solid mass with enhancement, Nonenhancing.

**SUMMARY/CONCLUSION**

This exhibit demonstrates the many imaging appearances of CNS lymphoma and suggests a diagnostic imaging approach that incorporates lesion location and patient immune status.

**KEY WORDS:** CNS, lymphoma, MR imaging
Time-Resolved Contrast-Enhanced MR Angiography of the Brain Using CAPR

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PURPOSE
To report on our initial clinical experience with a 3D high temporal and high spatial resolution contrast-enhanced intracranial MR angiography (MRA) technique, using cartesian acquisition with projection-reconstruction-like sampling (CAPR).

APPROACH/METHODS
CAPR MRA (1) synergistically uses a combination of 2D SENSE acceleration, partial Fourier acquisition, and view sharing to allow acquisition of 3D whole head MRA with 1-2 mm near isotropic resolution. Typical CAPR acquisition parameters were matrix size 256 x 160, 88 sections, FOV 25 cm, bandwidth +/- 62.5 KHz, TR/TE 4.1/1.9 msec, temporal update 2.3 sec, temporal footprint 6.9 sec. Studies were obtained using a commercially available 8-channel head coil. No timing bolus was required. The sequence was applied continuously for 90 seconds, providing 35 or more individual 3D time frames. The MRA is initiated prior to an appropriate hand or power-injected intravenous bolus of gadobenate dimeglumine, followed by an intravenous saline injection. Reconstruction is performed off line, but entirely automated. All images are available for clinical review within 2 minutes of scan completion. CAPR MRA was evaluated in 20 patients undergoing routine clinical imaging for which MRA was clinically indicated, at both 1.5 T and 3 T. The studies were obtained between the dates of 6/10/2008 and 12/9/2009. Fifteen of the cases were obtained at 3 T, and five were obtained at 1.5 T.

FINDINGS/DISCUSSION
Patient ages ranged from 3 days old to 86 years of age, with three patients under the age of 5 years. Study indications and diagnoses included cerebral infarction, hypoxic ischemic encephalopathy (HIE), primary CNS neoplasm (grade 4 GBM, anaplastic astrocytoma, subependymal giant cell astrocytoma), giant cell temporal arteritis, vascular malformations (AVM, orbital venolymphatic malformation, Osler-Weber-Rendu syndrome, Cavernoma, dural AVF), moyamoya disease, intracranial hemorrhage, headache, and aneurysm. The high temporal fidelity of CAPR MRA is sufficient to resolve intracranial arteriovenous-transit of blood. Important clinical information was obtained in 15 of the 20 cases, and patient management was altered directly in five cases. One exam was nondiagnostic because of patient motion. All remaining CAPR acquisitions were successful, without technical failure in acquisition or reconstruction.

SUMMARY/CONCLUSION
CAPR time-resolved MRA is feasible in a clinical setting using commercially available hardware. CAPR MRA is helpful for evaluation of flow-dependent vascular pathology.
stroke. Appropriate choice of sharpening parameters including kernel size, threshold, and amount can lead to increased visual interest in photographs and may highlight pathology in neuroimaging. Finally, HDR processing offers photographers the ability to expand displayed dynamic range at the expense of an "unnatural" look, and our novel proposed technique offers the same ability to radiologists in simultaneous depiction of bone and soft tissue pathology.

**SUMMARY/CONCLUSION**

We present several parallels between photography and computed tomography imaging of the brain. Appreciation of these similarities may lead to improvements in our "postprocessing" technique both at the photographic workstation and in the reading room, with the benefits reaped by viewers and patients alike.

**KEY WORDS:** HDR, lightroom, photoshop

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**Electronic Scientific Exhibit 41**

**Neuroradiology Applications of Volume-Rendered Images**

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**PURPOSE**

The aim of this exhibit is to evaluate the applications of volume-rendering (VR) techniques for neuroradiology.

**APPROACH/METHODS**

Brain images were acquired with a Phillips Achieva ® 1.5 T resonator, by different volume sequences, including: T1W 3D TFE, T1W 3D FFE, T2W Vista, T1W IR ISO and WAVE. The data were postprocessed with Vitrea ® Software, allowing for 3D evaluation of brain surface and certain brain volumes, such as the hippocampus, inner ear reconstructions and tumors. Regarding the latter, images obtained at the time of the diagnosis were compared to control images after treatment.

**FINDINGS/DISCUSSION**

The best images for analyzing brain surface are achieved with T1W 3D FFE sequence, which portrays with excellent anatomical detail every cerebral sulci and gyri. An additional advantage of this level of detail is as an aid for the surgical strategy, as it can be used as a guide for craniotomies. In order to calculate the volume of both hippocampi the best technique is a T1W IR ISO sequence, which provides a good definition of them in little time in a semiautomatic fashion. This has proved useful for the study of Alzheimer disease and mesial temporal sclerosis. For inner ear reconstructions the best results are obtained with T2W Vista, these reconstructions are frankly superior to those acquired with MIP. Finally, the possibility of tumor reconstruction and tumor volume calculation depends on the precision of its demarcation. This is most favorably achieved with WAVE sequence, specially in contrast-enhanced growths. The high precision level achieved permits comparison between pre and post-treatment images, thus enabling the evaluation of treatment response.

**SUMMARY/CONCLUSION**

Volume-rendered imaging techniques, generated by high-resolution 3D MR, are a powerful tool with multiple applications for neuroradiology.

**KEY WORDS:** Volume-rendering, cancer

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**Electronic Scientific Exhibit 42**

**Differential Diagnosis of Bright Lesions on Diffusion-Weighted Brain MR Imaging**

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**PURPOSE**

1. To define the principles and technical basis of diffusion-weighted imaging (DWI) of the brain and provide a comprehensive differential of lesions appearing bright on DWI. 2. To discuss the role of DWI in evaluation of select brain disorders including ischemic changes, inflammatory, infective and neoplastic lesions.

**APPROACH/METHODS**

Diffusion-weighted MR imaging can be performed during a standard cranial MR examination, and can add useful clinical information in several brain disorders besides acute ischemic stroke. Diffusion-weighted imaging enables a better characterization of the lesions demonstrated by conventional MR imaging, for instance in hypoxic encephalopathy, in infections and in the inherited metabolic diseases. Diffusion-weighted imaging has established role in the differential diagnosis between brain abscess and cystic tumors. Diffusion is one of the most relevant MR techniques to have contributed to a better understanding of the pathophysiologic mechanisms of multiple sclerosis. We present a systematic review of bright lesions on DWI and their differential diagnosis, with emphasis on the practical and clinical approaches of differential diagnosis.

**FINDINGS/DISCUSSION**

Diffusion-weighted images have shown high sensitivity and specificity in the diagnosis of acute cerebral infarction. However, high signal intensity on DWI are seen in diverse conditions as hemorrhage, abscess, neoplastic masses, cystic lesions, encephalitis and demyelination. Diffusion-weighted imaging is complementary to conventional MR imaging in the evaluation of these conditions. Establishing the differential diagnosis of intracerebral necrotic tumors and cerebral abscesses frequently is impossible with conventional MR imaging. Diffusion-weighted imaging and apparent diffusion coefficient (ADC) maps are useful in the differential diagnosis of ring-enhancing cerebral masses. High-signal intensity on DWI and low ADC values may favor the diagnosis of lymphoma versus glioma or metastasis. Diffusion-weighted imaging is a valuable diagnostic test in the differentiation of malignant and benign meningiomas. Encephalitis, demyeli-
nation, solid metastasis (Figure), toxic/metabolic disorders and pregnancy-induced brain changes can show bright signal on DWI.

SUMMARY/CONCLUSION
Diffusion-weighted imaging has a very high sensitivity in diagnosis of acute cerebral infarctions. However, high signal intensity on DWI is seen in diverse conditions as hemorrhage, infections, abscess, neoplasms and demyelination. We provide a comprehensive differential of bright lesions on DWI.

KEY WORDS: Diffusion-weighted, differential, bright

Electronic Scientific Exhibit 43
Neuroimaging of Ophthalmoplegia

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PURPOSE
To outline the different categories of diseases encountered in patients with ophthalmoplegia, based on their location along the oculomotor pathways, and the most appropriate imaging for the given scenarios. To cover basic anatomical and clinical concepts about ophthalmoplegia, to help understand pathophysiology of ophthalmoplegia, and to provide the neuroradiologist with the necessary knowledge to discuss clinical cases with the referring clinician.

APPROACH/METHODS
Representative neuroimaging examples of pathologic processes causing ophthalmoplegia are displayed, sequenced by anatomical location and disease category. Correlation between clinical presentation and site of pathology, with imaging protocol recommendations also are presented.

FINDINGS/DISCUSSION
In general, diseases affecting ocular movement can be divided into categories including: injuries or diseases of the cerebral hemispheres, midbrain, pons, and cerebellum, ocular motor nerve palsies, intrinsic extraocular muscle diseases, and orbital diseases secondarily affecting the extraocular muscles. The cranial nerves responsible for ocular movements can be affected intrinsically or extrinsically along their nuclei, their course in the brain stem, in the cisterns, skull base, cavernous sinuses and orbits; the extraocular muscles can be affected primarily or secondarily by adjacent pathologic processes in the orbits. Clinical information should help narrow the differential diagnosis in terms of anatomical site of involvement and prompt the most appropriate neuroimaging techniques.

SUMMARY/CONCLUSION
Ophthalmoplegia can have numerous etiologies and varying clinical presentations according to each. Most causes of ophthalmoplegia can be narrowed to specific anatomical locations based on clinical presentation. By understanding the pathophysiology of ophthalmoplegia, the radiologist can discuss clinical cases with the referring clinician and determine a timely, accurate method of imaging, achieving the most precise differential diagnosis.

REFERENCES

KEY WORDS: Ophthalmoplegia, oculomotor, neuroimaging

Electronic Scientific Exhibit 44
Apparent Diffusion Coefficient Map Optimization for Detecting Subtle Gray Matter Damage from Hypoxic-Ischemic Encephalopathy

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PURPOSE
The cerebral cortex is considered to be the most vulnerable area to hypoxic-ischemic encephalopathy (HIE). However, the cortex damage due to HIE may not be readily apparent or may even appear deceptively normal by conventional MR and diffusion-weighted imaging (DWI). This is due to relatively subtle and symmetric changes early on in HIE even when extensive infarction has occurred. Apparent diffusion coefficient (ADC) mapping is crucial for DWI analysis and a methodological approach should help avoid errors of analysis. At our institution we have noted subtle MR cases of HIE with significant underlying damage that have initially been difficult to diagnose. The purpose of this study is to optimize a methodology for ADC map display for objectively assessing subtle cortical abnormalities in HIE.

APPROACH/METHODS
Among 30 patients with HIE, seven who showed no obvious cortical abnormality on MR imaging and diffusion-weighted imaging were included in this retrospective study. Six of the seven patients died from HIE and the remaining patient was severely impaired. Seven healthy subjects matched for age, sex and imaging protocols were used as normal controls. On ADC color maps, various ADCs were analyzed as threshold values. We utilized a rainbow color ramp. The cerebrum with an ADC lower than the lower color ramp threshold value
PURPOSE

The purpose of this exhibit is to familiarize junior residents taking call for the first time with brain emergencies requiring immediate intervention or resulting in alteration of patient management. After reviewing this exhibit, readers should be familiar with the imaging spectrum of significant brain abnormalities that may be encountered on-call. This exhibit also serves as a refresher for senior residents and other radiologists who interpret imaging of the brain.

APPROACH/METHODS

This exhibit is a case-based approach with clinical-pathologic correlation of common brain entities encountered on-call. Cases will be presented as unknowns, followed by a discussion of the entity and discussion of important differential considerations.

FINDINGS/DISCUSSION

A variety of important brain emergencies may be encountered on-call by the junior resident. Etiologies include: 1. Traumatic hemorrhage - hemorrhagic contusions, epidural, subdural, and subarachnoid hemorrhage; 2. Vascular abnormalities - ruptured and unruptured cerebral aneurysms, stroke/arterial occlusion, dural venous sinus thrombosis; 3. Infection - brain abscess, meningitis, epidural empyema, herpes encephalitis; and 4. Miscellaneous - hydrocephalus, herniation, anoxic brain injury.

SUMMARY/CONCLUSION

In an era of increased utilization of radiologic imaging in the assessment of emergency room patients, it is becoming increasingly important for the junior resident to recognize clinically significant brain disease processes. Many of these entities have characteristic imaging patterns. Educating junior residents on these imaging patterns will ultimately lead them to formulate accurate diagnoses and therefore optimize patient management. Studies have shown overnight misinterpretations by junior residents can result in a delay in diagnosis, adverse patient outcomes, increased patient morbidity and increased healthcare costs. Additionally, management decisions in the emergency room often are based on preliminary interpretations, further emphasizing the need for accurate interpretations by junior residents.

KEY WORDS: Emergency, brain, imaging

Electronic Scientific Exhibit 45

Neuroradiology On-Call: What the Junior Resident Needs to Know about Emergent Brain Imaging

Sheth, S. · Destian, S. · Krauthammer, A.

St. Vincent’s Hospital Manhattan

New York, NY

PURPOSE

In an era of increased utilization of radiologic imaging in the assessment of emergency room patients, it is becoming increasingly important for the junior resident to recognize clinically significant brain disease processes. Many of these entities have characteristic imaging patterns. Educating junior residents on these imaging patterns will ultimately lead them to formulate accurate diagnoses and therefore optimize patient management. Studies have shown overnight misinterpretations by junior residents can result in a delay in diagnosis, adverse patient outcomes, increased patient morbidity and increased healthcare costs. Additionally, management decisions in the emergency room often are based on preliminary interpretations, further emphasizing the need for accurate interpretations by junior residents.

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SUMMARY/CONCLUSION

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KEY WORDS: Emergency, brain, imaging

Electronic Scientific Exhibit 46

Imaging of the Clival and Paraclival Region: What the Neuroradiologist Needs to Know

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Henry Ford Health Systems

Detroit, MI

PURPOSE

Clivus means “downward sloping surface” and is located deep at the anatomical center of the skull base. It can be involved in a wide spectrum of diseases such as primary neoplasms, metastatic tumors, inflammatory, vascular, and hematopoietic disorders. The purpose of our exhibit is to review the imaging anatomy/variants, embryology and to illustrate the different pathologies affecting the clivus and paraclival region.

APPROACH/METHODS

MR imaging and CT show the region of the clivus and paraclival region and help characterize diseases that affect this area. Multiplanar capability of MR imaging provides good visualization of adjacent nerve roots and vascular structures aiding in surgical planning and radiation therapy. High quality MR and CT images will illustrate the anatomy, variants and pathologic spectrum.

FINDINGS/DISCUSSION

Normal imaging anatomy of the clivus will be reviewed with detailed embryology, bony and sutural anatomy. High-resolution CT demonstrates bony detail whereas MR provides superior soft tissue resolution and characterization along with multiplanar capability. Teaching cases showing various pathologies affecting the clivus will be illustrated. In addition benign conditions such as echordosis physaliphorus...
and rare foramina and prominences in the clival and paraclival region such as fossa navicularis, canalis basalis medians, condylus tertius will be described with their contents and embryology where relevant.

**SUMMARY/CONCLUSION**

After viewing this exhibit, the radiologist should have a better understanding of the imaging anatomy and embryology of the clivus and paraclival region. Pathology and embryology will be illustrated by incorporating teaching cases wherever relevant.

**KEY WORDS:** Clivus, anatomy, embryology

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**Electronic Scientific Exhibit 47**

**Cerebrospinal Spinal Fluid Flow Phase-Contrast MR Imaging: Principals, Protocols and Practice**

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Bloomington, IL

**PURPOSE**

Describe clinical indications and interpretation of cerebrospinal spinal fluid (CSF) flow phase-contrast MR imaging (MRI) through a series of case presentations.

**APPROACH/METHODS**

Cerebrospinal spinal fluid hydrodynamic physiology, principles of phase contrast, techniques of CSF flow measurement and CSF flow study MR protocols are discussed. Cerebrospinal spinal fluid oscillatory flow occurs during cardiac systole and diastole. Moving signal producing tissue such as CSF results in incorrect phase encoding by MR imaging. Phase-contrast CSF velocity imaging is acquired with two sequences, one with and the other without flow compensation. Signal location comparison between the two allows determination of amount of motion. The phase-contrast sequence is designed so that the different flow velocity displays a maximum of 360 degrees phase shift, referred to as the VENC (Velocity encoding). Images are displaced in a repetitive loop to simulate cine motion in temporal relation to one cardiac cycle. This allows for analysis of CSF flow in temporal relation to a cardiac cycle, CSF peak flow velocity and CSF flow volume. Strategic placement regions-of-interest (ROI) allows for construction of CSF velocity waveforms correlated to the cardiac cycle using vendor postprocessing software.

**FINDINGS/DISCUSSION**

These assessments are discussed in the context of Chiari type 1 malformation, syringohydromyelia, normal pressure hydrocephalus (NPH) and third ventriculostomy treatment.

**SUMMARY/CONCLUSION**

Phase-contrast cine CSF flow imaging augments routine MR imaging in the evaluation of Chiari type 1 malformation, syringohydromyelia, normal pressure hydrocephalus (NPH) and third ventriculostomy treatment.

**KEY WORDS:** CSF flow, phase-contrast MR imaging, Chiari malformation

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**Electronic Scientific Exhibit 48**

**Looking beyond the Surface: A Radiologic Approach to the Cerebral Cortex**

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Nassau University Medical Center
East Meadow, NY

**PURPOSE**

To review the diverse spectrum of entities which involve the cerebral cortex utilizing an algorithmic approach. We illustrate potential pitfalls and mimics, emphasizing distinguishing differential features.

**APPROACH/METHODS**

We retrospectively reviewed the clinical and imaging findings (CT/CTA, MR/MRA, MR spectroscopy and nuclear medicine) of the wide diversity of cases from our institution obtained during the past 5 years which involve the cerebral cortex. We categorized entities according to cortical thickness (thick, thin or normal), with further subdivisions according to floccality (diffuse versus focal), sulcal size and etiology. Patterns of enhancement, vascularity, calcification and morphology are highlighted. In addition, we demonstrate masqueraders with confounding radiologic appearances, as well as several vascular and developmental entities with unique cortical associations.

**FINDINGS/DISCUSSION**

A *diffusely thickened* cortex is a primary feature of both lissencephaly and pachygyria. The radiologist should be familiar with the appearance of a premature newborn’s brain, which might bear a superficial resemblance. In the ischemic category, diffuse cortical swelling occurs with global anoxic injury. A combination of both cortical and basal ganglia involvement may be seen in Creutzfeld-Jakob disease (CJD). *Focally thickened* cortex may be seen in a wide diversity of conditions. Congenital etiologies include focal cortical dysplasia (FCD) and polymicrogyria. Hemimegalencephaly, generalized hypertrophy of an entire hemisphere, has both white matter and cortical gray enlarge-ment. Encephalitis, with or without associated meningeal involvement, can be viral (e.g., herpes), bacterial or granulomatous. Focal swelling of the cerebral cortex also can occur with cerebral infarction, as well as hypoglycemia and status epilepticus. Infiltrating neoplasms, such as gliomatosis cerebri, typically involve the hemispheric white matter, but also may produce cortical expansion. Focal cortical thickening can be mimicked by the appearance of an isodense subdural hematoma. In regards to the thin cortex, chronic entities are the usual culprits. Anoxic changes may result in cystic encephalomalacia, with a ribbon-like cortex. Territorial infarction may be associated with the calcifications of cortical laminar necrosis. Degenerative conditions may target specific cortical regions and include Alzheimer, Pick’s, Huntington’s and ALS. An assortment of pathologies have unique associations with the cerebral cortex. Developmental processes related to neuronal migration include heterotopias, which may be focal or diffuse, nodular or band-like (“double cortex”), as well as schizencephaly (open and closed lip). Vascular conditions include Sturge-Weber (pial angiomato-sis and cortical tram-track calcifications), AVMs and superficial siderosis.
SUMMARY/CONCLUSION
The range of conditions which involve the cerebral cortex is vast and can be confusing. A systematic approach, with focus on whether the cortex is thick or thin, together with keen inspection for associated findings can help narrow and establish the correct diagnosis.

KEY WORDS: Cerebral cortex

Electronic Scientific Exhibit 49
Posterior Reversible Encephalopathy Syndrome: Atypical and Unusual Imaging Manifestations

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1University of North Carolina School of Medicine, Chapel Hill, NC; 2King Chulalongkorn Memorial Hospital, Bangkok, THAILAND; 3Centro Hospitalar de Lisboa Central, EPE, Lisbon, PORTUGAL

PURPOSE
Although the term posterior reversible encephalopathy syndrome (PRES) was popularized because of the typical presence of symmetric vasogenic edema in the parietal and occipital lobes, other regions of the brain also are affected frequently. The purpose of this presentation is review the least common MR presentations of PRES, their differential diagnosis, and the best imaging approach.

APPROACH/METHODS
Posterior reversible encephalopathy syndrome is a distinct clinic-radiologic entity clinically characterized by a reversible neurologic syndrome, manifested by headaches, confusion, seizures, visual disturbances or a combination of these symptoms. We review the atypical imaging findings of PRES, and their differential diagnosis.

FINDINGS/DISCUSSION
The typical imaging findings of PRES are symmetric vasogenic edema in the parieto-occipital and posterior frontal cortical and subcortical white matter and less commonly in the brainstem, basal ganglia and cerebellum in combination or isolated. Atypical imaging appearances include contrast enhancement, hemorrhage, restricted diffusion and perfusion alterations on MR imaging. Unilateral involvement and minimal or no detectable parieto-occipital edema are also unusual manifestations of PRES. All of these will be reviewed in this exhibit.

SUMMARY/CONCLUSION
Neuroradiologists should be aware that atypical imaging manifestations of PRES are more common than commonly perceived. Recognition of atypical variants of PRES can be helpful to manage these patients and avoid complications in a timely manner.

KEY WORDS: Posterior reversible encephalopathy syndrome, atypical manifestations

Electronic Scientific Exhibit 50
Untangling the Wires: A Radiologic Strategy to Deciphering the Cranial Nerves

Rehmani, R. · Lev, S.
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East Meadow, NY

PURPOSE
To present a simplified location-based approach to the interpretation of CT and MR imaging of patients with cranial nerve palsies. We review the broad spectrum of pathologic entities and discuss clinical-anatomic correlates. Emphasis is given to those subtle and unusual lesions which might be underappreciated without the benefit of a structured survey.

APPROACH/METHODS
We retrospectively reviewed the CT and MR findings of patients with cranial nerve symptoms who presented at our ED or outpatient clinics during the past 5 years. We correlated the clinical and imaging features, organizing entities according to both etiology and location. The complementary roles of CT and MR are discussed, as is the value of configuring a patient-specific protocol. We diagrammatically illustrate the pertinent anatomy from brainstem to periphery for each nerve, and highlight a systematic radiologic approach.

FINDINGS/DISCUSSION
The tortuous and complicated pathways of the cranial nerves are a rather unfortunate consequence of our protracted evolutionary development. The radiologist can make the arduous task of searching for abnormalities considerably more manageable, however, by following a location-based approach, with careful inspection of the individual anatomical segments of each cranial nerve and its innervations. Commonalities in the radiologic assessment of any cranial nerve, however unique, include a thorough evaluation of the brainstem (cranial nerve nuclei), cisterns, skull base and extracranial regions. CT is the ideal modality for elucidation of specific bony pathologies, such as those referable to skull base foraminae. MR imaging, however, can more specifically highlight the affected nerve itself and its multiple segments. Brainstem pathologies include a diversity of acute and chronic conditions such as multiple sclerosis, infarction, astrocytoma, rhomboencephalitis and DAI. Less often, metastases and vascular malformations may occur. Inspection of the cisternal spaces warrants careful assessment of vascular structures (e.g., aneurysms, AVMs and vertebrobasilar dolichoectasia) which may impinge on exiting nerve roots. Neoplasms include schwannomas, meningiomas and epidermoids. Inflammatory/infectious processes such as meningitis (bacterial, viral or granulomatous) and Lyme disease may produce multiple cranial neuropathies. Sellar/parasellar (cavernous sinus and Meckel’s cave) pathologies commonly include metastases and regional primary neoplasms (aggressive macroadenoma and nasopharyngeal carcinoma). Other relevant anatomical structures include the petrous apex (Dorello’s canal), pterygopalatine fossa, jugular foramen and hypoglossal canal. Careful review of specific foraminae and fissures may reveal perineural tumor spread. Diffuse processes of the skull base such as fibrous dysplasia and Paget’s may produce an assortment of cranial nerve palsies. Finally, extracranial assess-
Electronic Scientific Exhibit 51
Diagnosis of Pituitary Apoplexy: Misconceptions and Pitfalls
Shah, R. · Riley, K. · Bag, A. · Cure, J. K.
University of Alabama at Birmingham
Birmingham, AL

PURPOSE
The purpose of this educational exhibit is to demonstrate the imaging spectrum of clinical pituitary apoplexy and entities that can mimic apoplexy on imaging.

APPROACH/METHODS
A case-based approach is utilized to emphasize the teaching points listed below.

FINDINGS/DISCUSSION
Pituitary apoplexy may have a variable clinical presentation but should be suspected in any patient with severe headache, visual deficits, ophthalmoplegia, or altered mental status. Apoplexy commonly complicates a preexisting pituitary adenoma. MR imaging can be useful to demonstrate pituitary hemorrhage, but hemorrhage is not an essential element, because clinical apoplexy may occur in the setting of bland pituitary infarction. Furthermore, not all cases of pituitary hemorrhage are accompanied by clinical apoplexy. Presence of peripheral contrast enhancement of an intrasellar mass on MR images (ring sign) has been described as diagnostic of pituitary apoplexy. However in our experience this appearance is not specific and can be seen with cystic pituitary adenoma, craniopharyngioma, Rathke’s cleft cyst, pituitary abscess, lymphocytic hypophysitis and sarcoidosis.

SUMMARY/CONCLUSION
Major teaching points of this exhibit are: 1. Presence of hemorrhage is not essential for diagnosis of pituitary apoplexy as bland infarction can also present with clinical apoplexy. 2. Presence of hemorrhage within a pituitary adenoma does not always result in clinical apoplexy. 3. T1 hyperintensity and ring sign which are used for MR diagnosis of apoplexy can be mimicked by other entities. Imaging and clinical clues for differentiating these entities from pituitary apoplexy are discussed.

KEY WORDS: Apoplexy, pituitary, Rathke’s cleft cyst

Electronic Scientific Exhibit 52
Corpus Callosum, MR Imaging Anatomy and Pathology Montage
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Rochester, NY

PURPOSE
Wide range of diseases can affect the corpus callosum. A systemic approach as well as knowledge of various pathologies affecting the corpus callosum is needed for proper radiologic evaluation. This electronic exhibit aims to explain the radiologic anatomy and to describe different diseases involving the corpus callosum using MR imaging, both the conventional and the advanced modalities.

APPROACH/METHODS
We have reviewed cases at our institution regarding the different conditions affecting the corpus callosum, focusing on the MR findings, which include the advanced imaging modalities available nowadays in most imaging centers.

FINDINGS/DISCUSSION
A. Understand the MR imaging anatomy of the corpus callosum; B. Present various conditions and diseases affecting the corpus callosum; C. Review the key MR imaging findings and the differentiating points for these cases; and D. Highlighting some of the MR advanced imaging modalities such as diffusion-weighted and tensor imaging.

SUMMARY/CONCLUSION
This electronic exhibit will provide a wide range of disease entities involving the corpus callosum and review their MR diagnostic features, both the conventional as well as the advanced modalities such as diffusion-weighted and tensor imaging.

KEY WORDS: Corpus callosum, MR imaging

Electronic Scientific Exhibit 53
Postoperative Appearance of Decompressive Craniectomy and Cranioplasty: What the Neurosurgeon Needs to Know
Surratt, J. K. · Bonfant-Mejia, E. E. · Supsupin, E. P. · Esquenazi, Y. · Riascos, R. F. · Useche, N.
1University of Texas Medical School at Houston, Houston, TX, 2University of Texas Medical Branch, Galveston, TX, 3Indiana University School of Medicine, Indianapolis, IN

PURPOSE
To illustrate the imaging findings after uneventful and complicated decompressive craniectomy and cranioplasty procedures.

APPROACH/METHODS
Cases of severe intracranial hypertension treated with decompressive craniectomy and subsequent cranioplasty were compiled and reviewed by both the neuroradiology and neurosurgical services. Representative cases were selected to
depict both the expected postoperative appearance and examples of described complications of these two neurosurgical procedures.

**FINDINGS/DISCUSSION**
Decompressive craniectomy is widely used in the treatment of severe intracranial hypertension, most commonly in the setting of trauma or cerebral infarction. Almost all patients surviving a decompressive craniectomy will require cranioplasty. Significant complications have been described with both procedures, which leaves the exact role of decompressive craniectomy yet to be defined in this clinical setting. These potential complications are many. Presented examples following craniectomy include epidural hematomas, subdural hematomas, subdural hygromas, external cerebral herniation, and sunken flap. Adverse outcomes following subsequent cranioplasty include infection, bone resorption, wound dehiscence, sunken bone flap, and hematoma, some of which may require additional surgical intervention.

**SUMMARY/CONCLUSION**
To interpret the imaging studies of patients after decompressive craniectomy and cranioplasty, the radiologist must be familiar with their expected appearance and complications, allowing for early recognition and treatment.

**KEY WORDS:** Craniectomy, cranioplasty, complication

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**Electronic Scientific Exhibit 54**

**Symmetric Bilateral Basal Ganglia Abnormalities on MR Imaging: A Pictorial Essay**

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¹College of Medicine, Myongji Hospital, Kwandong University of Korea, Koyang-City, KOREA, REPUBLIC OF; ²College of Medicine, The Catholic University of Korea, Seoul, KOREA, REPUBLIC OF

**PURPOSE**
The purpose of this study is to classify and review the main categories of diseases causing symmetric bilateral basal ganglia abnormalities and to identify usefulness of diffusion-weighted imaging (DWI) in differentiating a wide variety of diseases causing symmetric bilateral ganglia lesions.

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**Electronic Scientific Exhibit 55**

**Multimodality Imaging of Intraparenchymal Hemorrhagic Stroke: A Teaching File Approach**

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**PURPOSE**
The purpose of this exhibit is to review the imaging findings in patients with intraparenchymal hemorrhagic stroke using multiple case examples with a variety of imaging techniques in an interactive format.

**APPROACH/METHODS**
Using a case-based, interactive, teaching file approach, the imaging findings of hemorrhagic stroke from a variety of causes will be reviewed. This will include, where appropriate, a discussion of the pathophysiology, clinical findings and imaging techniques.

**FINDINGS/DISCUSSION**
This exhibit will cover the following aspects of intraparenchymal hemorrhagic stroke imaging: 1. CT and MR findings of hemorrhagic stroke from a variety of causes, including hypertension, amyloid angiopathy, vascular mal-
forms, coagulopathy, vasculopathy and tumor; 3. The use and interpretation of CTA, MRA and conventional angiography in the setting of hemorrhagic stroke; 3. Helpful imaging and clinical hints that may help differentiate among the various causes of intraparenchymal hemorrhage; and 4. An overview of the appearance of intraparenchymal hemorrhage on noncontrast CT and MR imaging.

SUMMARY/CONCLUSION
This computer-based exhibit provides an ideal means for the review of a variety of causes of intraparenchymal hemorrhagic stroke using an interactive format that will allow active participation of the learner. The viewer of this exhibit will be provided with an interactive overview of imaging in patients presenting with intraparenchymal hemorrhagic stroke.

KEY WORDS: Brain, hemorrhage, intraparenchymal

Electronic Scientific Exhibit 56


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PURPOSE
To emphasize the importance of CT dose monitoring and to acquire facility with the relevant technical terminology. We intend to familiarize neuroradiologists, medical physicists and radiation technologists with ways of minimizing radiation dose while maintaining necessary diagnostic image quality. In addition, to give the dose numbers more meaning, we have developed schematic charts comparing doses from CT to those from radiographs and common natural sources of radiation.

APPROACH/METHODS
We review the definitions of the dose indices that are displayed routinely on a CT monitor, including CT dose length product (DLP) and CT dose index (DI), and we also emphasize the importance of knowing the effective patient dose. In addition, we evaluate various strategies intended to minimize radiation dosages, including adjustment of technical parameters (e.g., kVp, mA and time per rotation) and individualizing head CT protocols. In order to better facilitate appreciation of CT radiation dose magnitudes among both patients and staff, we have prepared schematics simultaneously comparing radiation doses from medical diagnostic tests with known cosmic and terrestrial radiation sources.

FINDINGS/DISCUSSION
During the past 20 years, the cumulative radiation dose a patient may receive for diagnostic testing has increased significantly, primarily secondary to CT examinations. The pediatric population is at 10 times greater risk than the adult to develop future radiation-related illnesses, including skin and eye diseases and all varieties of cancers. It therefore behooves the radiologist and technical staff to lower dose levels as much as possible for each patient while maintaining necessary image quality. Specific indications in which a lower mA technique (of otherwise high-dose studies) can be used include serial head CT evaluations and routine inspection for paranasal sinus disease, for example. The neuroradiologist might consider alternatives to head CT, such as MR imaging, for conditions in which the pretest probability is low. A protocol team, consisting of the radiologist, medical physicist and CT technologist, should be established and meet on a regular basis to review image quality and design all protocols with the ultimate goal of minimizing radiation dose.

SUMMARY/CONCLUSION
Effective diagnosis need not be compromised by efforts to reduce patients’ exposure to radiation. Medical imaging providers should be familiar with the acronym ALARA (“as low as reasonably achievable”), a collective approach to managing radiation levels while maintaining the necessary diagnostic image quality to make a confident diagnosis. Patients have the right to understand CT radiation dose magnitude while realizing that a medically needed CT scan has potential benefits that may outweigh the radiation risks.

KEY WORDS: Radiation dose, ALARA

Electronic Scientific Exhibit 57

Brain Herniations: Imaging Findings, Clinical Signs and Complications

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PURPOSE
1. To discuss the causes and types of cerebral herniations and elaborate the imaging signs on CT/MR imaging. 2. To show the relationship between imaging findings and clinical signs and to further discuss the various complications of brain herniations.

APPROACH/METHODS
Many of the pathologic processes that increase intracerebral mass may eventually cause brain herniation. It is important to recognize brain herniation, as it can often produce the presenting clinical signs and symptoms and is often the cause of serious neurologic sequelae or death. The key to recognizing all herniations of the brain is evaluation of the cisterns. We will discuss the imaging findings, clinical characteristics and possible complications involved in the four main types of brain herniations.

FINDINGS/DISCUSSION
Brain herniations represent shift of the normal brain through or across regions to another site due to mass effect. These are generally complications of mass effect whether from tumor, trauma, or infection. When the intracranial pressure increases enough it will cause particular regions of the brain to herniate into adjacent compartments, resulting in mechanical trauma to the brain tissue and secondary vascular compromise. With the availability of CT and MR scan, brain herniations and their consequences can be studied at an earlier
stage in patients. Patterns of herniation can be classified according to which anatomical boundary the herniating structure crosses. Herniations of the brain can be divided into four large categories. These include transtentorial, subfalcine (Figure), foramen magnum, and alar or sphenoid herniation. The key to recognizing all herniations of the brain is evaluation of the cisterns. Imaging findings can be useful in assessing both, overall clinical risk and in determining the urgency of treatment.

**SUMMARY/CONCLUSION**

Acquired intracranial herniations can accompany many pathologic processes of the brain. Herniations are important to recognize because they are frequently responsible for the presenting clinical signs and symptoms and can often be the cause of major neurologic complications. We review the imaging findings, clinical signs and possible complications involved in the four main types of brain herniations.

**KEY WORDS:** Herniations, brain, clinical

**Electronic Scientific Exhibit 58**

**Cine Phase-Contrast MR Imaging: Applications to Cerebrospinal Fluid Flow Studies**

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1Clinica Davila, Santiago, CHILE, 2Asociación Chilena de Seguridad, Santiago, CHILE

**PURPOSE**

To assess the usefulness of cine phase-contrast MR imaging (MRI) to the evaluation of cerebrospinal fluid (CSF) flow abnormalities.

**APPROACH/METHODS**

In this exhibit we present a protocol of CSF flow studies to improve the evaluation of CSF flow abnormalities. This protocol includes: contrast gradient cine-phase studies, quantitative CSF flow information and high-resolution T2 sagittal images. Thus enriching the analysis of pathologies, such as: idiopathic normal pressure hydrocephalus, functional analysis of third ventricle ventriculostomy, arachnoid cysts and aqueductal stenosis.

**FINDINGS/DISCUSSION**

Different pathologies that compromise CSF flow are depicted along their phase-contrast imaging characteristics. Inherent to idiopathic normal pressure hydrocephalus is an aqueductal "flow void" sign, which represents an increment of CSF flow at this level. This can be assessed by employing Q flow measurement in the aqueduct of Sylvius, thus rendering specific quantitative information of CSF flow, such as: maximum diastolic and systolic velocity, mean velocity, maximum diastolic and systolic blood flow, mean flow and stroke volume. Of the aforementioned parameters, only the quantitative measurements of flow and stroke volume are significantly different between healthy individuals and patients with normal pressure hydrocephalus. In the case of endoscopic third ventriculostomy the quantification of stroke volume is a valid indicator of the postoperative functional status. Phase-contrast MR imaging can be applied, on one hand, for the analysis of communications between intracranial arachnoid cysts and cisterns, and, on the other hand, for patients with aqueductal stenosis.

**SUMMARY/CONCLUSION**

Either quantitative or qualitative cine phase-contrast MR studies of CSF flow represent an invaluable assistance to the diagnosis of specific clinical entities.

**KEY WORDS:** Cerebrospinal fluid, MR imaging, normal pressure hydrocephalus

**Electronic Scientific Exhibit 59**

**Neuroradiographic Findings of Amyloid Beta-Related Angiitis**

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Rochester, MN

**PURPOSE**

To describe the neuroradiographic imaging characteristics seen with amyloid beta-related angiitis.

**APPROACH/METHODS**

After IRB approval a retrospective review of the neuroimaging of 14 cases of amyloid beta-related angiitis (ABRA) were reviewed by three neuroradiologists. The imaging features and clinical presentations were compared and patterns of imaging findings catalogued.

**FINDINGS/DISCUSSION**

Over the past decade we have collected 14 cases of ABRA. Seven of the 14 cases (50%) have pathologic correlation with one case being biopsied twice for fear of a low-grade infiltrative astrocytoma. Clinically these patients presented
with a wide range of findings including altered mental status, TIA, seizure, and persistent stroke-like symptoms. The imaging features shared by nearly all of the cases was infiltrative white matter T2 hyperintensities with associated mass effect involving the subcortical U fibers. In a few cases there was overlying leptomeningeal enhancement but no parenchymal enhancement. In the majority of cases there was scattered tiny T2 hypointensities centered at the great white junction or along the overlying cortex typical for amyloid. It was not uncommon for this latter finding to be subtle if axial gradient imaging was not performed and was overlooked in two cases. In one patient we have follow-up imaging over a 10-year time frame and the findings were migratory and polyphasic. Given it is an inflammatory angiitis once diagnosed patients were treated with immunomodulation. The patients ranged in age from 60-78 years old which is older than for the typical primary angiitis of the central nervous system. The leading differential in three of the biopsy cases was primary infiltrative low-grade glioma. Pathologically the cases that went to biopsy showed a granulomatous pattern with vasculocentric mononuclear inflammation, occasional granulomas in the vessel wall, and multinucleated giant cells. The Beta A4 amyloid deposition typically was seen in the vessel wall but could be seen also within the granulomas.

**SUMMARY/CONCLUSION**

Amyloid is a common finding seen on MR imaging in an elderly population; however, the inflammatory vasculocentric form of amyloid is rare and less well known in the radiology community. It is important for the neuroradiologist to be aware of the imaging findings presented in this exhibit, as they may be the first to correlate the imaging, clinical, and pathologic findings preventing an unnecessary biopsy. Secondarily if a biopsy is to be performed the neuroradiologist can guide the neurosurgeon to biopsy the leptomeninges and gray white junction rather than just the diffuse white matter abnormality which may result in a false negative biopsy.

**KEY WORDS:** Amyloid beta-related angiitis, vasculitis, white matter

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**Electronic Scientific Exhibit 60**

**Diffuse Proliferative Cerebral Arterial Disorders: Similar Appearances, Different Diagnosis**

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University of North Carolina
Chapel Hill, NC

**PURPOSE**

In neuroradiology there is little knowledge about the diffuse arterial cerebral proliferative disorders and their imaging findings may be confusing. We will review the clinical and imaging findings of three cerebral arterial proliferative disorders that present distinct CT, MR and angiographic findings, require different treatments and have different prognosis.

**APPROACH/METHODS**

We searched our teaching database for cases of moyamoya, cerebral proliferative angiopathy (CPA) and hemorrhagic angiopathy (HA). All available CT, MR and catheter angiographic images were reviewed and those that better presented the findings were chosen for the exhibit. We also reviewed the available and pertinent literature and based on it present the clinical, therapeutic and prognostic implications of the findings.

**FINDINGS/DISCUSSION**

We identified 42 patients with moyamoya associated with sickle cell disease (SSD) seen in our hospital in the last 10 years that have all three diagnostic imaging modalities. Patients with moyamoya not related to SSD (N = 2) were excluded. Six patients with CPA and three with HA also were retrieved. Moyamoya generally presents with seizures and stroke. Watershed infarctions and the typical “puff of smoke” sign are the most common findings. Cerebral proliferative angiopathy patients are young females who present angiographic and clinical findings similar to those of moyamoya. Treatment and prognosis for these two diseases are similar. Conversely, little is known of HA except that it presents with angiographic findings similar to the other disorders but with acute hemorrhage and that empirical treatment with irradiation has yield good results.

**SUMMARY/CONCLUSION**

Cerebral arterial proliferative disorders may have similar angiographic appearances. Both moyamoya and CPA also have similar clinical presentations but most patients with the former have SSD. Hemorrhagic angiopathy is a newly recognized rare entity which presents with acute hemorrhage and angiographic findings of arterial proliferation without shunting.

**KEY WORDS:** Moyamoya, cerebral proliferative angiopathy, hemorrhagic angiopathy

**Electronic Scientific Exhibit 61**

**Arterial Spin Labeling Perfusion Imaging on Moyamoya Disease: Comparison of Regional Arterial Spin Labeling Perfusion Value with MR Finding**

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**PURPOSE**

We compared regional perfusion value by arterial spin labeling (ASL) and MRA score on moyamoya disease (MMD).

**APPROACH/METHODS**

Perfusion imaging by ASL [Q2TIPS, TI1/TI1s/TI2 (ms) = 700/1800/2000] and 3D-TOF-MRA on 3.0 T MR imaging were performed on 74 patients with MMD (148 sides; 25 males and 49 females; age range/average(year), 7 - 71/30.4). Regional ASL values were calculated with normalized ASL perfusion map and ROI maps including hemisphere, frontal lobe, temporal lobe, parietal lobe, occipital lobe, limbic lobe, lentiform nucleus, and thalamus. MR angiography score and
its elements including ICA, MCA, ACA, and PCA scores were evaluated on MRA source images according to modified Houkin’s grading system. Relationships between regional ASL values vs MRA score and its elements were analyzed under the significant level of 0.05 after Bonferroni adjustment for multiple comparisons (40 comparisons).

FINDINGS/DISCUSSION

Significant relations between ACA score vs frontal lobe and occipital lobe, and PCA score vs frontal lobe, temporal lobe, parietal lobe, occipital lobe, and limbic lobe were observed. No significant relations were observed between any regional ASL values vs ICA or MCA.

SUMMARY/CONCLUSION

Our results might reflect that blood flow is depends on the stenoocclusive severity of mainly not ICA or MCA, but ACA and PCA. ASL is expected to be helpful for evaluating the regional blood flow changes in MMD.

KEY WORDS: Moyamoya disease, arterial spin-labeling, MR angiography

Electronic Scientific Exhibit 62

Withdrawn

Electronic Scientific Exhibit 63

Imaging of Cerebral Venous System: Normal Anatomy, Variants and Review of Venous Pathology

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PURPOSE

Cerebral venous system can be divided into superficial and deep systems. The cerebral venous system is fraught with variations especially in the superficial cerebral veins and veins of the posterior fossa. Knowledge of variations in cerebral venous anatomy is essential to avoid potential diagnostic pitfalls. The purpose of this exhibit is to discuss the normal anatomy and variants of the cerebral venous system, to illustrate venous anatomy in the posterior fossa which is better delineated in diseased conditions like arterialized venous flow in dural arteriovenous fistula and arteriovenous malformations and also to illustrate the pathology as it relates to clinical manifestations.

APPROACH/METHODS

This exhibit will be grouped into sections covering skull venous system, superficial venous system, deep cerebral veins, dural venous sinuses, imaging modalities used for imaging the cerebral venous system and pathology affecting the venous system. This exhibit will illustrate normal anatomy, including small venous structures which are not visualized normally but become prominent in disease states. We will discuss the various venous imaging modalities like CTA/CTV, MRA/MRV and DSA. This exhibit also will demonstrate the spectrum of pathology affecting the cerebral venous system.

FINDINGS/DISCUSSION

The normal and variant anatomy of the cerebral veins and dural venous sinuses is poorly understood by many radiologists. This review illustrates clinically pertinent anatomy of the cerebral sinovenous system with detailed anatomy of the posterior fossa veins and variations of the superficial cerebral veins. Various methods of imaging cerebral veins and dural venous sinuses are described. Techniques and pitfalls of various imaging modalities also will be touched upon. Examples of various pathologies affecting the venous system also will be illustrated.

SUMMARY/CONCLUSION

After viewing this exhibit, the radiologist should have a better understanding of the imaging anatomy of the cerebral venous system. The cerebral venous system will be classified and a better understanding will be gained by incorporating teaching cases and line diagrams wherever relevant.

KEY WORDS: Cerebral venous system, anatomy, venous pathology

Electronic Scientific Exhibit 64

Decoding the Deep Gray: A Review of the Anatomy, Function and Imaging Patterns Affecting the Basal Ganglia

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Bronx, NY

PURPOSE

To review normal anatomy and function of the basal ganglia. To organize basal ganglia pathology into patterns of disease based on imaging findings and to introduce an imaging-guided algorithm to help in the differential diagnosis. After viewing this exhibit, viewers should be able to: 1. Identify all parts of the basal ganglia and describe their function; 2. Describe CT and MR imaging patterns of disease affecting the basal ganglia; and 3. Use an imaging-guided algorithm to narrow the differential diagnosis.

APPROACH/METHODS

We will begin with a review of the normal anatomy including vascular supply and function of the basal ganglia which includes the caudate, putamen, globus pallidus, nucleus accumbens septi, and olfactory tubercle. Disease mimics will be discussed including age-related calcification and perivascular spaces. A discussion of the spectrum of disor-
Purpose
To review the pathophysiology of the hypothalamus. 3. To show various pathologic conditions based on anatomical location and different disease category.

Findings/Discussion
The main teaching points of the exhibit are: 1. To understand the normal anatomy of hypothalamus, 2. To learn the pathophysiology of the hypothalamus and 3. To show various pathologic conditions based on anatomical locations and disease category.

Summary/Conclusion
To be familiar with this knowledge will enhance our ability for better diagnostic accuracy.

Key Words: Hypothalamus, MR imaging

Electronic Scientific Exhibit 66
Diagnosis and Treatment Considerations in Mass Lesions Involving the Cavernous Sinus
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Purpose
Cavernous sinus masses remain a formidable challenge in diagnosis and treatment. The cavernous sinus contains vital neural and vascular structures including portions of cranial nerves III-VI and the internal carotid artery. Additionally, it exists in close proximity to the pituitary gland, temporal lobe, orbit, and Meckel’s cave. Imaging characteristics among the various cavernous sinus masses are often nonspecific, and minute details can influence choice among therapeutic options. The cavernous sinus is among the most difficult of surgical approaches. Etiology and mass effect determine suitability for conservative treatment; however, extent of involvement within the cavernous sinus is also critical in presurgical evaluation.

Approach/Methods
Images will be used to illustrate the important facets of diagnosis and treatment when faced with a mass involving the cavernous sinus. Our aim is to help the radiologist effectively narrow the differential diagnosis, and to better understand the surgeon’s perspective in evaluating such lesions for treatment.

Findings/Discussion
Typical imaging characteristics of neoplastic and nonneoplastic cavernous sinus lesions will be reviewed.

Summary/Conclusion
The spectrum of mass lesions indicating treatment for involvement of the cavernous sinus is limited, but diverse. Due to the extreme difficulty of surgical approach to this region, less invasive treatment, where appropriate, is pre-
ferred. The radiologist is uniquely suited to help define treatment options, as well as to help inform surgical planning. This review describes the particular radiographic and surgical considerations when evaluating a patient with a cavernous sinus mass.

**KEY WORDS:** Cavernous sinus, anatomy, surgery

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**Electronic Scientific Exhibit 67**

**Hypoglossal Nerve Palsy: From Normal Anatomy, Clinical Manifestation to Pathologic Conditions**

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Tainan, TAIWAN

**PURPOSE**

1. To review the normal anatomy of hypoglossal nerve; 2. To describe the clinical manifestations of hypoglossal nerve palsy; 3. To demonstrate the various pathologic conditions affecting hypoglossal nerve based on anatomical location.

**APPROACH/METHODS**

1. Anatomy of hypoglossal nerve: from brainstem nuclei, cisternal segment, hypoglossal canal, carotid space, sublingual segment. 2. Clinical symptoms include medial medullary syndrome, tongue denervation. 3. Pathologic conditions based on location: a) brainstem: MS, infarct, glioma, hematoma; b) cistern: basilar ectasia, aneurysm, meningioma, metastasis; c) Hypoglossal canal: schwannoma, meningioma, metastasis; (d) carotid space: Eagle syndrome, dissection; e) sublingual: infection, carcinoma. 4. CN12 denervation.

**FINDINGS/DISCUSSION**

The major teaching points of this exhibit are: 1. Understanding normal anatomy of hypoglossal nerve is important in interpretation. 2. Damage to hypoglossal nerve produces tongue lateral atrophy. 3. CT and MR imaging can assess neuromuscular lesions and vascular condition 4. Familiarity with various pathologic conditions enables us to a prompt management for the patients, especially for those with hypoglossal denervation but unknown origin.

**KEY WORDS:** Hypoglossal nerve, denervation, MR imaging

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**Electronic Scientific Exhibit 68**

**3D Imaging of the Membranous Labyrinth Obtained by HRCT**

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**PURPOSE**

With improvement of imaging technique, 3D reconstructed images of the canalicular systems in the inner ear become possible. These images simulated the view of the endoscope projections. The technique, originally developed for exploration of intravascular lumina, the bronchial tree and gastrointestinal tract, has been applied to the inner ear. But, former techniques delineated only bone structures of the inner ear. Using our technique, everyone can observe the membranous structures of the inner ear.

**APPROACH/METHODS**

We studied 10 normal subjects. CT was obtained with collimation and pitch values of 1.00 mm and 0.50, respectively, and exposure duration of 22 sec (120 KV, 120 mA). We reconstructed the obtained data separately for each temporal bone in the axial planes by using a bone algorithm with 1.00 mm section thickness, 0.50 mm increments, and a FOV of 9.6 cm, with a matrix size of 512 X 512. The axial data were applied to create 3D images on the CT work station for post-processing with CT commercially distributed software.

**FINDINGS/DISCUSSION**

Three-dimensional visualization of the different structures of the membranous labyrinth allowed display of correct anatomy by high detail in all cases. We could observe cochlear duct, ductus reuinens, saccule, utricle and ampullae.
Although anatomical structures play an increasing role in clinical diagnosis, 3D imaging shows promise as a method for observation of the membranous labyrinth. These images can be applied to radiologic diagnosis, surgical planning and especially to teaching.

**KEY WORDS:** Membranous labyrinth, inner ear, 3D imaging

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**Electronic Scientific Exhibit 69**
Withdrawn

**Electronic Scientific Exhibit 70**

**Imaging and Anatomical Features of Juvenile Angiofibroma: What the Clinician Needs to Know**

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**PURPOSE**
Juvenile angiofibroma (JA) is a rare, highly vascular, locally aggressive tumor with benign histologic characteristics that occurs almost exclusively in adolescent males aged 5 to 25 years. It represents 0.5% of all head and neck tumors and its etiology is unknown. It is clinically diagnosed by a history of nasal obstruction and recurrent epistaxis: however, radiological imaging is important for diagnosis verification and preoperative anatomical evaluation.

**APPROACH/METHODS**
With CT, the diagnosis is based on the presence of a mass in the base of the pterygo-palatine fossa with bone erosion behind the sphenopalatine foramen. MR imaging is used for better evaluation of intracranial extension of the tumor. The presence of signal voids and strong enhancement after gadolinium administration confirms the diagnosis. Angiography is important in preoperative vasculature delineation and embolization. Radiologists have to be familiar with the clinical classification of JNA. Understanding the anatomical pathways that the lesion can extend to is essential for this purpose. It is important to know the extension to the orbit, nasal pathways or intracranial cavity for management.

**FINDINGS/DISCUSSION**
Show the different anatomical presentations of JNA using animated 3D illustrations and imaging cases.

**SUMMARY/CONCLUSION**
Understanding the imaging characteristics, anatomy and clinical classification of JNA is essential for the management. Animated 3D illustrations aid the understanding of the extension of JNA into the different adjacent compartments.

**KEY WORDS:** JNA, CT, juvenile angiofibroma

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Electronic Scientific Exhibit 71

**Schwannomatosis and Neurofibromatosis Type 2: Similarities and Differences**

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**PURPOSE**
Schwannomatosis recently has been categorized as a third major form of neurofibromatosis. Clear distinction of this disease entity from the well recognized neurofibromatosis type 2 (NF II) has been established on the basis of recent genetic information. Nevertheless, it shares similarities with neurofibromatosis type 2, both in genotypic and phenotypic perspectives. Our exhibition demonstrates imaging findings in patients presenting to our institution with both diseases, and provides recent educational information regarding diagnosis and controversies on these two disease entities.

**APPROACH/METHODS**
We present cases of schwannomatosis and neurofibromatosis type 2 found in our institution. Cross-sectional images acquired from patients in the two disease categories showing tumor characteristics and distribution are presented to provide visual comparison. Literature reviews are summarized for educational purposes.

**FINDINGS/DISCUSSION**
The hint in differentiating schwannomatosis from NF II is the presence of multiple schwannomas in an adult patient lacking evidence of imaging of vestibular schwannoma. Recent studies in genetics have found the mutations in SMARCB1 gene as a potentially responsible genetic abnormality in schwannomatosis.

**SUMMARY/CONCLUSION**
Schwannomatosis is a rare disease which recently has been recognized and categorized separately from other forms of neurofibromatosis. The presence of multiple schwannomas often misleads radiologists into a presumed mind-set state that the patient is having NF II. The understanding of the similarities and the differences between these two diseases is essential in order to make an appropriate interpretation, treatment and prognosis prediction.

**KEY WORDS:** Neurofibromatosis, schwannomatosis, multiple schwannomas
**Electronic Scientific Exhibit 72**

An Algorithmic Approach to CT of Benign Jaw Lesions

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**PURPOSE**

To demonstrate a diagnostically helpful algorithm for the differential diagnosis of benign jaw lesions including benign odontogenic and nonodontogenic tumors and epithelial cysts at high-resolution computed tomography (CT).

**APPROACH/METHODS**

A case review of benign jaw lesions will be presented, structured along the algorithmic guidelines proposed. The algorithm begins with categorization of lesions into lucent, sclerotic, ground glass, or mixed (lucency and sclerosis), subdivides each of these into tooth-related or nontooth-related categories, then branches into more specific diagnostic features. Characteristic CT imaging features as well as clinical and epidemiologic features of benign jaw lesions will be presented and contrasted to similar-appearing, but pathologically distinct lesions. Cases in which a specific CT diagnosis may not be possible also will be reviewed. The case presentation includes 3D volume-rendered CT imaging correlation where global lesion features are diagnostically important. Limited examples of diagnostically useful MR findings will be included.

**FINDINGS/DISCUSSION**

We have found this algorithmic approach very useful in the presurgical differentiation of common benign jaw tumors and cysts.

**SUMMARY/CONCLUSION**

The individual reviewing this presentation will acquire a logical method for differentiating common benign jaw lesions.

**KEY WORDS:** Jaw, computed tomography, cyst

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**Electronic Scientific Exhibit 73**

Spectrum of Carotid and Vertebral Waveforms

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**PURPOSE**

Carotid ultrasound is performed most commonly to evaluate for hemodynamically significant stenoses in patients that suffer from ischemic cerebrovascular diseases. However, this modality also is useful for assessing other conditions. The scan usually is performed using a high-frequency linear transducer and should include spectral waveform analysis and velocities in the external, internal, and common carotid arteries. In addition, the temporal tap and spectral analysis of the vertebral arteries are routinely performed. Normal and abnormal carotid ultrasound findings with MR imaging, CTA, and conventional angiography correlation, as well as potential pitfalls are reviewed.

**APPROACH/METHODS**

**Normal Findings:**
1. Reversal of flow often is seen at the bulb;
2. The temporal tap appears as oscillations in the external carotid waveform and implies that the vessel is patent;
3. A dicrotic notch occurs with closure of aortic valve; and
4. Stents appear as echogenic mesh structures, while endarterectomy is often imperceptible, manifesting as slight wall irregularity.

**Abnormal Findings:**
1. Atherosclerotic disease is common and ranges from intimal hyperplasia to occlusion;
2. The string sign is characteristic for nearly occlusive disease;
3. External carotid occlusion results in internalization of the common carotid; 4. Pulsus bisferiens occurs with aortic insufficiency and pulsus alternans with heart failure; 5. Subclavian steal affects the vertebral waveforms and is described in four stages of severity; and
6. Uncommon disorders such as dissection, carotid-jugular fistula, and fibromuscular dysplasia are readily evaluated by ultrasound.

**Pitfalls:**
1. Arrhythmias and the presence of cardiac assist devices can compromise the validity of the study;
2. Tandem lesions result in underestimation of the velocities in the distal lesions; 3. Contralateral internal carotid occlusions lead to velocity elevation; 4. Tortuous vessels may cause velocity overestimation; 5. Bradycardia results in low diastolic velocities; and 6. Collateral vessels may be misinterpreted as patency in the setting of occlusion.

**FINDINGS/DISCUSSION**

Carotid ultrasound is a cost-effective tool for evaluating a variety of conditions.

**SUMMARY/CONCLUSION**

Accurately distinguishing between normal variants and disease processes and awareness of potential pitfalls is essential for guiding proper management.

**KEY WORDS:** Carotid, ultrasound, waveforms
Acute Traumatic Eye Injuries: Imaging and Ophthalmologic Correlation

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PURPOSE
This is a pictorial review of commonly encountered eye injuries in the acute setting at a level 1 trauma center. Radiologic and ophthalmologic collaboration is emphasized.

APPROACH/METHODS
Commonly seen traumatic ocular injuries in the emergency center setting are presented. Radiologic images backed by ophthalmologic photographs depict the findings. The focus of our discussion is on the clinically relevant anatomy that serves as the basis for our understanding of management approach, whether surgical or nonsurgical.

FINDINGS/DISCUSSION
Injury is the leading cause of monocular blindness and is second only to cataract as the most common cause of visual impairment, according to the United States Eye Injury Registry. Commonly encountered eye injuries in our practice include: 1. Full-thickness corneal/corneo-scleral/scleral lacerations with or without uveal prolapse; 2. Intraocular foreign bodies (ranging from metal, nails, fish hooks, glass, plant materials, etc.); 3. Ruptured globe; 4. Traumatic hyphema; 5. Traumatic cataract and lens dislocation; 6. Vitreous hemorrhage; 7. Retinal tears, retinal hemorrhage, retinal detachment; 8. Choroidal detachment, choroidal rupture; and 9. Commotio retinae. These often are seen in conjunction with multiple and oftentimes serious traumatic injuries. Injuries with uveal prolapse tend to have the worst prognosis. Ruptured globe is a diagnosis by itself, resulting from compression of the globe with forces strong enough to cause it to rupture. Imaging findings correlated with ophthalmologic pictures provide an opportunity for better understanding of these ocular injuries, both from a radiologic and ophthalmologic perspective.

SUMMARY/CONCLUSION
A collaborative approach to the commonly encountered acute eye injuries in a level 1 trauma center is presented. Understanding the clinically relevant anatomy, both from a radiologic and ophthalmologic perspective, serves as the basis for our appreciation of the management approach to these conditions.

KEY WORDS: Traumatic eye injuries, globe rupture, intraocular foreign bodies
Is It Really Still Useful to Perform CT in the Study Protocol of Retinoblastoma?

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PURPOSE
To assess whether MR imaging associated with ophthalmologic investigations (ophthalmoscopy and ultrasonography) may erase the use of CT in detection of diagnostic intraleisional calcifications in retinoblastoma.

APPROACH/METHODS
Ophthalmoscopic findings, MR images, CT scans and histologic examination of 28 retinoblastomas from 23 consecutive children were evaluated retrospectively (11 males, 12 females; age range at admission, 1-35 months; mean, 11 months; median 9 months). Ultrasonography was performed in 18 patients with 21 retinoblastomas. MR study included T2-weighted spin-echo and gradient-echo images, fluid attenuated inversion recovery images, and T1-weighted spin-echo images with and without contrast enhancement. Clinical data were integrated with MR data, to evaluate the utility of both approaches to discover calcifications; particularly, a correlation between intraleional signal void spots at MR imaging and hyperattenuating areas at CT scans was performed.

FINDINGS/DISCUSSION
Ophthalmoscopy detected calcifications in 12 out of 28 eyes (42.85%). Ultrasonography detected calcifications in 20 out of 21 eyes (95.23%). CT showed hyperattenuating intraleional areas consistent with calcifications in 27 out of 28 eyes (96.42%). MR imaging showed intraleional signal void spots in 25 out of 28 eyes (89.28%). All spots detected with MR matched with the presence of calcifications on CT scans. Gradient-echo T2*-weighted, and fast spin-echo T2-weighted images showed the highest degree of correlation with CT. Putting together ophthalmoscopy, ultrasonography, and MR data no calcifications detected on CT were missed, and differential diagnosis was thorough.

SUMMARY/CONCLUSION
Interaction between clinical data and MR images may remove potentially harmful ionizing radiation from the study protocol of retinoblastoma.

KEY WORDS: MR imaging, retinoblastoma, calcifications

Imaging of Orbital Implants and Prostheses: Diagnostic Pearls and Interpretative Pitfalls

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PURPOSE
To present an educational review of commonly available orbital implants and prostheses, their clinical indications and imaging of the typical and atypical postoperative appearances and their complications using ultrasound, computed tomography and MR imaging.

APPROACH/METHODS
This review will cover the following: indications for the use of intraconal implants, extraconal sockets, sighted eye and orbital prostheses, relevant operative anatomy, surgical approaches, postoperative imaging findings including relative position of the optic nerve and intraocular muscles to the implant, imaging follow up inculcating diagnostic pearls and interpretative pitfalls and imaging of short- and long-term complications.

FINDINGS/DISCUSSION
Primary, secondary and exchange reconstructive eye surgery is becoming common practice with advances in implant technology and the clinical need for better cosmesis and eye-ball motility. New and innovative intraconal and extraconal implants are being made increasingly available and approved for use. However, there are potential postoperative assessment problems, for example in discerning normal tissue reaction from foreign body reaction, implant migration or failure. Multimodality imaging often helps resolve such diagnostic dilemmas.

SUMMARY/CONCLUSION
It is important for neuroradiologists to understand the key principles involved in the placement and assessment of orbital implants and prostheses and their possible complications, as there is a growing trend to their clinical applications. Our review aims at filling an essential knowledge gap in the practice of orbital surgery as this is often an ill understood subject and there is not much on the same in the published literature.

KEY WORDS: Orbital prostheses, orbital implants, intraconal and extraconal
Optimized Time-Resolved MR Angiography and Dynamic MR Evaluation of Vascular Lesions of the Orbit and Periorbita

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PURPOSE
To evaluate the performance of a novel dynamic contrast-enhanced MR imaging protocol in characterizing vascular lesions of the orbit and periorbita by their differing enhancement kinetics and distensibility with valsalva maneuver.

APPROACH/METHODS
A retrospective review of patients with vascular lesions of the orbit and periorbita undergoing dynamic contrast-enhanced MR and MR angiography (MRA) utilizing the vascular lesion of the orbit MR protocol was performed. Particular emphasis was placed on analysis of distinctive lesion characteristics during time-resolved imaging of contrast kinetics (TRICKS; GE Healthcare), during multiple temporal phases of contrast enhancement, and during performance of a valsalva maneuver. The imaging diagnoses were confirmed with pathologic or clinical follow up, as appropriate.

FINDINGS/DISCUSSION
A total of 26 patients with vascular lesions of the orbit meeting the criteria were available for review. Included in this group were four patients diagnosed with capillary hemangioma of the orbit, two diagnosed with cavernous hemangioma of the orbit, five patients diagnosed with venous varices, one patient diagnosed with hemangiopericytoma/solitary fibrous tumor of the orbit, two patients diagnosed with orbital lymphoma, one patient diagnosed with orbital inflammatory pseudotumor, and three patients diagnosed with arteriovenous malformations. Contrast-enhanced MRA, early and delayed phase contrast-enhanced imaging, and valsalva maneuver allowed accurate classification of the lesions. Findings on time-resolved MRA were particularly distinctive, and also provided vascular detail useful for presurgical planning and endovascular therapy planning.

SUMMARY/CONCLUSION
Our review suggests that many vascular lesions of the orbit demonstrate distinctive characteristics when examined with a dedicated MR protocol designed to take advantage of differences in early vascular blush and temporal differences in contrast enhancement. Additional valuable therapy planning information can be obtained from TRICKS MRA images.

KEY WORDS: Vascular, orbit, TRICKS
Neuroradiology On-Call: What the Junior Resident Needs to Know about ENT Imaging

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PURPOSE
The purpose of this exhibit is to familiarize junior residents taking call for the first time with serious and critical ENT emergencies requiring immediate intervention or resulting in alteration of patient management. After reviewing this exhibit, readers should be familiar with the imaging spectrum of ENT abnormalities that may be encountered on-call. This exhibit also serves as a refresher for senior residents and other radiologists who interpret ENT imaging.

APPROACH/METHODS
This exhibit is a case-based approach with clinical-pathologic correlation of common ENT entities encountered on-call. Cases will be presented as unknowns, followed by a discussion of the entity and mention of important differential considerations.

FINDINGS/DISCUSSION
A variety of ENT emergencies may be encountered on-call by the junior resident. Etiologies include: 1) infectious—retropharyngeal abscess, acute epiglotitis, orbital cellulitis, sinusitis, Ludwigs, scrofula, otomastoiditis; 2) traumatic—Lefort fractures, temporal bone fractures, orbital blow-out fractures, trimalar fractures; 3) neoplastic—nasopharyngeal carcinoma, lymphoma; and 4) vascular—carotid dissection.

SUMMARY/CONCLUSION
In an era of increased utilization of radiologic imaging in the assessment of emergency room patients, it is becoming increasingly vital for the junior resident to recognize clinically significant ENT disease processes. Many of these entities have characteristic imaging patterns. Recognition of these imaging patterns ultimately will lead the junior resident to formulate an accurate diagnosis and, therefore, optimize patient management. Patient management decisions often are based on preliminary interpretation, further emphasizing the need for accurate diagnosis by junior residents. Studies have shown that overnight misinterpretations by junior residents can result in a delay in diagnosis, increased patient morbidity and increased healthcare costs.

KEY WORDS: Trauma, ENT, on-call

Problem-Solving in the Head and Neck: A Review of Advanced MR Imaging Techniques

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PURPOSE
Head and neck MR imaging is often challenging because of small imaging targets, nonspecific findings, inhomogeneous magnetic susceptibility, and motion artifacts. Recent advances in MR imaging techniques show great potential in terms of problem-solving in head and neck imaging. The purpose of this exhibit is: 1. to illustrate recently introduced advanced MR imaging techniques as they apply to various head and neck pathologies; and 2. to discuss their pitfalls and to review clinical impact of these imaging techniques on diagnosis and treatment decision.

APPROACH/METHODS
Various advanced MR imaging techniques have been introduced recently to address problems inherent to head and neck imaging. These techniques include periodically rotated overlapping parallel lines with enhanced reconstruction (PROPELLER or BLADE), single-slab 3D-TSE (SPACE), diffusion-weighted imaging (DWI), and various fat suppression techniques including short tau inversion recovery (STIR), chemical shift selective (CHESS) saturation and Dixon technique (DIXON), with or without spectral attenuation inversion recovery (SPAIR) and binomial pulse. We review these advanced MR imaging techniques as they apply to various head and neck pathologies including benign and malignant tumors, inflammatory and infectious processes, denervation injury, and developmental anomalies.

FINDINGS/DISCUSSION
We illustrate strategies for current head and neck imaging problems using novel techniques: 1) PROPELLER/BLADE sequence significantly decreases motion artifacts; 2) higher spatial resolution for small targets and multiplanar imaging can be obtained with SPACE; 3) quantitative analysis and tissue characterization may be possible with DWI; and 4) more homogeneous fat suppression in the inhomogeneous magnetic susceptibility can be obtained by DIXON technique. Cases with improved image quality and diagnostic capability are presented. Further, we discuss limitations and pitfalls of these advanced techniques.

SUMMARY/CONCLUSION
Recently introduced advanced MR techniques show promise in the evaluation of various head and neck pathologies, and may be useful adjuncts to conventional MR imaging.

KEY WORDS: MR imaging, head and neck
Electronic Scientific Exhibit 80
Early Experience with Gemstone Spectral Imaging of the Neck: Review of Technique and Potential Clinical Applications

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PURPOSE
The purpose of this exhibit is: To describe and review the basic principles of Gemstone Spectral Imaging (GSI) technology and to discuss and illustrate potential clinical applications in the neck using this novel technique.

APPROACH/METHODS
The GSI technology provides a new method for imaging the various material densities that we can image with CT. As opposed to the dual source technology that only permits detection of two K-edges, the GSI technology allows continuous spectral analysis ranging from 80-140 keV. The spectral image is created as though it comes from a single kilovolt source and individual spectral images can be derived from 101 user-selectable energy levels. Gemstone Spectral Imaging aids with the characterization of pathology, potentially enhancing the ability to characterize lesions through the separation of materials such as water, calcium and iodine. It has the ability to create virtual non-IV contrast images by subtracting iodine from the images to generate a non-IV contrast-like image. Gemstone Spectral Imaging enhances and has the potential to improve image quality with the spectral image and by optimizing enables image contrast optimization, which is vital to differentiating anatomical areas of interest from the surrounding tissue density which is beneficial in distinguishing between tissue types. It also enables accurate CT numbers identification which can help characterize small indeterminate lesions with up to 50% reduction in common beam-hardening and metal artifacts. The spectral image is created as though it comes from a single kilovolt source and individual spectral images can be derived from 101 user-selectable energy levels.

FINDINGS/DISCUSSION
Technique: The technique has the following characteristics: 1) Single tube ultra-fast dual energy switching; 2) Acquires up to 128 slices per rotation over the full 50 cm scan field-of-view; 3) Gemstone detector supports separation of materials such as calcium, iodine and water; 4) Raw data-based processing to derive Gemstone Spectral Images--images created as though they came from a single kilovolt source; and 4) Optimize image contrast with potential, reduced reduction of beam hardening artifacts. Potential Clinical Applications: Initial results evaluating GSI technology suggest that spectral imaging has potential benefits in imaging of the extracranial neck. The potential clinical applications, which will be illustrated in the exhibit, include: 1) Improvement of vascular enhancement in patients with poor contrast bolus; 2) Reduction of metallic streak artifact from dental amalgam, etc.; 3) Elimination of the spray artifact from dental amalgam extending into the adjacent paraspinal soft tissues; 4) Improved visualization of the base of neck and thoracic inlet at the level of the shoulders; 5) Reduction of streak artifacts from dense venous contrast; 6) Potential to identify the margin of certain tumors and potentially beneficial to evaluate thyroid gland; and 7) To identify tumors from the normal soft tissues and benign lesions and better identify tumor margins.

SUMMARY/CONCLUSION
The dual capabilities of Gemstone Spectral Imaging, material separation and image quality enhancement can work together to aid in a fast and more confident diagnosis.

KEY WORDS: Gemstone spectral imaging, clinical applications, beam hardening artifacts

Electronic Scientific Exhibit 81
Branchial Apparatus: A Pictorial Review of Embryology and Related Anomalies

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PURPOSE
Anomalies of the branchial apparatus are rare with the majority related to the second (approximately 95%) and first (<8%) branchial apparatus. Anomalies of the third and fourth apparatus are rarer and frequently misdiagnosed. The purpose of this presentation is to familiarize the reader with the embryologic development and spectrum of branchial apparatus anomalies.

APPROACH/METHODS
After a brief review of the related embryology using original diagrams, a number of cases will be presented. Based on the location of the anomaly and knowledge of related embryology one can arrive at the differential diagnosis and often the diagnosis of the branchial apparatus anomalies.

FINDING/DISCUSSION
Anomalies of the branchial apparatus present in the form of cysts, sinus tracts and fistulae. Sinus tracts typically communicate externally. Fistulae communicate both internally and externally resulting from persistence of both a branchial cleft and branchial pouch. Lesions related to the third branchial apparatus are mostly within the posterior triangle in the upper neck posterior to the carotid artery. In the lower neck they can be in the anterior triangle. Ectopic thymus, cysts, sinus tract and fistula can be seen along the course of the thyro-pharyngeal duct. The fourth pharyngeal pouch can manifest as a fistula extending from the apex of the pyriform sinus to the anterior lower neck adjacent to the thyroid gland. It can become infected and often is associated with a thyroid abscess in a young patient as the first manifestation of this condition.

SUMMARY/CONCLUSION
Anomalies of the branchial apparatus are rare conditions and often present in the form of cysts, sinuses or fistulae. Understanding the embryology of the branchial apparatus and associated anomalies the physician will be able to arrive at an accurate differential and often the diagnosis.

KEY WORDS: Congenital, neck lesions, cysts
**PURPOSE**

The vagus nerve is tortuous, extending from the brainstem to the splenic flexure of the colon with multiple key functions. We review the anatomy and course of the left and right vagus nerve (CN X) and its three major branches; the pharyngeal, superior laryngeal, and recurrent laryngeal branches. We review the motor (branchial and visceral) and sensory (general and visceral) functions of the vagus nerve. We also demonstrate a series of cases which illustrate clinical manifestations and disease processes that involve the vagus nerve.

**APPROACH/METHODS**

Detailed illustrative images of vagus nerve anatomy and function will be shown as it originates from the nucleus ambiguus in the medulla, gives rise to the pharyngeal branch, superior laryngeal nerve, and distally the recurrent laryngeal nerve, with asymmetric course of the right and left nerves. We present a series of cases of common and uncommon conditions which involve the vagus nerve. Correlative imaging using cross-sectional imaging, PET/CT, digital subtraction angiography, and CT/MR angiographic images are shown as appropriate. Clinical manifestations of the pathologic conditions also are described.

**FINDINGS/DISCUSSION**

Vagus nerve pathology can occur anywhere along its course. Commonly, recurrent laryngeal nerve injury is a postsurgical complication in anterior cervical diskectomy/fusion and thyroid surgery. Commonly involved tumors include: metastasis from lung, breast, prostate, thyroid, and parathyroid carcinomas, nasopharyngeal/oropharyngeal squamous cell carcinomas, gliomas, lymphoma, paragangliomas, meningiomas, nerve sheath tumors. Vascular etiologies include: Wallenberg syndrome, brainstem hemorrhage, aortic arch aneurysms, vascular malformation, cardiomegaly, and ICA dissection. Infectious etiologies include: abscesses, Lyme disease, and skull base osteomyelitis. Head and neck trauma, tuberculosis meningitis, leptomeningeal sarcoidosis, clivus chordoma and multiple sclerosis also may produce vagus nerve palsy. Imaging features of vagus nerve pathology are broad and can be organized into five segments as described by Policeni and Smoker: nuclear, cisternal, skull base, suprahypoid neck, and infrahyoid neck segments. The vagus nerve is the only lower cranial nerve to continue into the mediastinum. Isolated right vocal cord paralysis can be seen with right recurrent laryngeal nerve paralysis in thyroid or parathyroid carcinoma, most commonly with extracapsular spread, or with direct invasion secondary to esophageal carcinoma. The most common finding with isolated left recurrent laryngeal nerve is pathology within the aorticopulmonary window, most commonly bronchogenic carcinoma. Imaging features of denervation atrophy include asymmetric decrease in affected muscle volume, fatty infiltration of the involved muscle group, and usually occur several weeks after initial injury. Imaging signs of vocal cord paralysis include atrophy of the thyroarytenoid muscle, deviation of the arytenoid cartilage, enlargement of the laryngeal ventricle and piriform sinus on the side of paralysis, and paramedian position of the involved vocal cord. Pooling of secretions on the side of the paralysis can be seen as well as atrophy of the posterior cricoarytenoid muscle.

**SUMMARY/CONCLUSION**

The anatomy and course of the vagus nerve is tortuous and unique, making it susceptible to a multitude of disease processes along its course. Thorough knowledge of its anatomy and spectrum of pathology can improve accuracy in the imaging diagnosis of vagus nerve pathology.

**KEY WORDS:** Vagus nerve, vocal cord paralysis, cranial nerve pathology

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**Electronic Scientific Exhibit 83**

**Inner Ear Anomalies in Children: Overview of Imaging Manifestations Using the Sennaroglu Classification**

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**PURPOSE**

Inner ear anomalies are complex and previous classifications have been based primarily upon polytomographic methods (1). Modern imaging methods (CT and MR) allow a much more complete assessment of inner ear anatomy and are used frequently to guide therapeutic decisions. Newer classifications [Sennaroglu (SC)] have used these techniques to describe inner ear anomalies, relate them to putative times of embryogenesis, and build on previous classifications to provide a framework for imaging reporting and clinical application (2). We present an overview of the SC with imaging correlation.

**APPROACH/METHODS**

Case material from a large academic, tertiary care pediatric medical center is utilized to demonstrate the spectrum of inner ear anomalies. Techniques used include high-resolution volumetric CT, and MR imaging at 3T with dedicated surface coils. Postprocessing with multiplanar and volumetric reconstructions is performed and applications discussed. Graphical representations of anomaly subtypes are provided and related to imaging findings and embryogenesis.

**FINDINGS/DISCUSSION**

Utilizing the SC, cochleovestibular malformations can be divided into: Complete labyrinthine aplasia (Michel deformity), cochlear aplasia, common cavity deformity, and cochlear hypoplasia. New incomplete partition subtypes; incomplete partition type I (cystic cochleovestibular malformation), and incomplete partition type II (classic Mondini malformation) are suggested. Related malformations of the semicircular canals, internal auditory canal, and vestibular aqueduct are discussed. A standardized approach to inner anomaly reporting and clinical application is presented.
a) anatomical variation: asymmetric fatty marrow, trapped
dizziness and fullness in the ear. Lesions are classified into
Clinical features included cranial neuropathies, vertigo,
and contrast-enhanced high-resolution MR imaging of IAC.
patients had high-resolution CT scan of the temporal bone
PACS system of 32 patients with petrous apex lesion. All
We retrospectively reviewed the imaging studies from our
APPROACH/METHODS
gies.
entiating points between the various petrous apex patholo-
1. To learn the radiologic anatomy of petrous apex and its
PURPOSE
relationship with surrounding brain structures and cranial
nerves; and 2. To highlight the importance and salient differ-
Figure. Three year old with severe right-sided sensorineural
hearing loss. Top row - Axial CT with volume rendered 3-D
image (a-d) displays predominantly cystic cochlea (*, a) and
dysplastic vestibule (long arrow, c) with incomplete separa-
tion. Three-dimensional image from CT shows IAC (short
arrow, d) and dysplastic, cystic appearing cochlea and
vestibule (long arrows, d). Note rudimentary, poorly formed
semicircular canals. Bottom row - Thin-slice 1.5 T FIESTA
MRI (e-h) shows cystic cochlea and vestibule (double arrow)
and thin partition (arrowhead). Three-dimensional image (h),
nicely demonstrates featureless but separate cochlea (short
arrow) and dysplastic vestibule (long arrow) and semicircu-
lar canals (arrowheads).
SUMMARY/CONCLUSION
Imaging evaluation of children with hearing loss provides
critical information that can impact treatment significantly.
Utilization of a more standardized classification scheme can
improve clinical communication and provide a framework to
compare treatment strategies in these complex disorders.
REFERENCES
2. Sennaroglu L, Saatci I. Laryngoscope 2002;112:2230-2241
KEY WORDS: Temporal bone anomalies, pediatric
Electronic Scientific Exhibit 84
Anatomy and Pathology of Petrous Apex: “touch me versus touch me not” Lesions
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PURPOSE
1. To learn the radiologic anatomy of petrous apex and its
relationship with surrounding brain structures and cranial
nerves; and 2. To highlight the importance and salient differentiating points between the various petrous apex pathologies.
APPROACH/METHODS
We retrospectively reviewed the imaging studies from our PACS system of 32 patients with petrous apex lesion. All patients had high-resolution CT scan of the temporal bone and contrast-enhanced high-resolution MR imaging of IAC. Clinical features included cranial neuropathies, vertigo, dizziness and fullness in the ear. Lesions are classified into a) anatomical variation: asymmetric fatty marrow, trapped
fluid; b) infection; c) cholesteatoma and cholesterol granuloma; d) neoplastic lesions: primary involving the bone and secondary/metastasis to apex; e) vascular.
FINDINGS/DISCUSSION
We illustrate the imaging appearances of the various processes and discuss the clinical significance.
SUMMARY/CONCLUSION
Since clinical presentations of petrous apex pathologies are nonspecific and it is a difficult area for otolaryngologist to operate, imaging plays a very important role in identifying and characterizing various lesions of petrous apex. Imaging also helps in differentiating “touch me versus touch me not” lesions. This exhibit will be a core learning tool for petrous apex anatomy and pathology.
KEY WORDS: Petrous apex, temporal bone

Electronic Scientific Exhibit 85
Utility of Diffusion-Weighted MR Imaging for Cholesteatoma Evaluation
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PURPOSE
Several recent studies have demonstrated the efficacy of diffusion-weighted (DW) magnetic resonance (MR) imaging in the detection of residual or recurrent cholesteatoma following mastoidectomy. Although not well understood, cholesteatomas are hyperintense on diffusion-weighted imaging (DWI) compared to cerebrospinal fluid (CSF) and brain parenchyma, like epidermoid cysts which are histologically identical. Despite this compelling data, many practices in the United States have yet to adopt DWI for evaluation of residual/recurrent cholesteatoma. The purpose of this exhibit is to demonstrate the utility of DWI for evaluation of cholesteatoma. We discuss the limitations of the clinical exam in the postmastoidectomy patient, review the advantages and disadvantages of various diffusion techniques, and highlight the MR findings in several instructive clinical cases.
APPROACH/METHODS
Traditional DWI echo-planar imaging (EPI) based sequences are time efficient, but sensitive to the field inhomogeneities present near the skull base. To reduce image artifacts, spin-echo based techniques can be applied. One such sequence is a single-shot turbo-spin echo (TSE) method such as HASTE. Image quality and resolution can be improved further by a multishot technique such as DWI BLADE. This reduces T2 blurring at the expense of a longer acquisition time.
FINDINGS/DISCUSSION
Patients traditionally have undergone two-stage operations for cholesteatoma removal, with a second-look procedure performed to look for residual or recurrent disease (1). This second surgery has been necessary due to limited visibility of the middle ear cavity following canal wall-up mastoidectomies or cartilaginous reconstructions. More recently authors have used DWI for assessment of recurrent disease.
Initial attempts at DWI for cholesteatoma evaluation used EPI-DWI techniques. These EPI images generally were effective for detection of lesions 5 mm or larger in size, but frequently missed smaller lesions (2, 3). More recent studies have used non-EPI techniques and shown greater success at detecting lesions as small as 2 mm (4). In our experience, DWI can be used to follow patients after cholesteatoma surgery to evaluate for recurrence, as demonstrated by the cases presented in this exhibit. Diffusion-weighted imaging is also a useful adjunct to CT in initial evaluation of cholesteatoma if there is erosion of the tegmen tympani, semicircular canal fistula, or facial nerve canal dehiscence.

SUMMARY/CONCLUSION
Diffusion-weighted imaging is a useful tool for evaluation of residual or recurrent cholesteatoma. Our experience has changed the way we follow patients after mastoidectomy for cholesteatoma to include MRI with DWI in lieu of second look procedures.

REFERENCES

KEY WORDS: Cholesteatoma, diffusion

Electronic Scientific Exhibit 86
Petrus Apex Lesions: Pictorial Essay

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Gentry, L. R.
University of Iowa Hospital, Iowa City, IA
Kennedy, T. A.
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PURPOSE
Petrus apex lesion is not an uncommon lesion. The purpose of this exhibit is: 1. To review the normal anatomy of the petrous apex; 2. To illustrate the spectrum of lesions at the petrous apex; 3. To review the typical and atypical imaging appearance of lesions at the petrous apex; and 4. To discuss the complementary role of advanced MR imaging sequences in evaluation of petrous apex.

APPROACH/METHODS
Management of lesions at petrous apex poses a unique challenge for the radiologist. A diverse spectrum of inflammatory, infective, benign, malignant, vascular lesions as well as normal variant simulating tumors have been reported at the petrous apex.

FINDINGS/DISCUSSION
These lesions may present with symptoms caused by mass effect or cranial nerve palsies, or incidentally discovered. Imaging helps to detect the extent of the lesion, relation to surrounding structures. Advanced MR imaging helps in characterization of the lesions at petrous apex.

SUMMARY/CONCLUSION
Imaging helps in diagnosis and characterization of petrous apex lesions. This information is essential for decision of treatment planning.

KEY WORDS: Apex, petrous

Electronic Scientific Exhibit 87
Ossicular Injury in Temporal Bone Trauma

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Waukesha Memorial Hospital, Waukesha, WI
University of Iowa Hospital, Iowa City, IA
Long Island College Hospital, Brooklyn, NY

PURPOSE
This scientific exhibit illustrates the patterns and frequency of ossicular injury in the setting of temporal bone trauma using multidetector computed tomography (MDCT). Due to the complex anatomy, diagnosing ossicular injuries can be challenging. This computer module highlights ossicular anatomy and allows participants to review patterns of ossicular injury in the setting of temporal bone fracture, with emphasis on the spatial relationships of the ossicles within the middle ear cavity.

APPROACH/METHODS
The CT images of 286 patients with temporal bone fractures between 2001 and 2009 at a level I trauma center were reviewed retrospectively. Multidetector computed tomography was performed on 8, 16 and 64 row scanners. Images were obtained in the axial plane. Reconstructions were performed in the coronal plane, oblique plane parallel to the petrous bone and oblique plane perpendicular to the petrous bone. The studies were assessed for the presence of temporal bone fractures and ossicular injury.

FINDINGS/DISCUSSION
Of the 286 patients (aged 2 to 92 years) with temporal bone fractures, there were 74 patients who sustained bilateral fractures. Injuries occurred from motor vehicle collisions, falls, blunt trauma and crush injuries. There were 131 cases in which ossicular injury was identified (97 male and 21 female). There were 46 cases in which the injury was noted on the left, 59 on the right and 13 patients who sustained bilateral ossicular injuries. Ossicular injury was seen in the setting of 42 complex temporal bone fractures, 82 longitudinal type fractures and seven transverse fractures according to the Ulrich classification. Five of the fractures were intralabyrinthine, 113 extralabyrinthine and 13 that had both intra and extra labyrinthine components. Ossicular injury included dislocations (112 cases), ossicular fractures (32 cases) and ligamentous injuries (35 cases). Dislocations, fractures and
Electronic Scientific Exhibit 88

Spontaneous Regression of Intracranial In-Stent Restenosis

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PURPOSE

In-stent restenosis is an important issue in stent practice. It may be due to inflammatory reaction, fibrosis or ongoing atherosclerosis. We would like to present three cases having intracranial stent in-stent restenosis and spontaneous regression on follow up.

APPROACH/METHODS

We are presenting three cases that had been treated with stents. One was treated because of atherosclerotic stenosis, and two had aneurysms. Case 1: 58-year-old man presented with posterior system transient ischemic attacks and had intracranial left vertebral artery occlusion and severe stenosis of right vertebral artery intracranial segment. Patient treated with balloon-expandable stent and control DSA showed in-stent restenosis in 1 year and regression of the restenosis in 18-month and 3-year control angiography. Case 2: Patient with intracranial aneurysm was treated with balloon-expandable stent in left posterior cerebral artery and 1-year control DSA showed in-stent restenosis where 18-month and 5-year control DSA demonstrated total regression. Case 3: Twenty-four-year-old male patient presented with ruptured ICA aneurysm treated with Silk stent and 3-month DSA showed in-stent restenosis and under dual antiplatelet therapy 6-month DSA demonstrated total regression.

FINDINGS/DISCUSSION

In-stent restenosis is a very well known issue in stent business especially in coronary area and atherosclerosis. In intracranial circulation it is less seen but sometimes it could be severe and need additional treatment.

SUMMARY/CONCLUSION

In this study we are sharing our experience in three cases that showed total regression of the in-stent stenosis in all cases with dual antiplatelet therapy.

KEY WORDS: In-stent restenosis, regression
Spontaneous Intracerebral Hemorrhage in Children: Causes and Imaging Features

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PURPOSE
1. To form a systemic approach in radiologic evaluation of spontaneous intracerebral hemorrhage in children; 2. To discuss the etiologies of spontaneous intracerebral hemorrhage in the pediatric age group; and 3. To discuss the imaging findings of the common etiologies of spontaneous intracerebral hemorrhage in the pediatric age group.

APPROACH/METHODS
Spontaneous intracerebral hemorrhage (SIH) in children is relatively less common as compared to adults and there are limited studies addressing this issue in children. This exhibit reviews a number of intracranial lesions that cause non-traumatic hemorrhages in the pediatric population. Most of these lesions include vascular malformations such as arteriovenous malformations, intracranial aneurysms and cavernous malformations. Even though other lesions such as vein of Galen malformations (Figure), moyamoya disease and intracranial bleeds associated with tumors are less common, they must be considered in children presenting with nontraumatic hemorrhages. We discuss the various etiologies, differences in presentation and radiologic evaluation of these lesions.

FINDINGS/DISCUSSION
Although more common in older adults, spontaneous intracerebral hemorrhage also occurs in neonates, infants, children and young adults, resulting in significant morbidity and mortality. The etiology, clinical presentation and differential diagnosis of hemorrhagic stroke in children is significantly different from the adults. Hypertension and amyloid angiopathy are by far the major causes of SIH in the adult age group. Spontaneous intracerebral hemorrhage in childhood most often is due to arteriovenous malformation, hematologic abnormality or brain tumor. Other etiologies include cavernous hemangioma, vasculopathy, vasculitis, cerebral and systemic infections and rarely, illicit drug use. Pediatric patients with clinical signs of hemorrhagic stroke should first have a CT scan. After the patient is stable, elective MR imaging is required in majority of cases for further evaluation of the blood clot seen on CT. The choices of the additional investigations are based upon CT/MR findings. For arteriovenous malformations, the gold standard for diagnosis remains cerebral angiography. The physician should keep in mind the diagnosis of SH in children, even though the presenting symptoms may be nonspecific and the incidence in children is low.

SUMMARY/CONCLUSION
The causes of pediatric spontaneous intracerebral hemorrhage are discussed along with imaging features of the common pathologies. Together, this will help in developing a systemic approach in evaluation of spontaneous intracerebral hemorrhage in children.

KEY WORDS: Spontaneous, intracerebral, hemorrhage

Chiari Patient: The Things You always Wanted to Know, but Were Afraid to Ask

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PURPOSE
The purpose of this exhibit is: 1. to describe the germane imaging findings in patients who have different types of Chiari malformations types I-III, 2. to define the clinical relevance based on imaging findings and patient symptomatology and 3. to explore the imaging findings most correlative to patient symptomatology with respect to reparative neurosurgical intervention such as suboccipital decompression.

APPROACH/METHODS
Through numerous imaging examples, this exhibit will review the typical imaging findings of the different Chiari malformations. The exhibit will focus on the typical MR imaging findings associated with each type of Chiari malformation, and how they relate with patient symptomatology. The importance of the key imaging findings related to patient symptomatology will be addressed as it relates to neurosurgical intervention and agreement between the neuroradiologist and neurosurgeon.

FINDINGS/DISCUSSION
The spectrum of congenital anomalies labeled Chiari malformations is broad and is categorized into the three major subtypes. The imaging findings of Chiari malformations are as follows: Type I: Pointed cerebellar tonsils ≥ 5 mm below foramen magnum +/- syringohydromyelia (14-75%), Type II: “Cascade” or “waterfall” of cerebellum/brainstem downwards, small posterior fossa with associated neural tube closure defect which is usually a lumbar myelomeningocele, and Type III: Intracranial Chiari type II malformation with a high cervical/occipital meningoencephalocele. The common symptoms of Chiari malformation patients include suboccip-
ital headaches, dizziness, vertigo, lower cranial nerve and spinal cord signs. These symptoms can become debilitating to the point where patients can no longer function at home or at their workplace. It is important for the neuroradiologist to know what imaging findings are pertinent to symptomatology. For example, findings such as tonsillar herniation greater than 12 mm nearly always are associated with clinical symptoms. Conversely, unless the tonsils are displaced greater than 5 mm below the line connecting the basion and opisthion, there is probably no significant Chiari malformation. Accurate, formalized and consistent description allows for reliable agreement between radiologist and neurosurgeon, who will ultimately decide upon conservative versus interventional management.

**SUMMARY/CONCLUSION**
Chiari malformations are migrational disorders of the posterior fossa which have a broad spectrum of imaging and clinical findings. There is current controversy regarding when neurosurgical intervention should be considered. A complete understanding of the pertinent imaging appearance and clinical relevance will allow the radiologist to correctly diagnose the different types of Chiari malformations, and accurately convey the findings to the referring neurosurgeon who will ultimately decide on conservative versus interventional management.

**KEY WORDS:** Chiari malformation, tonsillar herniation, syringomyelia

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### Electronic Scientific Exhibit 92

**Normative Tensor Metrics for School-Aged Children**

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**PURPOSE**
To expand the clinical applications of DTI by providing high-quality diffusion tensor data in a usable format derived from children with age-appropriate cognition and behavior.

**APPROACH/METHODS**
Cohort included 32 right-handed English speaking subjects ages 6-18 years. Cognitive and behavioral normalcy was determined with FSIQ (>84), Child Behavior Checklist (T score <70), Clinical Evaluation of Language Fundamentals (score >5), and measures of reading. Parameters for DTI; matrix 1282, voxel 2 mm3, 9000/74, b = 700; SENSE = 2; no signal averaging, 3 acquisitions; 30 directions. FA data were aligned to 9-year-old control brain using nonlinear registration and affine transformed into MN152 standard space. Voxel-by-voxel statistical analysis was done with TBSS with age as covariate and corrected for multiple comparisons using TFCE (p corrected <.05). Mean FA, SD, age effects on FA, and coefficient of variance (CV) were analyzed using custom program written in IDL.

**FINDINGS/DISCUSSION**
The callosal genu (CG) and splenium (CS) showed the highest FA values, smallest age effects, and lowest between-subject variability (r=0.36; p=.04, CV 2.8) (Table I). The largest age effects on FA were in the cingulum bilaterally, superior temporal (STG) WM, right centrum semiovale (CS), and the inferior frontal occipital-inferior longitudinal fasiculus (IFO-ILF). Radial diffusivity consistently decreased more than axial diffusivity increased. The largest decreases in radial diffusivity were in the right >right ILF, dorsal callosal body, right CST, cingulum, and left CS. The highest CV were in the dorsal callosal body, occipital WM, superior frontal (SFG), STG, and right CS.

Table I. Mean FA and Lower Limits by Location

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<th></th>
<th>6 yrs</th>
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**SUMMARY/CONCLUSION**
Valid comparisons of FA between normal children and subjects with neurodevelopmental problems require age-matched cohorts unless the affects of the disease are known to be large in comparison to the scale of age effects. Knowledge of age effects on FA and degree of location-specific variability in FA is important in power analysis.

**KEY WORDS:** Diffusion tensor imaging, age norms, TBSS

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### Electronic Scientific Exhibit 93

**Multimodality Imaging of Rasmussen Encephalitis: Diffusion Tensor Imaging and PET-MR Imaging; Correlation with Clinical, Histopathologic and Electroencephalogram Data**

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Los Angeles, CA

**PURPOSE**
1. To demonstrate the range of imaging characteristics in Rasmussen Encephalitis (RE) using 18F-fluorodeoxyglucose positron emission tomography (PET-MR) and diffusion tensor imaging (DTI), and compare it with clinical entities which may have similar imaging findings. 2. To corre-
late neuroimaging findings of RE with clinical, electroencephalogram and histopathologic data to illustrate the wide spectrum and progression of disease presentation.

**APPROACH/METHODS**
Fifteen surgically proved cases (seven females and eight males) of RE were reviewed retrospectively. All patients were evaluated with EEG monitoring; MRI and PET were obtained in all cases. Diffusion tensor imaging was performed in 12 cases. MR imaging was performed on a Siemens 1.5 T scanner using an epilepsy protocol. Diffusion tensor imaging was obtained with 2 mm thick slices in six directions with two b values. Apparent diffusion coefficient (ADC) and fractional anisotropy (FA) values were measured in areas of MRI signal abnormality and compared to the contralateral normal appearing tissue. Tractography also was performed.

**FINDINGS/DISCUSSION**
Seven females and eight males were included in the study. The mean seizure onset age was 5.6 years (range of 1.9-17). EEG showed typical epilepsy partialis continua in all patients. Conventional MRI showed FLAIR high intensity in the gray matter in 10 cases, and in the white matter in seven cases. Cortical atrophy was seen in 12 patients. FDG PET showed hypometabolism in 12 cases and hypermetabolism in six cases. Areas of PET hypermetabolism correlated to gray matter FLAIR signal hyperintensity on MRI and perivascular inflammatory macrophage accumulation on pathologic specimens. Later in the disease progression, areas of PET hypometabolism are seen, correlating to atrophy on MRI and neuronal loss on pathology. Diffusion tensor imaging showed increased ADC and decreased FA in the areas of MRI signal abnormality. Tractography demonstrated axonal fiber loss both on the side of the MRI/PET abnormality and the “unaffected” contralateral hemisphere.

**SUMMARY/CONCLUSION**
Multimodality imaging can help make a diagnosis of RE when evaluated in conjunction with clinical and EEG data. Areas of PET hypermetabolism correlated well to areas of FLAIR signal hyperintensity and active inflammation. Areas of PET hypometabolism correlated to areas of atrophy on MRI and neuronal loss on histopathology. Diffusion tensor imaging is instrumental in localizing and quantifying axonal fiber loss, in both the ipsilateral and contralateral hemispheres, and may therefore help to identify surgical candidates before extensive atrophy has occurred.

**REFERENCES**

**KEY WORDS:** Diffusion tensor imaging, Rasmussen encephalitis, tractography
**SUMMARY/CONCLUSION**
The initial description of DIGs as being confined to infants and exhibiting clinically benign characteristics should be amended, as a small but significant percentage of these tumors will exhibit a more complicated and morbid clinical course, underscoring the need for expanded biological and molecular investigation.

**KEY WORDS:** Desmoplastic infantile ganglioglioma, DIG, pediatric brain tumor

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**Electronic Scientific Exhibit 95**

**Melanotic Medulloblastoma: Case Report and Review of the Literature**

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Cincinnati, OH

**PURPOSE**
Medulloblastoma with melanotic differentiation is a rare diagnosis, with only 19 cases reported in the literature since this entity was first described in 1962. In this exhibit we present a case of medulloblastoma with melanotic differentiation with MR and CT imaging and review the prior reports of this entity to summarize the pertinent imaging, clinical, and pathologic features of this rare and aggressive tumor.

**APPROACH/METHODS**
A 4-year-old male with a 2-week history of headaches had a posterior fossa mass identified on CT. Subsequent MR imaging showed the mass to be heterogeneously enhancing, with some cystic foci. In addition, there were multiple metastatic lesions seen throughout the brain and spinal cord. At surgery, all of the lesions were markedly dark in color, nearly black, and pathologic evaluation demonstrated medulloblastoma with melanotic differentiation. He was treated with chemotherapy and radiation, but his clinical course was complicated by seizures, hypertension, PRES, hyponatremia, intracranial hypertension, pseudomonas meningitis, and SIADH. Chemotherapy was terminated after 5 cycles due a myriad of complications and relatively chemoresistant disease. Serial MR examinations over the five courses of chemotherapy demonstrated stable, diffusely metastatic disease. He is currently clinically stable, with a good quality of life, on phenobarbitol for control of seizures. A literature search for cases of melanotic medulloblastoma revealed 19 previous reports dating back to 1962. All reports were analyzed for age at presentation, gender, presenting symptoms, radiological and surgical findings, histological characteristics, treatment course, and follow up.

**FINDINGS/DISCUSSION**
Based upon these 20 cases, melanotic medulloblastoma is found most commonly in the vermis young children; only two cases were diagnosed in adults (21 and 28 years old), and there is a 5:1 male to female predominance. Leptomeningeal spread of tumor was documented in only four of the 20 cases, but only three cases were reported with disease-free survival on follow up. Imaging evaluations ranged from skull radiographs only in some early cases to MR, CT, and nuclear medicine evaluation in our case. Despite the extensive melanotic pigmentation evident at surgery and pathology, there are no reports of hyperintense signal on noncontrast T1-weighted imaging with these tumors, and such T1 shortening was not seen in our case.

**SUMMARY/CONCLUSION**
Medulloblastoma with melanotic differentiation is an aggressive subtype of medulloblastoma that presents more frequently in males at a slightly younger age than typical medulloblastoma. Although the incidence of leptomeningeal spread of tumor at diagnosis does not seem to be greater than in typical medulloblastoma, this subtype appears to be particularly chemotherapy and radiation therapy resistant, and has an overall worse prognosis.

**KEY WORDS:** Medulloblastoma, melanotic, brain tumor

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**Electronic Scientific Exhibit 96**

**Dysembryoplastic Neuroepithelial Tumors: Varied MR Imaging Appearances**

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Detroit, MI

**PURPOSE**
Dysembryoplastic neuroepithelial tumors (DNETs) are rare benign neoplastic proliferations that can cause seizures. The purpose of this exhibit is to review the history, epidemiology, pathophysiology, and varied MR imaging appearances of these tumors.

**APPROACH/METHODS**
Select MR images from 30 patients with DNETs confirmed by histopathologic examination are presented in interactive Powerpoint format. MR imaging features including T1 and T2 signal characteristics, size, location, enhancement, bony remodeling, calcification, hemorrhage, "ring sign", and cysts/pseudocysts are discussed. Differential diagnoses also are presented and discussed.

**FINDINGS/DISCUSSION**
Dysembryoplastic neuroepithelial tumors are cortical/subcortical masses that often present in the pediatric population during seizure workup. They are discovered most commonly in the temporal lobes but also can present in frontal, parietal, and occipital lobes. Dysembryoplastic neuroepithelial tumors have varied imaging appearances that can mimic other tumors. For example, DNETs which are solid with cystic components resemble gangliogliomas. Dysembryoplastic neuroepithelial tumors which are predominantly infiltrative resemble gliomas. MR imaging features from our series are discussed and compared with those in the literature.

**SUMMARY/CONCLUSION**
By understanding the varied MR appearances of DNETs, they can be more confidently included in the differential diagnosis for patients with cortical or subcortical tumors.

**KEY WORDS:** Pediatric, neoplasm, DNET
Central Nervous System Involvement and Chemotherapy Complications in Pediatric Patients with Leukemia

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1Clínica Davila, Santiago, CHILE, 2Asociación Chilena de Seguridad, Santiago, CHILE

PURPOSE
To review the different types of magnetic resonance imaging (MRI) brain abnormalities in children with acute lymphoblastic leukemia (ALL), which are present either at diagnosis or subsequently to chemotherapy.

APPROACH/METHODS
A retrospective analysis of brain MR images of patients with leukemia at our institution was conducted. Including studies performed for diagnostic purposes and those to rule out complications during treatment of ALL, from the years 2004 to 2009. The lesions encountered were classified in two groups: those due to tumor involvement and those secondary to chemotherapy.

FINDINGS/DISCUSSION
The disease-related complications of leukemia observed in this study were: parenchymal infiltration documented by spectroscopy, leptomeningeal disease, chloromas, infundibular stem leukemia and cranial nerve impairment. Of the chemotherapy-related lesions, the following were encountered: chronic leucoencephalopathy related with methotrexate, acute methotrexate-induced neurotoxicity, vascular thromboses, posterior reversible encephalopathy, hemorrhage and brain atrophy.

SUMMARY/CONCLUSION
A wide spectrum of brain abnormalities can be present at diagnosis or throughout treatment for leukemia. Their evolution is variable, and even though some of them are reversible others are at risk of definitive sequelae, thus the radiologist must be familiar with them in order to recognize them promptly.

KEY WORDS: Leukemia, chemotherapy

MR Imaging Diffusion Characteristics on Head and Neck Tumors in the Pediatric Population: Pictorial Review

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Charleston, SC

PURPOSE
To show the value of MR diffusion imaging for head and neck tumor assessment in the pediatric population.

APPROACH/METHODS
Sixteen cases of head and neck lesions in patients ranging in age from 1 month to 17 years were selected. The abnormalities included soft tissue tumors (juvenile nasoangiofibroma-1, rhabdomyosarcoma-2, Ewing’s tumor-1, salivary ductal carcinoma-1, undifferentiated sarcoma-1, Rosai-Dorfman disease-1, retinoblastomas-2), vascular tumors (hemangioma-1), cystic-like lesions (lymphangiomata-1, dilated salivary duct-1, dermoid cyst-1), an infectious process (orbital salmonella infection-1), and bone pathologies (Inflammatory process-1, Salmonella osteomyelitis-1 and Rosai-Dorfman disease-1), with histologic and clinical information available for correlation with imaging findings. Diffusion-weighted images (DWI) were obtained with echo planar acquisition in the axial plane, with b values of 0 and 1000. In five cases of the soft tissue tumors, posttreatment follow-up images also were reviewed. ADC values were available in 11 cases.

FINDINGS/DISCUSSION
Diffusion-weighted imaging was of diagnostic quality in 15 of the 16 subjects. In only one case there was a prominent image distortion at the lesion site, which significantly impaired the diagnostic quality. However, in all of the cases identification of the lesion was possible. Three cases of bone lesions showed more conspicuous visualization of the lesions at the DWI images when compared to T1- and T2-weighted imaging with fat-suppression. In 11 cases of soft tissue tumors the ADC values were relatively low when the tumor cellularity was high. In four cases of posttreatment follow-up images (2 rhabdomyosarcomas, 1 Ewing’s tumor and 1 Rosai-Dorfman disease) good response was followed by reduction in tumor size and increase in ADC values. The cystic lesions showed very high ADC values.

SUMMARY/CONCLUSION
Diffusion MRI is feasible in the pediatric population and helpful for lesion detection and characterization of head and neck lesions. It may add information on the tumor cellularity, as well as posttreatment tumor response.

KEY WORDS: Diffusion-weighted imaging, MR imaging, head and neck lesions

Trainee Misinterpretations on Pediatric Neuroimaging Studies: Classification, Imaging Analysis, and Outcome Assessment

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PURPOSE
On-call trainee (resident and fellow) initial interpretations of neuroimaging studies are common in large pediatric medical centers. Although an integral part of training, discrepancies occur and can impact patient care. Few studies have evaluated this process, and the unique neuroimaging issues encountered in children have not been assessed fully. This study will identify the frequency of trainee misinterpretations on pedi-
Trainee reported exams (without initial attending radiologist assessment) are tracked within the RIS at our hospital (TRE). These included CT and MR imaging of the head, face, neck, and spine; and CTA and MRA examinations. Any clinically significant discrepancies (discrepant exams, DE) are added as an addendum to reports by the staff radiologist by a voice recognition macro, allowing for identification within the RIS. The RIS was searched for TRE and DE for a consecutive 18-month period. The medical record was reviewed for each DE. Discrepant exams were reviewed by two experienced neuroradiologists, a consensus obtained, and were classified as Major, life threatening (type 1), Minor - related to clinical presentation (2), Minor - unrelated (3), Possible abnormality (4), and Abnormality called when none present (overcall) (5). Clinical outcomes (CO) of the DE were classified as None (type 1), No direct treatment change - imaging or clinical follow-up (2), Direct treatment change (morbidity) (4), and Death potentially related to the DE (5). A detailed sub-classification was used for assessing the types of DE for each modality.

**FINDINGS/DISCUSSION**

There were 152 DE and a total of 3,496 TRE during the study period for an overall discrepancy rate (DR) of 4.35%. Of these, 6 were classified as type 1, for a major DR of 0.17%. These major discrepancies included diffuse brain edema (four cases, hypoxic-ischemic, PRES), and significant traumatic ICH (2 cases, EDH and SDH). There were 76 Type 2 discrepancies of varied cause (most common: minimal traumatic ICH (14), calvarial fractures (10), ventricle size assessment (9), focal parenchymal changes (6), and mass lesions (3). There were 35 type 5 DE (overcalls), 2 of which resulted in inappropriate therapy (other imaging exams). There was no permanent morbidity or mortality related to the DE. There were 43 type 2 CO, and three type 3 CO in the study group. Detailed analysis of the DE by imaging modality and discrepancy type will be presented.

**SUMMARY/CONCLUSION**

Trainee misinterpretations occur in approximately 4% of on-call pediatric neuroimaging examinations. A very small number (0.17%) were life-threatening. No permanent morbidity or mortality resulted from these discrepancies. On-call TRE remains an integral component of radiology training. Detailed analysis of the types of misinterpretations can inform proactive trainee education, and potentially reduce these discrepancies further, resulting in improved education and patient care.

**KEY WORDS:** Pediatric, quality assurance, trainee discrepancies

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**Electronic Scientific Exhibit 101**

**Pediatric Spine Anomalies: Classification, Pitfalls and Malformations with Interactive Self-Assessment Exam**

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1University of Missouri, Kansas City/St. Lukes Hospital, Kansas City, MO, 2University of Missouri, Kansas City School of Medicine, Kansas City, MO, 3Children’s Mercy Hospital and Clinics and the University of Missouri, Kansas City/St. Lukes Hospital, Kansas City, MO

A variety of anomalies occur in the pediatric spine. Modern imaging techniques such as MR imaging and ultrasound have allowed advanced characterization of spine anomalies. The goal of this electronic exhibit is to provide an update on the classification of pediatric spine anomalies using an interactive review of spine embryology, anatomy, and imaging pitfalls with concomitant self-assessment examination. This exhibit illustrates the recent updates on classification regarding pediatric spinal anomalies with a self-assessment examination to reinforce the material.

**KEY WORDS:** Spine anomalies, pediatric

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**Electronic Scientific Exhibit 100**

**User-Friendly Online Service for Neuroradiology Fellowship Website Content Management**

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Beth Israel Medical Center
New York, NY

**PURPOSE**

To introduce a user-friendly online service as a tool for neuroradiology fellowship website development.

**APPROACH/METHODS**

Neuroradiology fellowship program websites frequently provide very limited information and are linked deeply within the radiology departmental website. However, a website can be a valuable recruiting and management tool for neuroradiology fellowship programs. This exhibit describes an inexpensive, user-friendly web-based system to create, edit, manage, and publish content.

**FINDINGS/DISCUSSION**

A content management system can be managed by someone with no previous experience in hypertext markup language or website development expertise. The site can be used to provide very limited information and are linked deeply within the radiology departmental website. However, a website can be a valuable recruiting and management tool for neuroradiology fellowship programs. This free application can be used to post the neuroradiology fellow policy manual and fellowship goals and objectives. A dynamic calendar function can be used to post the conference and lecture schedule. Educational material and external links can be posted. A lim-
PURPOSE
England Baptist Hospital, Boston, MA
1North Shore University Hospital, Manhasset, NY, 2New
mobility can lead to the development of pathology resulting
articulation and/or at the contralateral facet joint. This hyper-
above the transitional segment, at the ipsilateral anomalous
stabilization. On the other hand, there is hypermobility
or anomalously articulating level creates a greater degree of
vertebrae affect the normal biomechanics of the lumbar spine.

TRANSITIONAL LUMBOSACRAL VERTEBRAE
Lumbosacral transitional vertebral segments can be associat-
ed with the development of low back pain. Transitional ver-
LSTV . The exhibit will demonstrate the various sources of
pain in “Bertolotti’s syndrome” with low back pain.

APPROACH/METHODS
Through numerous cases of Bertolotti’s syndrome, this
exhibit will review the relationship of low back pain with
LSTV. The exhibit will demonstrate the various sources of
pain seen in this syndrome: 1) Disk and posterior element
pathology at the level above a transition, 2) degeneration of
the anomalous articulation between an LSTV and the
sacrum, 3) facet joint arthrosis contralateral to a unilateral
fused or articulating LSTV, and 4) extraforaminal stenosis
secondary to the presence of a broadened transverse process.
Treatment options based on the source of pain will be dis-
cussed.

FINDINGS/DISCUSSION
Transitional lumbosacral vertebral segments can be associat-
ed with the development of low back pain. Transitional ver-
tebrae affect the normal biomechanics of the lumbar spine.
At the level of the transitional vertebrae, the partially fused
or anomalously articulating level creates a greater degree of
stabilization. On the other hand, there is hypermobility
above the transitional segment, at the ipsilateral anomalous
articulation and/or at the contralateral facet joint. This hyper-

SUMMARY/CONCLUSION
Use of a readily available web-based content management
system is a valuable tool in the development of a neuroradi-
ology fellowship program website. The site can function as
both a recruiting tool for prospective fellows and a valuable
resource for the education and daily activities of a neurora-
diology fellow.

KEY WORDS: Website, fellowship

Electronic Scientific Exhibit 102
Bertolotti’s Syndrome
Wang, A.1 · Konin, G.1 · Rencus, T.2 · Spitz, D.2 ·
Woldenberg, R. F.1 · Walz, D. M.1
1North Shore University Hospital, Manhasset, NY, 2New

Electronic Scientific Exhibit 103
2010: A Spine Odyssey: Novelties in Spine Implants
Konin, G.1 · O’Donnell, J.1 · Madoff, S.1 · Spitz, D. J.1 · Walz,
D. M.1 · Rencus, T.1
1North Shore University Hospital, Manhasset, NY, 2New

SUMMARY/CONCLUSION
Low back pain is one of the most common causes of disabil-
ity in the adult population. It is crucial to identify its cause to
correctly guide treatment. Transitional lumbosacral seg-
ments are common and, although often disputed, have been
associated with low back pain. A complete understanding of
the different morphologies of transitional lumbosacral verte-
brae and how each relates to the development of back pain is
crucial for the radiologist to aid spine clinicians in treating
and diagnosing these patients.

KEY WORDS: Spine, Bertolotti, pain

APPROACH/METHODS
Surgical approach and potential complications will be
addressed including new indications for upright myelogra-
phy and techniques, 2. explain the rationale behind these
devices and the novel surgical approaches used, 3. demon-
strate their appearance on X-ray, MR imaging, CT, and
myelography and 4. alert the radiologist to the potential
complications of these new implants and procedures.

FINDINGS/DISCUSSION
Spinal implants are constantly evolving. It is a challenge for
even the most dedicated spine radiologist to stay abreast of
new technologies (Axial LIF, interspinous spacers, allograft
facet fusion, expandable interbody devices, biologic agents).
The purpose of this exhibit is to 1. update the radiologist
with the latest devices in minimally invasive spine implantation
and techniques, 2. explain the rationale behind these
devices and the novel surgical approaches used, 3. demon-
strate their appearance on X-ray, MR imaging, CT, and
myelography and 4. alert the radiologist to the potential
complications of these new implants and procedures.

APPROACH/METHODS
The newest spine implants will be reviewed with special
attention to the rationale behind each new development.
Surgical approach and potential complications will be
reviewed. Relevant changes in imaging protocols will be
addressed including new indications for upright myelogra-
phy and potential indications for dynamic MR imaging.
Normal and abnormal imaging findings will be shown and
commonly encountered complications will be highlighted.

FINDINGS/DISCUSSION
Maintaining up-to-date knowledge of the surgical techniques
and instrumentation used in spinal surgery is essential for the
radiologist. Novel techniques including Axial LIF, inter-
spinous spacers, allograft facet fusion, expandable interbody
devices, and biologic agents are rapidly replacing conven-
tional techniques. New complications can arise from novel
surgical approaches, subsequent altered biomechanics, and
from use of biological agents.

SUMMARY/CONCLUSION
Spine surgery utilizes a constantly evolving armamentarium
of hardware. With new devices and surgical techniques come
new complications. Our aim is to help the radiologist main-
tain a current knowledge of orthopedic hardware, surgical technique and postoperative imaging.

**KEY WORDS:** Implant, spine, surgery

**Electronic Scientific Exhibit 104**

*My Back Pain Has a Last Name*

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**PURPOSE**

The use of eponyms in medicine, though generally discouraged, is widespread. Knowledge of the commonly encountered eponyms aids the radiologist in avoiding miscommunication with referring clinicians. The purpose of this exhibit is to 1. review the causes of back pain and radiculopathy that commonly are referred to by a proper name, 2. discuss the pathophysiology and presentation of each disease, and 3. place the physician for whom each condition is named within a historical context.

**APPROACH/METHODS**

Eponymous conditions known to cause back pain and radiculopathy will be reviewed systematically. For each condition, the relevant anatomy, physiology, and pathology will be discussed, with emphasis on the mechanisms by which the combination of these factors may cause back pain. Imaging characteristics of each condition will be reviewed in all relevant modalities. In addition, a brief historical discussion, including information regarding the background of the naming clinician and circumstances surrounding the discovery and description of each condition, will be provided.

**FINDINGS/DISCUSSION**

A wide variety of eponymously named conditions will be reviewed, ranging from commonly encountered entities, such as Schmorl’s nodes, to rare disorders such as Foix-Alajouanine syndrome. The presented conditions will represent a broad range of pathophysiology, including entities resulting from altered anatomy and biomechanics, degenerative causes, infectious diseases, vascular anomalies, and congenital abnormalities.

**SUMMARY/CONCLUSION**

The use of eponyms in medicine is ubiquitous. A variety of conditions that result in back pain and radiculopathy are referred commonly to eponymously. These represent a wide variety of pathologic states, and encompass both commonly encountered and exceedingly rare conditions. A working knowledge of commonly utilized eponyms is desirable in facilitating communication between the radiologist and referring clinicians.

**KEY WORDS:** Eponym, spine

**Electronic Scientific Exhibit 105**

*Lumbar Diskography in the Modern Age*

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1North Shore University Hospital, Manhasset, NY, 2New England Baptist Hospital, Boston, MA

**PURPOSE**

The purpose of this exhibit is: 1. to review lumbar diskography indications, technique and potential risks; 2. to describe the role and limitations of lumbar diskography in diagnosing low back pain; and 3. to review the imaging findings of common pathology on diskography.

**APPROACH/METHODS**

Through numerous illustrations and imaging examples, this exhibit will review the anatomy of the lumbar intervertebral disk and offer a strategy for safely performing lumbar diskography and provocatively diagnosing lumbar disk pathology. Indications for the procedure will be reviewed and imaging findings of common disk pathology will be displayed and discussed.

**FINDINGS/DISCUSSION**

Lumbar diskography is safe and useful as both a diagnostic and provocative test in the diagnosis of low back pain when other imaging modalities and prior surgeries fail to reveal a cause. Pathology involving the nucleus pulposus and annulus fibrosis can be diagnosed accurately through the injection of contrast into the lumbar intervertebral disks and clinically significant pain can be localized to a specific level facilitating directed surgical planning. Postprocedure CT scanning further aids in evaluating the affected disks as well as providing significantly more information about surrounding osseous pathology.

**SUMMARY/CONCLUSION**

Although MR imaging and CT have supplanted diskography as the most common techniques used to evaluate low back pain, diskography, when combined with CT, remains a useful and indicated exam in the correct clinical setting due to its anatomical and provocative nature.

**KEY WORDS:** Diskography, pain, spine

**Electronic Scientific Exhibit 106**

*Interactive Teaching Module of Lumbar Disk Anatomy and Pathology*

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Hershey, PA

**PURPOSE**

To create an effective electronic teaching tool for lumbar disk anatomy and pathology (MR imaging based) using standardized nomenclature and classification.

**APPROACH/METHODS**

Various cases (MR imaging based) from our teaching files will be used to create web-based interactive teaching mod-
ules consisting of pertinent images followed by several quiz questions. After answers are submitted by the user for each set of questions, the correct answers and detailed explanations are provided.

**FINDINGS/DISCUSSION**

Despite the publication of a consensus document titled “Nomenclature and Classification of Lumbar Disc Pathology” by the Combined Task Force of the NASS, ASSR and ASNR in 2001, we find that trainees often have difficulty applying the definitions and guidelines in this paper to actual cases at the workstation. Moreover, there is still substantial variation amongst neuroradiologists in their use of the accepted nomenclature. These case-based modules will focus on normal anatomy and on pathology with attention to location of disk abnormality, disk morphology, as well as other contributing abnormalities in the facet joints and ligamentous structures. Teaching points also will address the effect these changes have on the caliber of the canal, the subarticular recess and the neural foramina (i.e., degree of stenosis and impingement of nerve roots).

**SUMMARY/CONCLUSION**

This interactive module will allow trainees to “practice” with real cases and learn to apply the accepted terminology in an accurate and systematic way. It is our hope that this also will help to standardize the teaching of evaluation of lumbar spine pathology.

**KEY WORDS:** Spine, lumbar, disk

**Electronic Scientific Exhibit 107**

**Spine Interventional Procedures under Imaging-Guidance: Combining/Comparing Fluoroscopic Views with 3D and Cross-Sectional CT Anatomy**

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¹Medical University of South Carolina, Charleston, SC, ²Ospedali Riuniti di Bergamo, Bergamo, ITALY

**PURPOSE**

1. To review pertinent normal, fluoroscopic, and CT spine anatomy for spine interventionalists, 2. to review the main practical principles for effective and safe imaging guidance in spine interventions, and 3. to review fluoroscopic projections and views for percutaneous spine procedures, in combination and comparison to 3D and cross-sectional CT anatomy.

**APPROACH/METHODS**

1. Pertinent normal spine anatomy, 2. pertinent radiographic, 3D and multiplanar cross-sectional CT spine anatomy, and 3. practical principles in fluoroscopy and CT imaging-guidance for spine procedures.

**FINDINGS/DISCUSSION**

Fluoroscopy projections and views for the main spine procedures, in combination and comparison with the corresponding 3D and multiplanar cross-sectional CT images.

**SUMMARY/CONCLUSION**

Imaging guidance, with fluoroscopy or CT, allows safe performance of many percutaneous spine procedures. Knowledge of spine anatomy and imaging guidance principles is critical for spine interventionalists. This educational exhibit reviews pertinent spine anatomy, image-guidance principles and tips, and presents fluoroscopic views of the spine, in combination and comparison with the corresponding 3D and cross-sectional CT images, for a better understanding of the relevant underlying anatomy.

**KEY WORDS:** Spine interventions, fluoroscopy, CT

**Electronic Scientific Exhibit 108**

**Vertebroplasty and Vertebral Augmentation: A Primer**

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Mount Sinai Medical Center
New York, NY

**PURPOSE**

The treatment of osteoporotic and pathologic vertebral compression fractures (VCFs) has been studied extensively with management options including conservative management as
well as interventional procedures such as vertebroplasty and vertebral augmentation. This educational exhibit will illustrate the clinical and radiographic findings of VCFs, the technical aspects of vertebroplasty, discuss the current indications and complications of the procedure and review the current equipment and cement available for use.

**APPROACH/METHODS**
1. Review the clinical and radiographic features of VCFs. 2. Understand the differences between vertebroplasty and vertebral augmentation. 3. Learn the indications, contraindications and complications of the procedure. 4. Become familiar with the commercially available products used for vertebroplasty and vertebral augmentation. 5. Understand the differences in the commercially available cement. 6. Review other options for vertebroplasty.

**FINDINGS/DISCUSSION**

**SUMMARY/CONCLUSION**
Vertebraloplasty and vertebral augmentation are intervention-al procedures used in the treatment of osteoporotic and pathologic VCFs. The educational exhibit highlights the diagnosis of VCFs as well as a variety of commercially available products currently available for interventional therapy.

**KEY WORDS:** Vertebraplasty, kyphoplasty, spine intervention

**Electronic Scientific Exhibit 109**

Multidetector CT Fluoroscopy-Guided Percutaneous Sacroplasty for the Treatment of Sacral Insufficiency Fractures: Short- and Mid-Term Outcomes of 30 Cases

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Wooridul Hospital
Seoul, KOREA, REPUBLIC OF

**PURPOSE**
The purpose of this study is to introduce a technique and clinical results of multidetector computed tomography (MDCT) fluoroscopy-guided percutaneous sacroplasty for sacral insufficiency fractures.

**APPROACH/METHODS**
From June 2006 to July 2009, we performed MDCT fluoroscopy-guided percutaneous sacroplasty on 29 patients (30 cases) who had sacral insufficiency fractures. Their median age was 75.4 years (range, 61-84 years), median body mass index (BMI) was 21.9 (range, 12.4-31), median bone mineral density (BMD) for L-spine was -4.22 (range, -0.4 to -6.9), and median BMD for femur was -4.21 (range, -2.7 to -5.9). All procedures were performed under local anesthesia using aseptic technique with the patient placed in the prone position on the CT examination table. Vital signs were monitored by the radiology nursing staff. We injected polymethylmethacrylate (PMMA) using 10-13G trocar needle(s) under 10- and 16-channel MDCT fluoroscopy guidance that helps us to see multiple images on a single image acquisition during the procedure. For all the patients, the degree and quality of pain relief were assessed using visual analogue scale (VAS) score (0 to 10) 1 day before and after the procedure, and they were followed up for 6-32 months.

**FINDINGS/DISCUSSION**
Technical success with adequate distribution of PMMA cement into the marrow spaces of the sacrum on imaging was achieved in 28 patients (97%) of the 29 patients. One patient experienced mild numbness and tingling sensation in her lower leg during the procedure because of a small cement leak into the ipsilateral L5-S1 neural foramen through the fracture crack, which was well demonstrated on CT during the procedure. We immediately performed epidural steroid injection into the neural foramen, and the patient’s symptoms subsided.

2.4-11.5 cc (mean, 5.02 cc) of PMMA was injected for the treatment. Before the treatment, 18 patients could not walk by themselves, and others had difficulty in walking to the bathroom. One day after the procedure, all the patients could walk to the bathroom without any assistance. One patient underwent the procedure twice because of a refracture with temporary relief of her symptoms 3 weeks after the first procedure. Average VAS score was 9.1 (back)/8.2 (leg) before the procedure and improved to 4.0 (back)/4.3 (leg) after the procedure, and the symptoms were improved gradually during the follow-up period.

**SUMMARY/CONCLUSION**
Percutaneous sacroplasty under MDCT fluoroscopy guidance is an effective and safe method for the treatment of sacral insufficiency fractures. The MDCT fluoroscopy allows not only near real-time visualization in the axial plane but also visualization of cranio-caudal cement migration.

**KEY WORDS:** Sacroplasty, CT fluoroscopy
Primary Diffuse Leptomeningeal Gliomatosis: Three Case Reports and Review of the Literature

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PURPOSE
Leptomeningeal gliomatosis usually is based on infiltration from a primary glioma, is a rather common feature and is referred to as secondary leptomeningeal gliomatosis. Primary diffuse leptomeningeal gliomatosis (PDLG), however, is an extremely rare and unique presentation, which has received little attention with only 35 cases described in the literature so far. The purpose of this study is to further increase our understanding of this disease by reviewing the current literature and adding an additional three case reports with biopsy-proved PDLG to the small number of reported cases.

APPROACH/METHODS
Even though mainly young men are affected, we present two young females, aged 9 years and 31 years, respectively. Our third case concerns a 19-year-old male. In our cases the clinical symptoms consisted of headache, based upon increased intracranial pressure, gait disturbance, motor paresis, paraesthesia and pain, which all have been described in other previously reported cases. We retrospectively analyze MR studies of the brain and spinal cord, including T1-weighted sequences after administration of gadolinium. Our cases showed both intracranial and diffuse spinal thickening and enhancement of the leptomeninges. In one case there was no parenchymal involvement, in the other cases there was parenchymal involvement of the spine and of the cerebellum, which developed later in the course of the disease.

FINDINGS/DISCUSSION
Our case reports further increase the understanding of this rare and highly aggressive disease with an increased insight in the extension of leptomeningeal involvement and clinical symptoms.

SUMMARY/CONCLUSION
Since this illness has a low prevalence, one cannot learn from large patient-group studies. Hence the importance of case reports on primary diffuse leptomeningeal gliomatosis.

KEY WORDS: Primary diffuse leptomeningeal gliomatosis, glioma, meningeal neoplasms
disease, eosinophilic granuloma, osteoporosis, renal osteodystrophy, and others, 3. to review the differential diagnosis for each appearance, and 4. to explore the cause of vertebral variant morphology.

**APPROACH/METHODS**
Utilizing a case-based approach, numerous examples of vertebral body anomalies will be presented. Cases will be shown using radiographs, CT and MR images. Full discussions of the pertinent differential diagnoses and related diseases will be offered.

**FINDINGS/DISCUSSION**
Abnormal vertebral body morphology can present a diagnostic challenge for the interpreting radiologist. The aim of this exhibit is to aid the radiologist in formulating a relevant differential diagnosis and to review those diseases that have a pathognomonic appearance. An explanation of the underlying cause for each appearance as it relates to each disease will be discussed as well.

**SUMMARY/CONCLUSION**
To present a case-based, multimodality presentation of variant vertebral body morphologies encountered in clinical practice with attention to those that are pathognomonic for a specific disease as well as those for which a practical differential diagnoses can be formulated.

**KEY WORDS:** Spine, morphology, variants

**Electronic Scientific Exhibit 112**

**Distinguishing Benign versus Malignant Diseases of the Skeletal Spine: Pictorial Review**

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**PURPOSE**
An important diagnostic dilemma arises in distinguishing benign from malignant diseases of the spine. Since the treatment options differ, it is crucial to establish a simple and effective approach to lesions of the spine in order to form an appropriate differential diagnosis. This electronic exhibit will provide an overview of imaging characteristics, which will assist the viewer in distinguishing benign versus malignant diseases of the spine.

**APPROACH/METHODS**
The goal of this electronic exhibit is to provide a simple and structured approach to evaluating malignant and malignant diseases of spine that often are difficult to distinguish from one another. Specifically, we will discuss: 1. the significance of the presence or absence of intervertebral disk involvement, and how it differs between the pediatric and adult population, 2. vertebral body compression fractures and key imaging characteristics that help distinguish osteoporotic vs traumatic vs pathologic causes, and 3. inflammatory conditions (neuropathic spondyloarthropathy, hemodialysis related spondyloarthopathy) of the spine, which may mimic malignant disease. Intradural extramedullary and intramedullary lesions are beyond the scope of this exhibit.

**FINDINGS/DISCUSSION**
CT and MR imaging play an important role in evaluating benign and malignant diseases of the spine; therefore, both imaging modalities will be used to describe key imaging findings. We present multiple cases highlighting intervertebral disks’ inherent properties inhibiting the spread of tumor, but not bacterial infections. We also will present a few cases where this principle does not hold true and the disk is invaded by tumor. Specific cases demonstrating how compression fractures can be further characterized by differences in marrow signal, fracture lines, fracture fragment extension, posterior element involvement and epidural extension will be reviewed. Granulomatous and inflammatory diseases of the spine will be reviewed.

**SUMMARY/CONCLUSION**
Both benign and malignant diseases of the spine often have similar imaging characteristics. However, subtle differences can guide the interpreter to the correct diagnosis, which is crucial for prompt initiation of therapy, or prevention of unnecessary interventions. After completing this case-based pictorial essay, the viewer will be able to confidently distinguish benign and malignant diseases of the spine.

**KEY WORDS:** Skeletal spine, pathologic fracture, inflammatory

**Electronic Scientific Exhibit 113**

**Diffusion-Weighted Imaging Facilitates Detection of Spinal Metastases and Assists in the Diagnosis of Equivocal Lesions**

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**PURPOSE**
Traditional metastatic spine surveys employ a combination of unenhanced T1-, STIR and T2-weighted images and some additional enhanced T1 techniques. Each technique and sometimes all can be equivocal in lesion detection, particularly in elderly or debilitated patients with heterogeneous bone marrow composition/signal. Diffusion-weighted imaging (DWI) can highlight the presence of lesions by sensitizing to the restricted motion of water. The utility of this sequence in the spine has been studied extensively with regards to characterizing vertebral body fractures (benign versus pathologic) and vertebral body lesions (metastatic versus benign) with mixed results. We attempt to document the incremental contribution and clinical utility of DWI in improving the visual conspicuity of lesions and refining the characterization of equivocal osseous lesions in patients with metastatic disease.
APPROACH/METHODS
A retrospective study of patients with spinal metastases who were referred for MR imaging of the spine from June to November 2009 at our institution was performed. Studies typically included sagittal T1-, STIR and T2-weighted scans with additional contrast-weighted sequences if there were no contraindications to contrast media. In addition all studies included sagittal EPI DWI (3-6 directions, 500-800 B). The conventional and trace-weighted DW studies were reviewed jointly by two experienced neuroradiologists to investigate the incremental value of DWI in this setting. Sequences were graded on number of lesions identified, confidence in diagnosis and relative conspicuity.

FINDINGS/DISCUSSION
Eighty-five spinal lesions were evaluated. In terms of conspicuity 23/85 were deemed similar, 40/85 were more conspicuous on DWI and 16/85 were more conspicuous on conventional sequences. Six lesions that were identified on DWI were missed initially on conventional sequences, and subsequently were diagnosed confidently in retrospect on conventional sequences. In terms of confidence 26/85 lesions that were deemed probable by conventional sequences were upstaged to confident in diagnosis of metastasis by DWI. Seven lesions deemed as equivocal were upgraded to confident. Four lesions that were deemed equivocal on conventional imaging were not seen on DWI and presumed to be benign. Two lesions deemed probable on conventional sequences were not seen on DWI.

SUMMARY/CONCLUSION
Diffusion-weighted imaging is a rapid pulse sequence that may be added practically to routine MR imaging of patients with suspected spinal metastases, improving sensitivity and assisting in lesion characterization.

KEY WORDS: DWI, metastases
Reduced field-of-view diffusion-weighted imaging is a promising and time-efficient method uniquely suited to the geometry of the spinal cord. We show that it can be used in the clinical setting, allowing contiguous imaging with high spatial resolution. We present initial radiographic examples of the human spinal cord utilizing this novel EPI method.

REFERENCES

KEY WORDS: MR imaging, diffusion, spinal cord

Electronic Scientific Exhibit 115
MR Neurography of Diffuse Peripheral Nerve Lesions
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MR neurography (MRN) is a novel technique to evaluate peripheral nerve lesions and can complement information gained from nerve conduction studies and electromyography. The exhibit will demonstrate utility of high-resolution MRN techniques employed in our institution on 3 T MR imaging, including 2D SPAIR and 3D T2-weighted and STIR SPACE sequences. Normal MRN appearance of peripheral nerves and diffuse nerve lesions along with their differentiating features will be highlighted with relevant case examples. Some of the cases will include examples of neurolabromatosis, amyloidosis, CIDP, intraneural perineuroma. Stump neuroma, infectious and radiation neuritis. The participant will gain knowledge of high-resolution MRN technique for evaluation of peripheral nerve lesions and will be able to familiarize with MRN appearances of diffuse peripheral nerve lesions and their distinguishing features.

KEY WORDS: MR neurography, peripheral nerve, lesions

Electronic Scientific Exhibit 116
Tethered Cord Syndrome
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PURPOSE
The tethered cord syndrome is a clinical entity caused by both congenital and acquired pathologies. The purpose of this educational exhibit is to review the definition and pathophysiology of this syndrome, and to demonstrate some of the pathologies that cause it, with emphasis on spinal dysraphism.

APPROACH/METHOD
The MR imaging spine teaching file data was reviewed and representative cases of pathologies that cause this syndrome were chosen. A review of the literature also was performed to supplement the gathered material. There is a background section on the embryology of the spine and its correlation with the congenital disorders.

FINDINGS/DISCUSSION
Congenital and acquired disorders of the spinal cord, as causes of the tethered cord syndrome, are presented. These pathologies will allow the attendee 1. to relate spinal dysraphism to embryological failure and its classification; 2. recall the features to identify in these entities; and 3. view acquired entities, such as neoplasms (primary and secondary) and arachnoiditis.

SUMMARY/CONCLUSION
The teaching point of this exhibit is to review the radiologist’s approach to the congenital and acquired pathologies that cause tethered cord syndrome.

KEY WORDS: Tethered cord, spinal dysraphism, spine embryology

Electronic Scientific Exhibit 117
Metabolic Disorders of the Spine
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PURPOSE
To review the spectrum of metabolic disorders of the spine, to discuss their imaging characteristics and the differential diagnosis with other spine conditions.

APPROACH/METHODS
We will present cases of metabolic disorders of the spine chosen from our teaching file. These cases represent prime examples of the effects of metabolic diseases on the vertebrae. Selected plain films, CT and MR images will illustrate the pertinent pathologic processes and their related imaging findings. The clinical, radiologic, and pathologic features of these entities will be discussed in the format of a didactic electronic exhibit.
FINDINGS/DISCUSSION
Metabolic disorders of the spine are characterized by altered function of osteoblasts, osteoclasts or abnormal patterns of mineralization secondary to metabolic disturbances. Abnormal amounts of mineralized bone, structural collagen and alteration of total bone mass are the most frequent pathologic abnormalities. The most common metabolic conditions affecting the spine are osteoporosis and renal osteodystrophy. Crystal deposition diseases, including gout, calcium pyrophosphate dihydrate and calcium hydroxyapatite crystal deposition, usually are associated with appendicular involvement, but may show characteristic spinal abnormalities. Endocrine gland disorders result in systemic hormonal alteration and subsequently spinal bone remodeling. Paget disease, not truly a metabolic disorder, shares similar imaging characteristics resulting from imbalance of osteoclast/osteoblast activity and subsequently abnormal bone remodeling. Paget and renal osteodystrophy both are characterized by sclerotic changes of the vertebral bodies, with an ivory vertebra or “picture frame appearance” in Paget, and a “rugger jersey” appearance in renal osteodystrophy. Spinal gout, pseudogout and destructive spondylarthropathy seen in patients treated with hemodialysis can mimic the appearance of spondyloarthropitis. Acromegaly and Paget are both characterized by enlargement of the affected vertebrae, monostotic or polyostotic in Paget, with remodeling of the entire skeleton in acromegaly. Metabolic bone diseases of the spine may result in ankylosis, demineralization, erosion, fracture, subluxation, and canal/neuroforaminal stenoses with significant impact on the quality of life of affected individuals.

SUMMARY/CONCLUSION
Skeletal manifestations of metabolic disease represent a heterogeneous group of conditions resulting from vitamin deficiencies, endocrine glands abnormalities, renal tubular dysfunction, and disorders of endogenous metabolism. Thorough understanding and correct identification of the pertinent radiologic manifestations of metabolic disorders of the spine, including their pattern of distribution, is critical to aiding in early diagnosis and timely therapeutic intervention.

KEY WORDS: Spine, metabolic disease

Electronic Scientific Exhibit 118
Neuroradiology On-Call: What the Junior Resident Needs to Know about Spine Imaging

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PURPOSE
The purpose of this exhibit is to familiarize junior residents, taking call for the first time, with spine emergencies requiring immediate intervention or resulting in alteration of patient management. After reviewing this exhibit, junior residents should be familiar with the imaging spectrum of clinically significant spinal disease entities that may be encountered on-call. This exhibit also serves as a refresher for senior residents and other radiologists who interpret imaging of the spine.

APPROACH/METHODS
This exhibit is a case-based approach with clinical-pathologic correlation of common spine entities encountered on-call. Cases will be presented as unknowns, followed by a discussion of the entity and mention of important differential considerations.

FINDINGS/DISCUSSION
A variety of spine emergencies may be encountered on-call by the junior resident. Etiologies include: 1. Infectious - epidural abscess, diskitis/osteomyelitis; 2. Traumatic - fractures of the spine, spinal cord injuries, ligamentous damage; 3. Neoplastic - cord compression secondary to primary or metastatic tumors; and 4. Degenerative - disk herniation with cord or nerve root compression.

SUMMARY/CONCLUSION
In an era of increased utilization of radiologic imaging in the assessment of emergency room patients, it is becoming increasingly vital for the junior resident to recognize clinically significant spinal disease processes. Many of these entities have characteristic imaging patterns. Educating junior residents on these imaging patterns will ultimately lead them to formulate accurate diagnoses and therefore optimize patient management. Studies have shown overnight misinterpretations by junior residents can result in a delay in diagnosis, adverse patient outcomes, increased patient morbidity and increased healthcare costs. Additionally, subsequent patient management decisions often are based on preliminary interpretations, further emphasizing the need for precise initial interpretations by junior residents.

KEY WORDS: Spine, emergency, on-call

Electronic Scientific Exhibit 119
Nontraumatic and Nonneoplastic Myelopathy: A Comprehensive Review of Pathologic Processes, Clinical Correlates, and Imaging Findings over a 15-Year Collection of Cases

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PURPOSE
The purpose of our project is to review imaging features consistent with nontraumatic and nonneoplastic myelopathy, provide a comprehensive detail of spinal cord anatomy with emphasis on pathologic processes, and provide associated clinical correlates. We hope to detail a wide variety of cases and pathology by combining cases from two major US academic institutions.

APPROACH/METHODS
Spinal cord illustrative anatomy, MR/MRA imaging and anatomy, CT/CTA imaging and anatomy, angiographic studies, and plain film/CT myelography will be utilized to review nontraumatic and nonneoplastic myelopathy cases collected over nearly 15 years at two major US academic institutions. Specific detail will be placed on key diagnostic imaging findings and associated clinical presentation.
FINDINGS/DISCUSSION
Nontraumatic and nonneoplastic etiologies of myelopathy including infectious, inflammatory and autoimmune, vascular, congenital, metabolic/neurodegenerative, radiation, and idiopathic are less prevalent but nevertheless result in severe clinical consequences affecting patient’s health and quality of life. Often these myelopathies are reversible, provided their causes are sought and treated aggressively. Many missed and delayed diagnoses result from poor physical examination techniques and inadequate imaging. MR imaging remains the best noninvasive method to image spinal cord parenchyma.

SUMMARY/CONCLUSION
Nontraumatic and nonneoplastic myelopathy although less prevalent has serious clinical consequences. We hope to instill more confidence in diagnosing myelopathic pathology, both common and rare, and hope to emphasize that prompt multimodality imaging, specifically MR, and adequate clinical correlation is paramount to fully evaluate spinal cord parenchyma in order to assess etiology and provide treatment options.

KEY WORDS: Myelopathy, spinal cord, inflammation
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Dear Colleagues,

Welcome to the ASNR 48th Annual Meeting and NER Foundation Symposium 2010. Dr. Carolyn Meltzer from Emory University, President-Elect of the ASNR and this year’s Program Committee Chair, has worked with members of her committee to present topical and significant educational and scientific material for this year’s programming. A special feature on Saturday morning “Technical Advances in Brain Tumor MR Imaging,” ASNR in collaboration with the International Society for Magnetic Resonance in Medicine (ISMRM).

The NER Foundation Symposium 2010 “Cancer Imaging for the Neuroradiologist. Fundamentals to Functional and Molecular Imaging” will be educationally beneficial for all attendees, both specialists and generalists.

The Annual Meeting features Self Assessment Module (SAM) sessions in each of the subspecialty areas of neuroradiology, a general content SAM session MOC sessions in brain, spine, head and neck, and advanced imaging, and new this year, Synaptic Function programming. Focus Sessions developed in cooperation with the American Society of Functional Neuroradiology (ASFNR), American Society of Head and Neck Radiology (ASHNR), American Society of Pediatric Neuroradiology (ASFNR), American Society of Spine Radiology (ASSR), and the Society of Neuroradiological Surgery (SNIS) cover a wide range of topics of interest for both the sub-specialist and general neuroradiologists. Once again, attendees may take the American Board of Radiology (ABR) neuroradiology MOC recertification examination on site at the meeting.

I wish to extend a special thanks to the following Co-Chairs for their efforts in organizing the programming for the following specialty areas:

American Society of Functional Neuroradiology (ASFNR) ............................................. Scott H. Faro, MD
American Society of Head and Neck Radiology (ASHNR) .............................................. Lawrence E. Ginsberg, MD
American Society of Pediatric Neuroradiology (ASFNR) ............................................. L. Santiago Medina, MD, MPH
American Society of Spine Radiology (ASSR) ............................................................... Jeffrey A. Stone, MD
Society of Neuroradiological Surgery (SNIS) ................................................................. Cameron G. McDougall, MD

The annual meeting provides a unique opportunity to gain a better understanding of how the ASNR functions to assist the practice of neuroradiology during a time of rapid change. The meeting also provides excellent opportunities to renew old friendships and make new ones, as well as exchange ideas and share conversation with world-renowned researchers and clinicians.

I congratulate Carolyn Meltzer and her committee for constructing an outstanding program. I welcome all attendees to one of the best products of the ASNR — our annual meeting. I hope to be able to greet you personally during the meeting.

Sincerely,

John R. Hesselink, MD, FACR
ASNR President
Includes Interactive CD-ROM

Program Contributors

ASNR 2010: PROCEEDINGS

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