Instructions for using bookmarks and links

At any point within the pdf you can easily go back to the table of contents and author index by using the bookmarks tab. The bookmarks tab is located on the left side of the pdf screen, just click the icon to open the tab. Once the tab is open you can choose to go to a page.

Bookmarks tab        Table of Contents Link

You are also able to jump to a specific presentation page by clicking on the corresponding number. This is found on the “Author Index” bookmark.
The Proceedings Book and CD-ROM are made possible by an educational grant from SIEMENS Medical Solutions, Inc.

*Programming is currently under review for qualification as a Self-Assessment Module (SAM) through the American Board of Radiology (ABR).
Dear Colleagues,

Welcome to the ASNR 47th Annual Meeting and NER Foundation Symposium 2009. Dr. John R. Hesselink from the University of California San Diego Medical Center, President-Elect of the ASNR and this year’s Program Committee Chair, has worked with members of his committee to present topical and significant educational and scientific material for this year’s programming.

The NER Foundation Symposium 2009: Neuroradiology of the Limbic System and Temporal Lobe will be educationally beneficial for all attendees, both specialists and generalists.

The Annual Meeting features proposed 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, Electronic Learning Center (ELC), and Business Center 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 (ASPNR), 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 neuroradiologists. Once again, attendees may take the American Board of Radiology (ABR) neuroradiology MOC recertification examination at the end of the annual 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) ....................... Timothy P.L. Roberts PhD
American Society of Head and Neck Radiology (ASHNR) ...................... Laurie A. Loevner, MD
American Society of Pediatric Neuroradiology (ASPNR) ....................... Blaise V. Jones, MD
American Society of Spine Radiology (ASSR) ................................. Bassem A. Georgy, MD
Society of NeuroInterventional Surgery (SNIS) ................................. Colin P. Derdeyn, 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. We look forward to your participation at the “The Global Culinary Experience” Reception on Monday evening at the Pan Pacific Vancouver. 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 John Hesselink and his committee for constructing an outstanding program. I welcome all attendees to one of the best products the ASNR produces—the annual meeting. I hope to be able to greet you personally during the meeting.

Sincerely,

Robert D. Zimmerman, MD, FACR
ASNR President
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2008-2009 ASNR Executive Committee

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About Vancouver

The ASNR 47th Annual Meeting and NER Foundation Symposium 2009 host venue is the Vancouver Convention & Exhibition Centre. Vancouver is a dynamic, multicultural city set in a spectacular natural environment. No matter what time of the year you visit, there are indoor and outdoor activities to please adults, families, couples and friends to no end. As the proud host of the 2010 Olympic & Paralympic Winter Games, Vancouver looks ahead to ongoing growth and great success in tourism, hospitality and business services each year. Catering to any interest throughout the year, you can enjoy world class shopping, gourmet meals, outstanding live entertainment, sporting events, theatre, outdoor adventure, spectacular sights and attractions - it’s all waiting for you in Vancouver.

Walking Map of Vancouver
General Information

Meeting Registration
Registration will take place in the East Lobby, Vancouver Convention & Exhibition Centre. The registration desk will be open during the following hours:

- Friday, May 15: 5:00 pm - 8:00 pm
- Saturday, May 16: 6:30 am - 6:00 pm
- Sunday, May 17: 6:30 am - 6:00 pm
- Monday, May 18: 6:30 am - 6:00 pm
- Tuesday, May 19: 6:30 am - 6:00 pm
- Wednesday, May 20: 6:30 am - 6:00 pm
- Thursday, May 21: 6:30 am - 6:00 pm

Speaker Ready Room Location & Hours

**Vancouver Convention & Exhibition Centre - Meeting Room 8**
- Saturday, May 16: 6:00 am - 6:00 pm
- Sunday, May 17 through Thursday, May 21: 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 East Lobby of the convention centre.

Meetings & Announcements Board
The Meetings & Announcements Board is located in the East Lobby of the convention centre. Please refer to the Daily Postings on the Meetings & Announcements Board for information on committee meetings.

CME Pavillion
Located in Meeting Room 7 of the Vancouver Convention & Exhibition Centre, the CME Pavillion computer terminals will be available to registered attendees that can be used to evaluate attended sessions and print CME certificates.

**Meeting Room 7**
- Vancouver Convention & Exhibition Centre
- Saturday, May 16: 7:00 am - 9:00 pm
- Sunday, May 17 through Thursday, May 21: 6:30 am - 9:00 pm

E-Access/Messaging Center
The E-Access Message terminals are located in Meeting Room 16 of the Vancouver Convention & Exhibition Centre. The terminals can access/send external email and leave internal messages for other attendees.

**Meeting Room 16**
- Vancouver Convention & Exhibition Centre
- Saturday, May 16: 7:00 am - 9:00 pm
- Sunday, May 17 through Thursday, May 21: 6:30 am - 9:00 pm

24-Hour Medical Clinic
Stein Medical Clinic
- #188-550 Burrard St., Vancouver
- Phone: 604-688-5924
- www.steinmedical.com

Hospital:
St. Paul’s Hospital
- 1081 Burrard Street
- Vancouver, BC, Canada V6Z 1Y6
- Phone 604-682-2344
- Approximately 10 blocks away from the convention centre.
General Information (continued)

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

Continental Breakfast
Sunday, May 17 through Thursday, May 21 .................................................. Ballroom C

Morning Breaks
Sunday, May 17 and Thursday, May 21 ............... Ballroom C / Delegate Concourse
Monday, May 18 through Wednesday, May 20 ........................................ Exhibition Hall B

Box Lunches
Sunday, May 17 and Thursday, May 21 .................................................. Ballroom C
Monday, May 18 through Wednesday, May 20 ........................................ Exhibition Hall B

Afternoon Breaks
Saturday, May 16,
Sunday, May 17 and Thursday, May 21 ............... Ballroom C / Delegate Concourse
Monday, May 18 through Wednesday, May 20 ........................................ Exhibition Hall B

Meeting Location: Vancouver Convention & Exhibition Centre
NOTE: All scientific sessions and exhibits are located at the Vancouver Convention & Exhibition Centre.

Registration
East Lobby

CME Pavilion
Meeting Room 7

E-Access/Messaging Center
Meeting Room 16

How-To Breakfast and Lunch Sessions
Hall A

Focus/Scientific Paper Sessions
Hall A, Ballroom B, Ballroom A, Meeting Room 1, and Meeting Room 12

Electronic Learning Center (ELC) Workshops & Lectures
Meeting Room 11

Business Center Programming
Meeting Room 2

EXHIBITS
Scientific Exhibits, Electronic Scientific Exhibits (eSE), Scientific Posters
Exhibition Hall C

Technical Exhibits
Exhibition Hall B

MISCELLANEOUS
American Board of Radiology (ABR) Information Desk
East Lobby

ABR Exam Room
Meeting Room 11

American Journal of Neuroradiology (AJNR) Desk
East Lobby

Coat Check
East Lobby

Headquarters Office
Meeting Room 13

Meetings & Announcements Board and Job Postings Board
East Lobby

NER Foundation Visionaries Lounge
Meeting Room 5

Restaurant Reservations
East Lobby

Speaker Ready Room
Meeting Room 8

VIP Lounge
Meeting Room 20

AJNR - East Lobby
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 Schedule
Saturday, May 16 .................................................. 12:00 pm - 5:00 pm
Sunday, May 17 through Thursday, May 21 .................................................. 8:30 am - 5:00 pm
GUEST HOSPITALITY

Pan Pacific Vancouver
OceanView 2

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 “The Global Culinary Experience” Reception with Technical Exhibitors and entertainment. There is on-site concierge service that provides information about Vancouver attractions, tours and dining. The city of Vancouver offers visitors an endless choice of activities that range from fine dining to lively family fun, many within walking distance of the Pan Pacific Vancouver, ASNR Headquarters Hotel.

Guest Hospitality Suite
Pan Pacific Vancouver
OceanView 2
Sunday, May 17 through Thursday, May 21 ............................................... 8:00 am – 10:00 am

Topics:
Monday, May 18 - 9:00am
“History of Chinese in Vancouver”

Tuesday, May 19 - 9:00am
“Vancouver 2010 Olympic Highlights”

Wednesday, May 20 - 9:00am
“Ocean Wise Program”

Thursday, May 21 - 9:30am
“Vancouver Art Gallery”

Thursday, May 21 - 9:45am
“Granville Island”

SOCIAL PROGRAM

Welcome Reception “The Global Experience”
Monday, May 18, 2009 • 6:30pm - 8:30pm
Atrium, Pan Pacific Vancouver

The ASNR Welcome Reception will be held on Monday, May 18, at the Pan Pacific Vancouver. This hotel is a local landmark of quality and distinction. It sits atop the magnificent Canada Place complex on Vancouver’s breathtaking waterfront. With over 250 years of international expertise, on 5 continents, the Pan Pacific’s culinary leadership team provides an unparalleled gastronomic experience. The welcome reception is an excellent opportunity to meet ASNR attendees and enjoy world-class food!

Ticket Required for Admission
A ticket to the Reception is included in the fee for registration categories that include Monday, May 18 and in the Guest Hospitality fee.
ASNR FUTURE ANNUAL MEETINGS

48th ANNUAL MEETING
May 15 - 20 | Hynes Convention Center
Boston, Massachusetts

49th ANNUAL MEETING
June 4 - 9
Washington State Convention and Trade Center
Seattle, Washington

50th ANNUAL MEETING
April 21 - 26
New York Hilton
New York, New York

51st ANNUAL MEETING
May 18 - 23
San Diego Convention Center
San Diego, California

52nd ANNUAL MEETING
May 17 - 22
Palais des Congrès de Montreal
Montreal, Quebec, Canada
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-Isabel 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 San Diego
San Diego

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
(Silver Anniversary)
May 10-15, 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
March 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 13-19, 1992
Adam’s Mark
St. Louis

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

Forty-Fourth Annual Meeting
April 29 - May 3, 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
### Founding Members

<table>
<thead>
<tr>
<th>Year</th>
<th>President</th>
<th>*deceased</th>
</tr>
</thead>
<tbody>
<tr>
<td>1962-64</td>
<td>Juan M. Taveras, MD*</td>
<td></td>
</tr>
<tr>
<td>1964-65</td>
<td>Mannie M. Schechter, MD*</td>
<td></td>
</tr>
<tr>
<td>1965-66</td>
<td>Donald L. McRae, MD*</td>
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Harold O. Peterson, MD*  
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Mannie M. Schechter, MD*  
Juan M. Taveras, MD*  
Ernest H. Wood, MD*  
*deceased
Hillier Baker
1924-2008

Dr. Hillier L. Baker Jr., Past-President and Gold Medalist of the American Society of Neuroradiology, died on December 22, 2008 in Rochester, Minnesota at the age of 84. Bud, as he was known to his friends, was born and grew up in Chicago, was graduated from the University of Chicago in 1943, and from its Medical School in 1947. Following internship at the Presbyterian Hospital, he completed a radiology residency at the Mayo Clinic. He spent his entire clinical career at Mayo, serving as Director of Neuroradiology and later as Chairman of the Department of Radiology and Professor of Radiology at the Mayo Medical School. In 1972, he traveled to England as a representative of the Mayo Board and negotiated the purchase of the first CT scanner in the United States which became operational in August of 1973.

Bud was particularly active in the Radiological Society of North America. As Secretary of the Board of Trustees, he was instrumental in expansion of its Annual Meeting and served on the committee to oversee its transfer from the Palmer House Hotel to its current venue at McCormick Place. He served on numerous other committees and eventually as President of the RSNA. He was awarded its Gold Medal in 1982.

Colin B. Holman, MD
1917-2008

Dr. Holman was born in Salt Lake City, Utah in 1917, the son of Carol Edwards Holman and Frank E. Holman. The family moved to Seattle, Washington when Colin was a boy, and he attended Garfield High School in Seattle. He graduated with a Bachelor of Arts degree from Dartmouth College in 1939. Dr. Holman then attended the University of Pennsylvania School of Medicine, graduating in 1943, and interned at King County Hospital in Seattle 1943-44. He married Miss Kathryn Puryear of Seattle in 1943.

Dr. Holman enlisted in the Medical Corps of the U.S. Army where he was chief of the roentgenologic service of the 116th United States Army General Hospital in England and Nuremberg, Germany and was discharged as a captain in 1946.

He enrolled in the Mayo Graduate School of Medicine as a Fellow in Roentgenology in 1946 and completed training in 1949. He was certified by the American Board of Radiology that same year and was appointed to the staff of the Department of Roentgenology at Mayo. He was appointed an instructor in roentgenology in 1954, assistant professor in 1957, associate professor in 1963, and professor in 1969.

Dr. Holman was invited to attend the famous meeting at Keen’s Chop House in New York that gave birth to the American Society of Neuroradiology in 1961. He was elected president of the ASNR in 1968, and helped launch the first fellowship training program at Mayo. He was a member of the American Roentgen Ray Society, becoming president in 1974.

He was a member of the Radiological Society of North America, American Association of Radiology, Neurological Surgeons (Harvey Cushing Society), and a Fellow of the American College of Radiology.

Dr. Holman published many papers on tumor diagnosis as well as articles on developmental anomalies. Colin was one of several residents and staff at Mayo that practiced radiology during their military service and adopted the use of lead gloves and aprons while performing fluoroscopy. Gradually, all Mayo radiologists adopted this practice. He also can be thanked for his contribution to the first foray into x-ray computed tomography. Maybe the next time we look at a CT scan, or put on our lead aprons and gloves, we can think of Colin Holman and his legacy.
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
Glenn S. Forbes, MD, FACR

Glenn S. Forbes was born and raised in Chicago, Illinois. He earned his Bachelor of Science degree from the University of Notre Dame, graduating magna cum laude in 1969. He was accepted into the Yale University School of Medicine, and graduated in 1973. Dr. Forbes completed fellowships at Notre Dame and Yale. Upon completion of medical school, he was offered an internship with the Mayo Graduate School of Medicine, and completed fellowships in Diagnostic Radiology and Neuroradiology at Mayo Clinic.

Dr. Forbes is Chief Executive Officer of Mayo Clinic Rochester, and Vice-President of Mayo Clinic. He serves as chair of Mayo Clinic Rochester Executive Board, is a member of Mayo Clinic Board of Governors, and completed fellowships in Diagnostic Radiology and Neuroradiology at Mayo Clinic.

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Throughout his career, Dr. Forbes has been active in the ASNR. Dr. Forbes has served a Secretary (1988-1990), Officer (1988-1990), Parliamentarian (1990-1991), Second Vice-President (1991-1992), President-Elect (1992-1993), and President (1993-1994). His involvement with the ASNR includes serving as Chair for the Intersociety Liaison Ad Hoc Committee, Publications Committee, and Scientific Exhibits Committee. He has also served on the ASNR Awards Committee, Rules Committee, Executive Committee, Program Committee, and Administrative Committee. Dr. Forbes currently serves at the Executive Liaison between the ASNR and the ABR.

In addition to the ASNR, Dr. Forbes is a Fellow in the American College of Radiology, holds professional memberships in the Radiological Society of North America (First Vice-President, 2000) and the American Board of Radiology. Within the ABR, he has held the position of Trustee since 2003. Dr. Forbes has served as an examiner in both general boards and Neuroradiology Certificate of Added Qualification, since 1994.

Dr. Forbes has served in editorial and reviewer positions for various medical journals, such as the American Journal of Neuroradiology, Journal of Computed Tomography, Journal of Neurology and Mayo Clinic Proceedings. He has given national and international presentations, and has authored or co-authored numerous articles, book chapters, editorials, electronic media, abstracts and letters. At Mayo Clinic, he actively participates in educational activities, and is a recipient of the Teacher of the Year Award.

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
Jian-Ping Dai, MD

Dr. Jian-Ping Dai, received his radiology residency at Beijing Xuanwu Hospital, Capital Medical University (1976-1979), and served as a research fellow in the Neuroradiology Division of the Department of Radiology at Massachusetts General Hospital (MGH) under Juan Taveras, M.D. (1979-1982).

Returning to China after his fellowship, Dr Dai worked with neurosurgery pioneer Zhong-Cheng Wang, M.D. at Beijing Neurosurgical Institute (1983). In this center, neurointerventional therapy was introduced to China. In 1989, Dr. Dai was awarded the position of Chairman of the Neuroimaging Center. Also, he was elected and served as Vice-President and President of Beijing Tiantan Hospital, Capital Medical University from 1989 to 2008. Dr Dai addressed the evolution of medical imaging in China as President of the Chinese Society of Radiology, and Chief Editor of the Chinese Journal of Radiology from 1996 to 2005. With his expertise in this area, he established the Chinese Society of Neuroradiology in 1987. Dr. Dai also served as the General Secretary of the International Congress of Radiology Organizing Committee in 1996. He was named an Honorary Fellow of the Hong Kong College of Radiologists in 2000, and has served as President of the Asia-Pacific Society of Cardiovascular and Interventional Radiology. Dr. Dai is serving as Vice-President of the Chinese Medical Association, Chinese Hospital Association, Chinese Doctor Association, and China Association of Medical Equipment, and as Chief Editor of the Chinese Journal of Medical Imaging Technology. He is also the President of the Asian and Oceanian Congress of Radiology (2008).

The recipient of several awards from the Chinese government, Dr. Dai is a professor of neuroradiology in the Beijing Neurosurgical Institute of Beijing Tiantan Hospital at the Capital Medical University. He has focused his research on medical image processing, interventional therapy for cerebrovascular disease, central nervous system imaging, and cerebral function MR imaging. During his academic life, he published 4 reference books and textbooks as chief editor and sub-editor, and has more than 150 paper publications as main author. He directed several domestic Congresses in radiology and neuroradiology, as well as international Symposia with international colleagues from the United States, European countries, and Asian and Oceanian countries. In 2006, he addressed the ISMRM Plenary Session on such topics as Opportunities and Challenges of MR in Developing Countries. As China began to rise to world-class status in radiology, colleagues worldwide pointed to Dr. Dai’s interpersonal skills, and his abilities as an educator.

An RSNA member since 1991, Dr. Dai attended many RSNA meetings, where he presented his research work, and the development of radiology in China. At their 2008 Annual Meeting, the RSNA presented Dr. Dai with the Honorary Membership Award for his prominent contribution to the worldwide community in Radiology.

Past ASNR Honorary Members

Torsten Almen, MD
James W. Bull, MD*
Graeme M. Bydder, MD, ChB
M. Paul Capp, MD
Sten Cronqvist, MD*
B. G. Ziedes des Plantes, MD*
George du Boulay, MD*
Richard R. Ernst, MD
Torgny V. B. Greitz, MD
Godfrey N. Hounsfie, PhD*

Yun Peng Huang, MD
Ian Isherwood, MD
Pierre Lasjaunias, MD, PhD
Paul C. Lauterbur, PhD*
Dennis LeBihan, MD, PhD
Marco Leonardi, MD
Erik Lindgren, MD*
Claude H. Manelfe, MD
Professor Luc Picard
Michel Ter Pogossian, MD*

Joseph Ransohoff, MD*
Jesus Rodriguez-Carbajal, MD
Lee F. Rogers, MD
Prof. Lucy Balian Rorke
Michael Radford Sage, MD,
FRANZCR, FRCR, FRCPC
(Lon), FRCPC (Ed), FHKCR
(Hon)
Georges Salamon, MD
George Schuyler

S. I. Seldinger, MD
Fjodor Serbinenko, MD
Mutsumasa Takahashi, MD
Galdino E. Valvassori, MD
Marjo S. van der Knaap, MD
Prof. Jacqueline Vignaud
M. Gazi Yasargil, MD
Ian R. Young, BSc, PhD

*deceased
Dr. Josser E. Delgado Almandoz is a fourth-year Diagnostic Radiology resident at the Massachusetts General Hospital, Harvard Medical School, in Boston. Originally from Puerto La Cruz, Venezuela, he was awarded a Galileo scholarship by the Fundacion Gran Mariscal de Ayacucho in 1994 to continue his high school education at the United World College of the American West in Montezuma, New Mexico, from which he graduated in 1996. He received his Bachelor of Arts degree with High Honors in Economics from Wesleyan University in Middletown, Connecticut in 2000, and was inducted into the Phi Beta Kappa honor society. While in college, he also studied the transition from communism to a market economy in Prague and the Palestinian-Israeli conflict in Jerusalem. Dr. Delgado Almandoz received his medical degree from Mount Sinai School of Medicine in New York in 2004, during which he was awarded the Joseph Collins Foundation scholarship for an interest in the arts and letters, and was inducted into the Alpha Omega Alpha honor medical society. He completed his medical internship at Cabrini Medical Center of Mount Sinai School of Medicine in New York in 2005, and then commenced his residency in Diagnostic Radiology in Boston. Dr. Delgado Almandoz’s research interests include the role of multi-detector CT angiography in the evaluation of patients presenting to the Emergency Department with acute non-traumatic intracerebral hemorrhage as well as acute head and neck trauma. Outside of work, he enjoys traveling around the world to scuba dive and pursue underwater photography with his wife. Dr. Delgado Almandoz will start his fellowship in Diagnostic and Endovascular Surgical Neuroradiology at the Mallinckrodt Institute of Radiology at Washington University School of Medicine in Saint Louis in July 2009.
AWARDS AND HONORS
Past ASNR Cornelius G. Dyke Memorial Award Recipients

1972
George M. McCord, MD
“The Venous Drainage to The Inferior Sagittal Sinus”

1973
Barton Lane, MD
“Cerebrospinal Fluid Pulsations at Myelography: A Video-Densitometric Study”

1974
Jacques Theron, MD
“Anatomical-Radiological Correlates of the Anterior Choroidal Artery”

1975
Thomas P. Naidich, MD
“The Normal Anterior Inferior Cerebellar Artery”

1976
No Award

1977
Burton P. Drayer, MD
“The Capacity for CT Diagnosis of Cerebral Infarction. An Experimental Study in the Non-Human Primate”

1978
Joseph A. Horton, MD
“The Grain in the Stone: A Computer Search for Hidden CT Patterns”

1979
Dieter R. Enzmann, MD
“Experimental Brain Abscess Evolution Studied with the CT Scan and Neuropathological Correlation”

1980
No Award

1981
A. Ronald Cowley, MD
“The Influence of Fiber Tracts on the CT Appearance of Cerebral Edema: An Anatomical Pathological Correlation”

1982
B. Ludwig, MD
“Postmortem CT and Autopsy in Perinatal Intracranial Hemorrhage”

1983
No Award

1984
Val M. Runge, MD
“Contrast Enhanced Magnetic Resonance Evaluation of a Brain Abscess Model”

1985
No Award

1986
Jeremy B. Rubin, MD
“Part 1 Imaging Spinal CSF Pulsation by 2DFT Magnetic Resonance: Significance During Clinical Imaging”
“Part 2 Harmonic Modulation of Proton MR Precessional Phase by Pulsatile Motion Origin of Spinal CSF Flow Phenomenon”

1987
No Award

1988
Vincent P. Mathews, MD
“Gadolinium Enhanced MR Imaging of Experimental Bacterial Meningitis: Evaluation and Comparison of CT”

1989
Allen D. Elster, MD

1990
Marvin D. Nelson, Jr., MD
“The Search for Human Telencephalic Ventriculofugal Arteries”

1991
Udo P. Schmiedl, MD
“Quantitation of Pathological Blood-Brain Barrier Permeability in an Astrocytic Glioma using Contrast Enhanced MR”

1992
R. Gilberto Gonzalez, MD
“Quantitative In Vivo Human Brain Lithium Magnetic Resonance Spectroscopy”
Frank J. Lexa, VII, MD
“Wallarian Degeneration in the Feline Visual System: Characterization by Magnetization Transfer Rate with Histopathologic Correlation”

1993
Marc Jouandet, MD
“Mapping the Human Cerebral Cortex with Brainprints”

1994
A. Gregory Sorensen, MD
“Functional Magnetic Resonance Imaging of Brain Activity and Perfusion in Patients with Chronic Cortical Stroke A”

1995
John L. Ulmer, MD
“Magnetization Transfer or Spin-Lock? An Investigation of Off-Resonance Saturation Pulse Imaging Using Varying Frequency Offsets”

1996
John C. Strainer, MD
“fMRI of Primary Auditory Cortex: An Analysis of Pure Tone Activation and Tone Discrimination”

1997
Stephen G. Imbesi, MD
“Why Do Ulcerated Atherosclerotic Carotid Artery Plaques Embolize? A Flow Dynamics Study”

1998
No Award

1999
Aquilla S. Turk, DO
“Definition of Aneurysm Ostium (Neck) and Morphology Using Intravascular Ultrasound: An Experimental Study in Canines”

2000
William F. Marx, MD
“Endovascular Treatment of Experimental Aneurysms Using Biologically Modified Embolic Devices: Coil-Mediated Intra-Aneurysmal Delivery of Fibroblast Tissue Allografts”

2001
No Award

2002
Mehmet Kocak, MD
“Functional MR Imaging of the Motor Homunculus: Towards Optimizing Paradigms for Clinical Scenarios”

2003
No Award

2004
Eric D. Schwartz, MD
“Apparent Diffusion Coefficients Within Spinal Cord Transplants and Surrounding White Matter Correlate With Degree of Axonal Dieback Following Injury”

2005
No Award

2006
Ashok Panigrahy, MD
“Quantitative Short Echo Time 1H Magnetic Resonance Spectroscopy of Untreated Pediatric Brain Tumors: Pre-operative Diagnosis and Characterization”

2007
Yulin Ge, MD
“Quantitative Assessment of Iron Accumulations in the Deep Gray Matter of Multiple Sclerosis by Magnetic Field Correlation Imaging”

2008
No Award
AWARDS AND HONORS

ASNR 2008 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 New Orleans 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 35: Lead Exposure During Childhood Disrupts Adult Brain Metabolism
Cecil, K.M.1 • Dietrich, K.N.2 • Altaye, M.1 • Egelhoff, J.C.1 • Wessel, S.D.2 • Lamphere, B.P.1
(Cincinnati Children’s Hospital Medical Center, Cincinnati, OH, 1University of Cincinnati, Cincinnati, OH)

Bayer Best Paper Award in General Neuroradiology

PAPER 23: Prediction of Conversion from Clinically Isolated Syndrome to Clinically Definite Multiple Sclerosis Using Diffusion Tensor Imaging
Jewells, V.L. • Chen, Y. • Speer, D. • Markovic-Plese, S. • Armao, D. • An, H. • Zui, H. • Bullitt, E. • Lin, W.
(University of North Carolina, Chapel Hill, NC)

Functional Neuroradiology

(due to a tie in review scores, this award is being split between two recipients)

PAPER 211: Detection of BOLD Response to Single Stimuli in Single Functional Units of Human Visual Cortex Demonstrated at 3.0 T
Atkinson, L.C. • Nemaniz, A. • Flannery, M.P. • Thulborn, K.R.
(University of Illinois at Chicago, Chicago, IL)

POSTER 25: Automated Generation of Diffusion Tensor Tractography Maps
Nucifora, P.G.P. • Wu, X. • Melhem, E.R. • Longhead, J. • Gur, R.E. • Gur, R.C. • Verma, R.
(University of Pennsylvania, Philadelphia, PA)

Interventional Neuroradiology

(The Michael Brothers Memorial Award)

Paper 443: Histopathologic Changes in Brain Arteriovenous Malformations after Embolization with Onyx® or n-BCA
Natarajan, S.K. • Born, D. • Ghodke, B. • Britz, G.W. • Sekhar, L.N.
(University of Washington, Seattle, WA)

2008/2009 Specialty/Regional Society Awards

American Society of Spine Radiology (ASSR) Mentor Award


Dr. Francesco Massari
University of Rome ‘Tor Vergata’, Rome Italy

Southeastern Neuroradiological Society (SENRS)

“Intracranial Abnormalities Detected by MRI in Prader-Willi Syndrome and Early-Onset Morbid Obesity”

Dr. Ilona M. Schmalfuss
University of Florida, Gainesville, FL

Eastern Neuroradiological Society (ENRS)

(The Norman E. Lewis Award)

“3D CT of the Temporal Bone: Anatomy and Pathology”

Dr. Girish M. Fatterpekar
Mt. Sinai Medical Center, New York, NY

Western Neuroradiological Society (WNRS)

(The Gabriel H. Wilson Award)

“Utility of Multi-Modal CT Imaging in the Endovascular Management of Acute Ischemic Stroke”

Dr. Joey D. English
UCSF Medical Center, San Francisco, CA

American Society of Neuroradiology (ASNR) 2008 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 New Orleans 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.

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(Cincinnati Children’s Hospital Medical Center, Cincinnati, OH, 1University of Cincinnati, Cincinnati, OH)

Bayer Best Paper Award in General Neuroradiology

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(University of North Carolina, Chapel Hill, NC)

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(University of Illinois at Chicago, Chicago, IL)

POSTER 25: Automated Generation of Diffusion Tensor Tractography Maps
Nucifora, P.G.P. • Wu, X. • Melhem, E.R. • Longhead, J. • Gur, R.E. • Gur, R.C. • Verma, R.
(University of Pennsylvania, Philadelphia, PA)

Interventional Neuroradiology

(The Michael Brothers Memorial Award)

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(University of Washington, Seattle, WA)

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University of Florida, Gainesville, FL

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(The Norman E. Lewis Award)

“3D CT of the Temporal Bone: Anatomy and Pathology”

Dr. Girish M. Fatterpekar
Mt. Sinai Medical Center, New York, NY

Western Neuroradiological Society (WNRS)

(The Gabriel H. Wilson Award)

“Utility of Multi-Modal CT Imaging in the Endovascular Management of Acute Ischemic Stroke”

Dr. Joey D. English
UCSF Medical Center, San Francisco, CA
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. These fellowships are jointly sponsored by Bayer Healthcare Pharmaceuticals, Inc. and the Neuroradiology Education and Research (NER) Foundation of the American Society of Neuroradiology.

The recipient of the 2009-2010 fellowship is:

Christopher T. Whitlow, M.D., PhD
Wake Forest University School of Medicine, Chapel Hill, NC

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

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”

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

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”

1997-98
Brandon A. Merchant, MD
The Johns Hopkins Hospital
“Novel Applications of Magnetic Resonance Imaging in the Study of Central Nervous System Trauma”

1998-99
Lee H. Monsein, MD
The Johns Hopkins University School of Medicine
“Primate Model of Reversible Regional Cerebral Ischemia”

1999-2000
Christopher T. Whitlow, M.D., PhD
Wake Forest University School of Medicine, Chapel Hill, NC

2000-01
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”

2001-02
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”

2002-03
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”

2003-04
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”

2004-05
Joseph T. Lurito, MD, PhD
The Johns Hopkins Hospital
“Functional MRI and Electrophysiologic Correlates of Sub-modality Specific Somatosensory Activation”

2005-06
Brandon A. Merchant, MD
The Johns Hopkins Hospital
“Novel Applications of Magnetic Resonance Imaging in the Study of Central Nervous System Trauma”

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

2006-07
Christopher T. Whitlow, M.D., PhD
Wake Forest University School of Medicine, Chapel Hill, NC

2007-08
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”

2008-09
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”

2009-10
Christopher T. Whitlow, M.D., PhD
Wake Forest University School of Medicine, Chapel Hill, NC
AWARDS AND HONORS
Past Bayer Healthcare Pharmaceuticals, Inc./NER Foundation Fellowship in Basic Science Research Awards

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”
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”
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”
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 Antiangiogenesis 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 Wintermark, 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
“In Vivo Monitoring of Human Embryonic Stem Cell-derived Grafts in the Central Nervous System of Living Animals Using Optical Imaging Technologies”
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 (GCPII) 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”
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.

The recipient of the 2009 award is:

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”

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 Extradural 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, Missouri
“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, Maryland
“Characterizing the Neural Substrates of Stroke Recovery utilizing fMRI and Perfusion Imaging”
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 2009.

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"

AWARDS AND HONORS

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, and is supported by Boston Scientific.

The recipient of the 2009-2010 fellowship is:
Frank C. Tong, MD
Emory University School of Medicine
"Comparison and Statistical Validation of Cerebral Flow Results Obtained Using Phase Contrast MRA and Computational Flow Dynamics in an In Vitro Cerebral Aneurysm Model"

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, Ohio
"Safety of Iodinated Contrast Material in a Middle Cerebral Artery Occlusion/Reperfusion Model"
CONTINUING MEDICAL EDUCATION (CME)

Take Your Official Continuing Medical Education (CME) Certificate Home With You!

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 2009 and ASNR 47th 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 2009 and ASNR 47th Annual Meeting CME Certificate.

Following the meeting, the ASNR 2009 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 East Lobby of the Vancouver Convention & Exhibition Centre.

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 2009 and ASNR 47th Annual Meeting, all evaluations must be entered by the end of the meeting.

Scientific Program and Meeting Evaluation

The 2009 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 Meeting Room 7 at the Vancouver Convention & Exhibition Centre. 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 32.50 of AMA PRA Category 1 Credit(s)™. Physicians should claim credit commensurate with the extent of their participation in the activity.

TARGET AUDIENCE

The ASNR 47th Annual Meeting is designed for the practicing general radiologist who reads neuroradiology studies or for the dedicated neuroradiologist who wishes to integrate advanced imaging such as magnetic resonance spectroscopy, CTA, MRA, CT perfusion, MR diffusion and perfusion, and functional magnetic resonance imaging into his/her daily practice. Sessions dealing with pediatric neuroradiology, head and neck imaging, spinal diagnostic and therapeutic interventions, vascular imaging and interventions, physiologic imaging, and adult neuroradiology will be offered. Programming is also focused toward the neuroscientist who seeks to better understand modern imaging techniques applied to a practice which includes adults or children, disorders of the spine, head and neck disease, and neurovascular intervention.
ASNR 47th ANNUAL MEETING EDUCATIONAL OBJECTIVES

At the conclusion of this meeting, participants will be able to:

General Programming
- Identify new and persistent infectious diseases that afflict populations around the world.
- Investigate how visual perception affects the performance of radiologists interpreting images of the central nervous system.
- Develop imaging protocols and differential diagnoses for diseases of the eye and orbit.
- Implement a multimodality approach for distinguishing recurrent tumor from therapeutic effects on the brain.
- Discover the role of genetics on brain longevity and mental wellness.
- Review the brain stem anatomy and neural pathways for ocular motility and reflex functions.
- Describe the clinical and neuroimaging workup of ophthalmoplegia.
- Optimize neuroradiology protocols for multi-slice, multi-detector CT technology.
- Implement evidence-based methods for utilization of CT angiography and perfusion.
- Discuss the trade offs between cost and quality.
- Discuss how to manage this conflict in their clinical practice.
- Review of the trends in healthcare economics will be presented and participants will be provided with recommendations planning for changes in reimbursement in their clinical practice.

Advanced Imaging Programming
- Identify MRS methods to measure neurotransmitters, and their clinical utility.
- Analyze the principles and major applications of molecular, perfusion and diffusion imaging.
- Comprehend the physics of hyper-polarized tracers and their use to measure flow and metabolism.

Neurointerventional Programming
- Discuss the optimal imaging strategy for patients with subarachnoid hemorrhage.
- Review the treatment options for intracranial atherosclerotic disease.
- Discuss the imaging options for the identification of intracranial atherosclerotic disease.
- Discuss the optimal imaging strategy for patients presenting with acute stroke.
- Describe the ongoing clinical trials of endovascular stroke intervention.

Spine Programming
- Review cutting-edge techniques for imaging and intervention of the post-operative back.
- Discuss recent advances in spine intervention techniques and review imaging paradigms for spine interventionalists.
- Review different imaging topics like non-traumatic emergencies, pediatric imaging and vascular lesions.
- Analyze carcinoma of the head and neck with an emphasis on patterns of tumor spread and surgical landmarks guiding surgery in the oral cavity, oropharynx, and nasopharynx.
- Identify current trends in head and neck cancer diagnosis, staging and treatment.
- Review anatomy and salient imaging features of malignancies affecting the salivary glands.
- Review pertinent anatomy of the skull base and temporal bone as it pertains to evaluating specific clinical problems including hearing loss, CSF leaks, and ENT symptoms related to the craniovertebral junction.
- Identify and evaluate acute processes of the head and neck including infections and sinustitis, as well as complications following treatment of head and neck cancer.
- Review anatomy, function and pathology of nerves innervating the face with an emphasis on evaluating facial pain, paresthesias, and paralysis.

Head and Neck Programming
- Analyze carcinoma of the head and neck with an emphasis on patterns of tumor spread and surgical landmarks guiding surgery in the oral cavity, oropharynx, and nasopharynx.
- Identify current trends in head and neck cancer diagnosis, staging and treatment.
- Review anatomy and salient imaging features of malignancies affecting the salivary glands.
- Review pertinent anatomy of the skull base and temporal bone as it pertains to evaluating specific clinical problems including hearing loss, CSF leaks, and ENT symptoms related to the craniovertebral junction.
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- Review anatomy, function and pathology of nerves innervating the face with an emphasis on evaluating facial pain, paresthesias, and paralysis.

Functional Programming
- Explore the role of integrated advanced imaging such as DTI, fMRI, MRS and MEG and special considerations for their use in the management of young patients.
- Examine the role of integrated advanced imaging such as DTI, fMRI, MRS and MEG and special considerations for their use in the management of adult patients.
- Explore the role of integrated advanced imaging such as DTI, fMRI, MRS and MEG and special considerations for their use in the management of aging patients.

Pediatric Programming
- Review the clinical spectrum of stroke in childhood, with an emphasis on developing new strategies for research, evaluation, and treatment.
- Identify the presentation and treatment of aneurysms and other focal cerebrovascular lesions in the pediatric population.
- Explore and discuss the manifestations and mimics of CNS injury in child abuse, and the role of the radiologist in the legal interrogation of non-accidental trauma.
- Discuss the clinical spectrum of vascular malformations presenting in childhood, with an emphasis on intervention and new and expanded classifications of these lesions and syndromes.

Maintenance of Certification (MOC) Programming
- Identify imaging features of common and unusual cerebrovascular disease presenting to the emergency department.
- Classify congenital anomalies of the spine.
- Identify the features that define inflammatory lesions of the head and neck and their differentiation from neoplastic masses.
- Identify the imaging features of traumatic lesions of the brain and spine.
- Interpret familiar treatment options for cerebroinfarction.

Overall Objectives for the ASNR 47th Annual Meeting
After attending the 47th Annual Meeting, you will be able to:
- Review the clinical spectrum of stroke, vascular malformations and CNS injury presented in childhood cases.
- Examine the role of integrated advanced imaging such as DTI, fMRI, MRS, and MEG and special considerations for their use in the management of young, adult, and aging patients.
- Participate in Maintenance of Certification (MOC) and Self Assessment Module (SAM) Programming with sessions highlighting Head & Neck, Brain, MRS, Spine, Pediatrics and Vascular and Interventional focus.
- Review the importance of Socioeconomic issues including Realities in the 21st Century, CMS Changes to Medicare and Quality Practice Improvement (PQI) and trends in healthcare economics and reimbursement issues in clinical practice.
- Comprehend and analyze MRS methods, molecular perfusion, diffusion imaging and physics of hyper-polarized tracers.
- Review anatomy and salient imaging features of malignancies affecting the salivary glands.
- Review cutting-edge techniques for imaging and intervention of the post-operative back and non-traumatic emergencies.
- Discuss and review imaging and treatment options for intracranial atherosclerotic disease and optimal imaging strategy for patients with subarachnoid hemorrhage and endovascular stroke intervention.

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**ELC Workshops - Room 11**

The ASNRC Learning Center (ELC) provides the opportunity for practicing neuroradiologists and neuroradiologist educators to learn new electronic methods in an interactive small group environment. This year’s program will build on the sessions offered at the 2008 meeting.

- Workshop attendance is limited
- ELC Workshops are not included in the Annual Meeting registration fee/ELC Lectures are FREE of charge
- A ticket is required for admission (workshops only)
- Two participants are allowed per computer during the workshop
- Workshop tickets are offered on a first-come, first-served basis for $50 Members/Non-members and $10 for Fellow/Trainees

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<td>H. Christian Davidson, MD</td>
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<td>Navigating the Software on Outside CDs</td>
<td>Tuesday, May 19</td>
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<td>John L. Go, MD</td>
<td>Room 11</td>
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<tr>
<td>PowerPoint for Scientific Presentations and Exhibits</td>
<td>Tuesday, May 19</td>
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<td>Barton F. Branstetter IV, MD</td>
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**PowerPoint 2007**

Monday, May 18 • 10:45am – 12:15pm • H. Christian Davidson, MD  
Location: Room 11

This workshop will introduce registrants to the new layout and new features in the latest version of Microsoft’s PowerPoint software. PowerPoint 2007 represents a radical shift in the layout of the program and the placement of the buttons and commands. Users attempting to make the transition to this new version inevitably have a steep learning curve the first few times that they use the program, but in the long run, most users find the new layout to be more efficient. The goal of this workshop is to save the registrant time and frustration by pointing out the major differences in the new interface, and show where some of the commands that are most useful to radiologists have been placed. Registrants are assumed to have a basic knowledge of earlier version of PowerPoint.

**Navigating the Software on Outside CDs**

Tuesday, May 19 • 10:45am – 12:15pm • John L. Go, MD  
Location: Room 11

Images obtained at other hospitals frequently need to be reviewed during transfer of care. These images are now almost always carried on compact discs (CDs) -- physical film is a rarity. Despite national standards for the format of image data on CDs, radiologists are most often forced to review the images in the context of the viewing software embedded on the CD. Unfortunately, the interfaces for this software differ dramatically depending on the manufacturer of the PACS, and a radiologist unfamiliar with the software on the CD might waste considerable time learning the new system before being able to review images. The purpose of this workshop is to familiarize registrants with the software most frequently encountered on CDs from other hospitals. Basic image manipulation and navigation skills for several different manufacturers will be demonstrated.

**PowerPoint for Scientific Presentations and Exhibits**

Tuesday, May 19 • 3:30pm – 5:00pm • Barton F. Branstetter IV, MD  
Location: Room 11

Microsoft’s PowerPoint is the most widely-used presentation software for scientific meetings, and most presenters know how to make basic slide shows. But PowerPoint can also be used to easily create figures for publication, and posters for scientific exhibits. This workshop will teach registrants how to leverage their existing PowerPoint skills for virtually any type of image presentation at scientific meetings. Some advanced uses of PowerPoint for scientific slide presentations will also be demonstrated. Registrants are assumed to have a basic knowledge of PowerPoint.

**Photoshop for Scientific Presentations and Exhibits**

Wednesday, May 20 • 3:30pm – 5:00pm • Steven G. Imbesi, MD  
Location: Room 11

Adobe’s Photoshop software is widely used for image manipulation and processing, and is available within most academic institutions. In addition to basic image manipulation, however, Photoshop can be used to create and improve images for scientific presentation and publication. This workshop will teach registrants how to leverage their existing Photoshop skills for image presentation at national scientific meetings. Registrants are assumed to have a basic knowledge of Photoshop.
The ASNR Electronic Learning Center (ELC) provides the opportunity for practicing neuroradiologists and neuroradiologist educators to learn new electronic methods in an interactive small group environment. This year’s program will build on the sessions offered at the 2008 meeting.

### Internet Resources for Research and MOC

**Monday, May 18 • 5:00pm – 6:00pm • Edward J. Escott, MD**

Location: Room 11

The internet contains a vast wealth of useful information that can enhance the research process. It also contains a vast amount of false and misleading information. The purpose of this lecture is to introduce attendees to the most useful online resources for scientific research and continuous lifetime learning. Emphasis will be placed on the new American Board of Radiology requirements for continuing medical education and maintenance of certification.

### Teaching Files Online and In-house

**Tuesday, May 19 • 5:00pm – 6:00pm • Adam E. Flanders, MD**

Location: Room 11

The traditional single-institution teaching file has become a thing of the past. Residents and other trainees have a vast array of case-based education at their fingertips for learning and for decision support, without having to walk across the department to a stationary teaching file. The purpose of this lecture is to review the options for teaching files both within an institution and shared across the internet. Emphasis will be placed on the RSNA’s MIRC initiative, and also on multi-institutional shared internet resources. Commercial decision support software will also be discussed.

### Switching to a New PACS Vendor

**Wednesday, May 20 • 5:00pm – 6:00pm • C. Douglas Phillips, MD; Richard H. Wiggins, III, MD**

Location: Room 11

PACS has become a near-ubiquitous technology within radiology. Much has been written about finding a PACS vendor that matches the needs of your department and your enterprise. With so much money, and the quality of patient care, at stake, the process of choosing a PACS vendor has been likened to a marriage. But what happens when it’s time for a divorce? When expectations are not met, and a new PACS vendor is required, the process is somewhat different than when PACS is first installed. The purpose of this lecture is to review the unique aspects of switching to a new PACS vendor, and to contrast this process with the original transition to PACS.
Synopsis: The ASNR Business Center will offer executive lectures encompassing topics pertinent to management and administration for both private practice and academic radiologists. 

Goals: The 2009 ASNR Business Center will delve into topics involving the roles of governments as overseer and payer for healthcare. This will include analysis of United States legislative effects at both the federal and state level upon radiology practice, as well as governmental impacts on turf wars. Lastly, given the Vancouver location of the annual meeting, we will also provide a Canadian perspective of the impact on radiology practice by government.

Target Audience: Radiologists who make business decisions for their practices or any radiologist interested in learning more about the mechanisms by which a practice functions.

ASNR BUSINESS CENTER PROGRAMMING

MONDAY, MAY 18 • 1:30pm - 3:15pm
ASNR Business Center • Programing Part I

1:30pm - 2:00pm
“Inappropriate Utilization of Imaging: Self-Referral, Stark Law [in]Effectiveness... and Maryland”
Gregory L. Katzman, MD, MBA
Professor and Chair, University of Texas Medical Branch

Inappropriate utilization, self-referral, and Stark laws are inextricably intertwined. To better understand their interactions, we will first establish a basic understanding of “Stark Law” in its current and potential future forms and then discuss their [un]expected consequences. Lastly, a controversial interpretation of a self-referral statute in Maryland will be discussed as an example of a state remedy seeking to remove the conflict of interest which arises when a physician determines which diagnostic services their patients require while simultaneously profiting from them.

2:00pm - 2:30pm
“Turf Wars in Radiology: What Federal and State Governments as well as Private Payers are Doing to Limit Self-Referrals?”
David M. Yousum, MD, MBA
Johns Hopkins Medical Institution

Description: Self-referral in imaging leads to higher utilization and healthcare costs. Although it is still widespread, there are indications that some states, some regional payors, and the Centers for Medicare and Medicaid Services (CMS) have begun to take actions to limit this activity. At the state level, these actions include consideration of anti-self-referral laws, crackdowns on scan leasing schemes, instituting mandatory facility accreditation programs, and bans on the installation of advanced imaging equipment in physician offices. Some commercial payors have instituted strict privileging programs in imaging, closed their panels to any facility that is not a full-service imaging provider, and begun requiring accreditation of advanced imaging modalities. CMS plans to institute an anti-markup rule and prohibit independent diagnostic testing facilities from leasing space or equipment to nonradiologist physicians. The objective of this talk is to review recent developments and their implications.

2:30pm - 3:00pm
“Imag(in)ing Turf Protection: Fighting Gravity 101”
Jonathan Breslau, MD
Radiological Associates of Sacramento

Radiologists appropriately focus on turf protection but can it be done? Is it “our” turf? This battle must be fought on multiple fronts, including federal and state regulatory/legislative, local community and through existing hospital medical staff structure.

3:00pm - 3:15pm
Speaker & audience roundtable discussion of today’s topics

TUESDAY, MAY 19 • 1:30pm - 3:15pm
ASNR Business Center • Programing Part II

1:30pm - 2:00pm
“Federal Policy, Macroeconomics, and Their Impact on Radiology in the USA”
Frank Lexa, MD, MBA
Professor, Wharton Graduate School of Business; Clinical Professor, University of Pennsylvania

The recent Federal election in the USA brought more than just a new president and a new Congress. The election will also lead to a substantial shift in both how and what the government pays for. US based radiologists will see significant changes not only in how the largest payer in this 2.3 trillion dollar market acts, but in how other payers follow that leader. Economic factors will play key roles in driving this change and constraining the choices available to the new administration. These scenarios and their impact on radiologists will be discussed.

2:00pm - 2:30pm
“Preop: What do Washington and Wall Street Have in Store For Us?”
Jonathan Breslau, MD
Radiological Associates of Sacramento

Are there ways to prepare for external changes in our field of medicine? I. We have seen cuts to reimbursement in imaging but more are coming. What will they look like? II. Several publicly traded companies are now primarily engaged in the “read” business. What is the impact to us and what more should we expect?

2:30pm - 3:00pm
Bruce Forster, MD
Professor, and Vice-Chairman, University of British Columbia, Canada

The Canadian health care system historically has been largely a single-payer, publicly-funded enterprise. However the rapidly rising cost of socialized health care over the last forty years has greatly affected medical practice, including Radiology. Wait-lists, equipment procurement, and radiology manpower have all been affected. The efforts to manage these issues, which include the evolution of private imaging centers, will be discussed, as will be ongoing economic pressures in our specialty, with comparisons and contrasts to the U.S. scenario made where appropriate.

3:00pm - 3:15pm
Speaker & audience roundtable discussion of today’s topics
In addition to the Technical Exhibition, the leadership of the ASNR is pleased to announce the twelfth 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 Breakfast and Lunch 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 over the last nine years 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 Hall A

#### Monday, May 18

**6:30 am - 7:30 am**

**Practical Protocols for Safe Contrast Use in MR Imaging**

6:30 am “Acute Adverse Reactions: Definition, Risk Factors and Preventive Measures”

Emanuel Kanal, MD
University of Pittsburgh Medical Center

7:00 am “Latest on Nephrogenic Systemic Fibrosis”

Val M. Runge, MD
White & Scott Hospital

#### Tuesday, May 19

**6:30 am - 7:30 am**

“Dynamic Volume CT: Acute Neuro & Stroke Imaging”

Sirini Mukundan, MD, Chief of Neuroradiology
Brigham & Women’s Hospital, Boston, MA

#### Wednesday, May 20

**6:30 am - 7:30 am**

“Ready – Set – Go: MOC”

American Board of Radiology (ABR)

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**PLEASE NOTE:** Due to the direct financial support from these companies and the commercial content, CME credit will not be granted for these sessions.
TECHNICAL EXHIBITS
EXHIBITION HALL B

ASNR 47th ANNUAL MEETING • MAY 16 - 21, 2009

Technical Exhibits

MicroVention
Dfine Inc
DePuy Spine, a Johnson & Johnson Co
Codman, a Johnson & Johnson Co
Bracco Diagnostics
Philips
Siemens Medical Solutions
Hitachi Medical Sys
Xoran Tech

Medtronic

American Recruiters

Bayer Healthcare Pharmaceuticals

Springer

Elsevier Canada

Amirsys, Inc
Lippincott Williams & Wilkins

Nordic Neurolab

Euroradiology

Vital Images

GE Healthcare

Entrance
TECHNICAL EXHIBITS ROSTER (AS OF 03/27/09)

Vancouver Convention & Exhibition Centre - Exhibit Hall B

Monday, May 18 ..............................................................................................................................................................................10:15 am – 4:00 pm
Tuesday, May 19 ..............................................................................................................................................................................10:15 am – 4:00 pm
Wednesday, May 20 .........................................................................................................................................................................10:15 am – 4:00 pm

American Society of Neuroradiology (ASNR) and NER Foundation ................................................................. Booth 525
2210 Midwest Rd
Oak Brook, IL 60523

Advanced Imaging Research, Inc ........................................ Booth 425
4700 Lakeside Avenue, Suite 400
Cleveland, OH 44114

American Medical Recruiters ........................................... Booth 104
6400 N Andrews Avenue, Suite 100
Ft. Lauderdale, FL 33309

Amirisys, Inc ........................................................................ Booth 303
2180 South 1300 East, Suite 405
Salt Lake City, UT 84106

Bayer Healthcare Pharmaceuticals .................................... Booth 101
6 West Belt
Wayne, NJ 07470

Bracco Diagnostics Inc ..................................................... Booth 407
107 College Road East,
Princeton, NJ 08540

Codman, a Johnson & Johnson Co ................................... Booth 506
325 Paramount Drive
Raynham, MA 02767

DePuy Spine, a Johnson & Johnson Co ................................ Booth 508
325 Paramount Drive
Raynham, MA 02767

Dfine, Inc ................................................................................ Booth 507
3047 Orchard Parkway
San Jose, CA 95134

Elsevier Canada ............................................................... Booth 400
905 King Street West, 4th Floor
Toronto, ON, Canada M6K 349

GE Healthcare ......................................................................... Booth 201
3000 N. Grandview Boulevard
Wakesha, WI 53188

Hitachi Medical Systems America, Inc ............................. Booth 107
1959 Summit Commerce Park
Twinsburg, OH 44087

Invivo .................................................................................... Booth 224
12601 Research Parkway
N 27 W23676 Paw Rd
Pewaukee, WI 53072

Lippincott Williams & Wilkins .......................................... Booth 301
4816 139th, Suite E
Snohomish, WA 98296

Medis medical imaging systems ........................................ Booth 402
751 Miller Drive, Suite D2
Leesburg, VA 20175

Medtronic ............................................................................. Booth 124
21600 Sofamor Danek Drive
Memphis, TN 38132

MicroVention ..................................................................... Booth 606
75 Columbia, Suite A
Aliso Viejo, CA 92656

Neurologica Corp ............................................................. Booth 325
14 Electronics Avenue
Danvers, MA 01923

Philips ................................................................................... Booth 307
3000 Minuteman Road
Andover, MA 01810

Siemens Healthcare ......................................................... Booth 207
51 Valley Stream Parkway
Malvern, PA 19355

Spine Wave ........................................................................... Booth 524
Two Enterprise Drive, Suite 302
Shelton, CT 06484

Springer ................................................................................ Booth 100
233 Spring Street
New York, NY 10013

Toshiba ................................................................................ Booth 225
2441 Michelle Drive
Tustin, CA 92780

Vital Images ......................................................................... Booth 125
5850 Opus Parkway, Suite 300
Minnetonka, MN 55343

Xoran Technologies .......................................................... Booth 106
309 North First Street
Ann Arbor, MI 48103
EXHIBITION HALL C

Scientific Exhibits
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Anatomy .......... 26-30
Head and Neck 31-43
Interventional ......44
Pediatrics .......... 45-54
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<tr>
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<tr>
<td>Donald F. Frei Jr.</td>
<td>Radiology Imaging Associates, Denver</td>
</tr>
<tr>
<td>Nafi Aygun, MD</td>
<td>The Johns Hopkins Hospital</td>
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<td>Michael Brant-Zawadzki, FACP</td>
<td>Franciscan Health System, Los Angeles, California</td>
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<td>Stefano Blumi, PhD</td>
<td>University of Southern California</td>
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<td>Jonathan Breslau, MD</td>
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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 the week based on Technical Exhibit hours and How-to Session programming.

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

ASNR 47th ANNUAL MEETING
MONDAY, MAY 18

6:00am - 7:55am
BREAKFAST

6:30am - 7:30am
HOW-TO SESSION BREAKFAST
Sponsor: Bracco

7:40am - 7:45am
(1) OPENING REMARKS
Page 1

7:45am - 8:45am
(2) MAINTENANCE OF CERTIFICATION (MOC) - ADULT SPINE AND INTERVENTIONAL (AR+)
Page 1

8:45am - 10:15am
(3) GENERAL SESSION: INFECTIOUS DISEASES OF THE BRAIN: THE BUGS STRIKE BACK
Page 2

10:15am - 10:45am
MORNING BREAK

10:45am - 12:30pm
(4) PARALLEL SCIENTIFIC PAPER SESSIONS
(a) Adult Brain: Inflammatory/Infectious Diseases and Epilepsy
Page 4
(b) Interventional: Aneurysms I
Page 11
(c) Adult Brain: New Techniques/Post Processing
Page 18
(d) Spine: Neoplasia, Trauma and Functional Imaging
Page 26
(e) Excerpta Extraordinaire: Adult Brain
Page 33

10:45am - 12:15pm
(5) ELC WORKSHOP POWERPOINT 2007
Page 46

12:15pm - 1:30pm
LUNCH BREAK

12:30pm - 1:30pm
LUNCH HOW-TO SESSION
Sponsor: Toshiba America Medical Systems, Inc. (TAMS)

1:30pm - 3:00pm
(8) ASFNR PROGRAMMING: FUNCTIONAL IMAGING IN THE PEDIATRIC POPULATION
Page 49

1:30pm - 3:15pm
(9) ASNR BUSINESS CENTER PROGRAMMING: GOVERNMENT AND RADIOLOGY - PART I
Page 50

3:00pm - 3:30pm
AFTERNOON BREAK

3:30pm - 5:00pm
(10) PARALLEL SCIENTIFIC PAPER SESSIONS
(a) Adult Brain: Vascular, Intracranial I
Page 51
(b) Interventional: Aneurysms II
Page 58
(c) Adult Brain: Trauma and Other
Page 64
(d) Adult Brain: Functional Imaging I
Page 70

3:30pm - 5:00pm
(11) ELC Workshop: NAVIGATING THE SOFTWARE ON OUTSIDE CDs
Page 77

5:00pm - 6:30pm
(12) ASSR PROGRAMMING: HOW I DO IT! OPERATIVE BACK
Page 77

5:00pm - 6:30pm
(13) SNIS PROGRAMMING: INTRACRANIAL ATHEROSCLEROTIC DISEASE (ICAD) IMAGING AND TREATMENT (AR+) (SAM)
Page 78

5:00pm - 6:30pm
(14) ADVANCED IMAGING SEMINAR: CLINICAL SPECTROSCOPY: BEYOND NAA
Page 80

5:00pm - 6:00pm
(15) ELC LECTURE: INTERNET RESOURCES FOR RESEARCH AND MOC
Page 81

6:30pm - 8:30pm
WELCOME RECEPTION AT THE PAN PACIFIC VANCOUVER ATRIUM LOBBY

Note: Programming is currently under review for qualification as a Self Assessment Module (SAM) through the American Board of Radiology (ABR).
TUESDAY, MAY 19

6:00am - 7:55am
BREAKFAST

6:30am - 7:30am
HOW-TO SESSION BREAKFAST
Sponsor: Medtronic

7:45am - 8:45am
(16) MAINTENANCE OF CERTIFICATION (MOC)
ADULT BRAIN AND PEDIATRIC SPINE (AR+)
Page 83

8:45am - 10:15am
(17) GENERAL SESSION: MOVING TOWARD SOLUTIONS TO IMAGE OVERLOAD THROUGH ADVANCES IN VISUAL PERCEPTION AND COMPUTER VISUALIZATION
Page 84

10:15am - 10:45am
MORNING BREAK

10:45am - 12:30pm
(18) PARALLEL SCIENTIFIC PAPER SESSIONS
(a) Adult Brain: Neoplasms I
Page 85
(b) Interventional: New Devices and Techniques
Page 93
(c) Adult Brain: Vascular, Extracranial and Vascular, Intracranial II
Page 100
(d) Pediatric: Functional Imaging
Page 107
(e) Excerpta Extraordinaire: Interventional and Spine
Page 116

10:45am - 12:15pm
(19) ELC WORKSHOP: NAVIGATING THE SOFTWARE ON OUTSIDE CDs
Page 126

12:15pm - 1:30pm
LUNCH BREAK

12:30pm - 1:30pm
FELLOWS’ LUNCHEON

12:30pm - 1:30pm
(20) AMERICAN SOCIETY OF FUNCTIONAL NEURORADIOLOGY (ASFNR)
Annual Business Meeting (Members Only)
Page 126

1:30pm - 3:00pm
(21) ASSR PROGRAMMING: TOPICS IN SPINE IMAGING
Page 126

1:30pm - 3:00pm
(22) SNIS PROGRAMMING: STROKE IMAGING AND DEVICES
Page 129

1:30pm - 3:15pm
(23) ASFNR PROGRAMMING: FUNCTIONAL IMAGING IN THE ADULT BRAIN
Page 130

1:30pm - 3:15pm
(24) ASNR BUSINESS CENTER PROGRAMMING GOVERNMENT AND RADIOLOGY - PART II
Page 131

1:30pm - 3:00pm
(25) GENERAL SESSION: SOCIOECONOMIC SESSION (AR+) (SAM)
Page 132

3:00pm - 3:30pm
AFTERNOON BREAK

3:30pm - 5:00pm
(26) PARALLEL SCIENTIFIC PAPER SESSIONS
(a) Adult Brain: Cerebrovascular Occlusive Diseases I
Page 134
(b) Head & Neck: Orbit, Face and Salivary Glands
Page 140
(c) Spine: Interventions and Pain Management
Page 147
(d) Socio economics and Brain Anatomy
Page 153

3:30pm - 5:00pm
(27) ELC WORKSHOP: POWERPOINT FOR SCIENTIFIC PRESENTATIONS AND EXHIBITS
Page 160

5:00pm - 6:30pm
(28) ASPNR PROGRAMMING: PEDIATRIC STROKE (AR+) (SAM)
Page 160

5:00pm - 6:30pm
(29) ASHNR PROGRAMMING: THE FACE: ANATOMY, FUNCTION AND PATHOLOGY
Page 162

5:00pm - 6:30pm
(30) ADVANCED IMAGING SEMINAR DIFFUSION IN THE BRAIN AND SPINE
Page 163

5:00pm - 6:00pm
(31) ELC LECTURE: TEACHING FILES ONLINE AND IN-HOUSE
Page 164

1Note: Programming is currently under review for qualification as a Self Assessment Module (SAM) through the American Board of Radiology (ABR).
WEDNESDAY, MAY 20

6:30am - 7:55am
BREAKFAST

7:40am - 8:40am
(32) MAINTENANCE OF CERTIFICATION (MOC)
PEDiatric BRAIN & HEAD AND HEAD & NECK (AR+)
Page 165

8:45am - 10:15am
(33) GENERAL SESSION: THE POST-THERAPEUTIC BRAIN
Page 165

10:15am - 10:45am
MORNING BREAK

10:45am - 11:00am
(34) ASNR PRESIDENTIAL ADDRESS
C(35) ASNR Award Announcements
- Gold Medal Award
- Honorary Member Award
- NER Foundation Outstanding Contributions in Research Award
- 2008 Outstanding Presentation Awards
- NER Foundation Scholar Award in Neuroradiology Research
- NER Foundation/Boston Scientific Fellowship in Cerebrovascular Disease Research
- Bayer Healthcare Pharmaceuticals/NER Foundation Fellowship in Basic Science Research
Page 167

11:00am - 11:45am
(36) KEYNOTE LECTURE: IMAGING GENETICS OF BRAIN LONGEVITY AND MENTAL WELLNESS: THE NEXT FRONTIER?
Page 168

11:45am - 12:10pm
(37) AMERICAN SOCIETY OF NEURORADIOLOGY (ASNR)
Annual Business Meeting (Members Only)
Page 168

11:45am - 1:15pm
LUNCH BREAK

1:15pm - 2:45pm
(38) ASNR PROGRAMMING: FUNCTIONAL IMAGING IN THE AGING POPULATION (AR+) (SAM)1
Page 168

1:15pm - 2:45pm
(39) ASNR PROGRAMMING: SKULL BASE PATHOLOGY: A PRACTICAL APPROACH TO CLINICAL PROBLEMS
Page 170

1:15pm - 2:45pm
(40) ASPNR PROGRAMMING: NEUROIMAGING OF CHILD ABUSE
Page 172

1:15pm - 2:45pm
(41) GENERAL SESSION: THE RESURGENCE OF CT
Page 173

2:45pm - 3:15pm

AFTERNOON BREAK

3:15pm - 4:45pm
(42) PARALLEL SCIENTIFIC PAPER SESSIONS
(a) Interventional: Thrombolysis/Stroke, Arteriovenous Malformations/Fistulae
Page 174
(b) Pediatric: Neoplasms and New Techniques
Page 180
(c) Spine: New Techniques and Miscellaneous
Page 187
(d) Head & Neck: Pharynx, Larynx and Neck
Page 193

3:30pm - 5:00pm
(43) ELC WORKSHOP PHOTOSHOP FOR SCIENTIFIC PRESENTATIONS AND EXHIBITS
Page 200

4:45pm - 6:15pm
(44) ASNR PROGRAMMING: IMAGING THE ACUTE HEAD AND NECK
Page 200

4:45pm - 6:15pm
(45) ASPNR PROGRAMMING: PEDIATRIC INTERESTING CASE CONFERENCE PANEL DISCUSSION (AR+)
Page 201

5:00pm - 6:00pm
(46) ADVANCED IMAGING SEMINAR: PERFUSION: STROKE AND HYPER-POLARIZATION
Page 202

Note: Programming is currently under review for qualification as a Self Assessment Module (SAM) through the American Board of Radiology (ABR).
THURSDAY, MAY 21

6:30am - 7:55am
BREAKFAST

7:45am - 8:45am
(48) MAINTENANCE OF CERTIFICATION (MOC) HEAD & NECK AND ADULT BRAIN (AR+)
Page 205

8:45am - 10:15am
(49) GENERAL SESSION: NEURO-OPTHALMOLOGY
Page 205

10:15am - 10:45am
MORNING BREAK

10:45am - 12:30pm
(50) PARALLEL SCIENTIFIC PAPER SESSIONS
(a) Adult Brain: Functional Imaging II
Page 207
(b) Adult Brain: Neoplasms II
Page 215
(c) Adult Brain: Degenerative/Demyelinating/Metabolic Diseases I
Page 223
(d) Pediatric: Infections, Metabolic, Other and Spine
Page 232
(e) Excerpta Extraordinaire: Pediatrics
Page 240

12:30pm - 1:30pm
LUNCH BREAK

12:30pm - 1:30pm
(51) AMERICAN SOCIETY OF PEDIATRIC NEURORADIOLOGY (ASPNR)
Annual Business Meeting (Members Only)
Page 257

1:30pm - 3:00pm
(52) PARALLEL SCIENTIFIC PAPER SESSIONS
(a) Head & Neck: Temporal Bone and Skull Base
Page 251
(b) Adult Brain: Cerebrovascular Occlusive Disease II
Page 258
(c) Adult Brain: Degenerative/Demyelinating/Metabolic Diseases II
Page 265
(d) Pediatric: Developmental/Congenital Malformations
Page 272

3:00pm - 3:30pm
AFTERNOON BREAK

3:30pm - 5:00pm
(53) ASPNR PROGRAMMING: VASCULAR MALFORMATIONS OF THE HEAD AND NECK
Page 279

3:30pm - 5:00pm
(54) ASHNR PROGRAMMING: HEAD AND NECK ONCOLOGY EVALUATION OF NEWLY DIAGNOSED CANCER (AR+) (SAM)¹
Page 280

3:30pm - 5:00pm
(55) ADVANCED IMAGING SEMINAR: CONTRAST AGENTS: HOW TO ENHANCE YOUR IMAGE
Page 282

5:00pm - 5:15pm
(56) CLOSING REMARKS
Page 283

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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/2009.

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Monday Morning

7:40 AM – 7:45 AM
Hall A

(1) Opening Remarks

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Monday Morning

7:45 AM – 8:45 AM
Hall A

(2) Maintenance of Certification (MOC) – Adult Spine and Interventional Audience Response Plus (AR+)*

*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.

(2) Adult Spine

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Interventional

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Adult Spine

Bassem A. Georgy, MD

LEARNING OBJECTIVES

Upon completion of this presentation, participants will be able to:
1) Identify a range of adult spine pathology.
2) Analyze adult spine CT and MR images.
3) Formulate appropriate differential diagnosis.

PRESENTATION SUMMARY

This is a MOC review session for adult spine. Unknown CT and MR cases of common pathologic processes will be presented. Differential diagnosis will be discussed after multiple choice questions are presented utilizing audience response system. The goal is to improve understanding of common imaging appearances of adult spine pathology.

Interventional

Steven W. Hetts, MD

LEARNING OBJECTIVES

Upon completion of this presentation, participants will be able to:
1) Describe the current state of the art in endovascular intervention for acute ischemic stroke.
2) Evaluate imaging and treatment strategies for subarachnoid hemorrhage.
3) Discuss imaging and treatment options for intracranial atherosclerotic disease.

PRESENTATION SUMMARY

Through the presentation of unknown cases this session will review the current imaging of and treatment algorithms for acute ischemic stroke, subarachnoid hemorrhage, and intracranial atherosclerotic disease. The central theme will be the appropriate use of diagnostic angiography as well as an update on interventional strategies and techniques. Emphasis also will be placed on the evolving use of advanced imaging techniques such as CT angiography (CTA) and CT perfusion (CTP) to supplement clinical decision-making in the diseases discussed.

REFERENCES

Monday Morning
8:45 AM – 10:15 AM
Hall A

(3) General Session: Infectious Diseases of the Brain: The Bugs Strike Back

(4) Bacterial and Fungal Diseases
— Gordon K. Sze, MD

(5) Parasitic Diseases of the Continents
— Spyros J. Karampekios, MD

(6) Viruses and Prions
— Walter Kucharzyk, MD, FRPC

Moderator: Gordon K. Sze, MD

Bacterial and Fungal Diseases
Gordon K. Sze, MD

PRESENTATION SUMMARY
Bacterial and fungal diseases of the brain are always serious events. Proceeding from the outside, the epidural and subdural spaces can be involved, resulting in empyemas. Both are visualized as extra-axial fluid collections, often rim enhancing and often demonstrating restricted diffusion. While epidural empyemas tend to be relatively confined by the dura, subdural empyemas can spread rapidly into the underlying tissues, thus causing them to be potential neurosurgical emergencies. Involvement of the underlying brain can result in cerebritis and abscess formation or in secondary thrombosis of vessels, causing infarcts. Bacterial and fungal meningitis also is a potentially fatal entity. Ventricular exten-

sion can occur, resulting in ventriculitis. While mild cases may not be visible on imaging, more serious infections can result in the demonstration of purulent material in the subarachnoid space, often in the basal cisterns in cases of granulomatous infections. Diffusion imaging can disclose restricted diffusion of the purulent debris in both meningitis and ventriculitis and also can reveal complications. Finally, bacterial and fungal parenchymal involvement of the brain also can occur. Initially, cerebritis is seen, followed by the evolution of abscesses. In fungal and other granulomatous cases, frank abscesses may be detected less often than solid enhancing masses. In these cases, lesions often appear somewhat hypointense on T2-weighted imaging. Diffusion imaging is the best method of differentiating abscess formation from other cystic and necrotic lesions, such as tumors, and can become positive early on, in the cerebritis stage. More recent work has centered on utilizing advanced imaging techniques to further refine our diagnostic capabilities. Different patterns of restricted diffusion have been described in fungal, as opposed to bacterial, abscesses. Increased fractional anisotropy has been noted in both abscesses and in other infected fluid collections, such as in empyemas and loculated meningitis. MR spectroscopy has been shown to have the potential to differentiate routine bacterial from mycobacterial from fungal abscesses by virtue of the presence or absence of certain metabolic by-products. All of these techniques have been utilized to demonstrate response to therapy. Even perfusion imaging and magnetization transfer techniques have been applied to the evaluation of parenchymal infections.

Parasitic Diseases of the Continents
Spyros J. Karampekios, MD

Dr. Karampekios was born in Athens, Greece in 1959. He received his M.D. from the University of Athens, Greece in 1984. Dr. Karampekios performed his Radiology Residency at the Arcteon Hospital, University of Athens, Greece in 1990. His M.D. thesis: “The role of MRI for the detection and characterization of spinal cord cavities” was completed in 1989. He did his Research Fellowship in Neuroradiology, at the University of California, San Diego from 1993-1994. Dr. Karampekios is Assistant Professor of Radiology, School of Medicine, University of Crete. Chief of Neuroradiology and Director of MRI, Department of Radiology, University Hospital of Heraklion, Crete, Greece. He has edited/written approximately 50 articles in publications and 5 chapters in Radiology textbooks and has been an Invited Speaker in 15 International and European Congresses and Meetings. His research interests include MRI of CNS infections, brain infections in immunocompromised patients (particularly AIDS patients) and application of advanced neuroimaging techniques (DWI, PWI, MRS) for the evaluation of brain tumors.

LEARNING OBJECTIVES
Upon completion of this presentation, participants will be able to:
1) Analyze the most common and important parasitic infections in immunocompromised patients (toxoplasmosis) and immunocompetent individuals (cysticercosis).
2) Apply advanced neuroimaging techniques in the detection
and characterization of parasitic diseases.
3) Identify the imaging findings of some rare parasitic diseases, especially in patients living in endemic regions.

PRESENTATION SUMMARY
Parasitic central nervous system (CNS) diseases, typically present as cystic lesions on imaging studies and are still an important and not uncommon clinical issue in underdeveloped countries and in patients with defective or suppressed immune status. Neurocysticercosis is the commonest parasitic infection in immunocompetent population and constitutes the main cause of adult-onset seizures in countries with poor hygiene. Toxoplasmosis which is the commonest opportunistic infection among patients with AIDS, produces an infection secondary to reactivation of a latent parasite encysted in the brain and constitutes the most frequent cause of intracranial mass lesion. The imaging features of those common parasitic infections will be reviewed and the importance of accurate and early diagnosis is emphasized, since parasitic diseases are potentially curable, with immediate institution of effective and prompt treatment. Furthermore, emphasis will be on the application of neuroimaging, especially the added value of advanced MR techniques (DWI, PWI, MRS), in the differentiation of cerebral toxoplasmosis lesions from other focal lesions in AIDS patients, such as primary CNS lymphoma, or other opportunistic infections. Although the advent of prophylactic antitoxoplasmic medication and the new antiretroviral therapy as a new standard of care, results in a significant reduction of opportunistic infections in AIDS population, including those caused by parasites, toxoplasmosis remains a very crucial and important issue for patient’s management. Finally, some rare parasitic infections, such as hydatid disease, paragonimiasis, sparganosis, echinococcosis, toxocariosis will be reviewed briefly. The role of imaging is of great importance, particularly when the clinical problem occurs in patients living in specific endemic regions.

REFERENCES

Viruses and Prions
Walter Kucharczyk, MD, FRCPC

LEARNING OBJECTIVES
Upon completion of this presentation, participants will be able to:
1) Review and recognize the imaging spectrum of viral and prion diseases of the CNS.
2) Formulate a concise differential diagnosis based on the imaging findings.

PRESENTATION SUMMARY
Viral and prion diseases of the brain, while uncommon are increasingly being recognized as causes of significant morbidity and mortality. From a diagnostic imaging perspective it is useful to divide viral CNS infections into 3 categories: herpetic infections, topographic viral infections, and HIV. Characteristic imaging abnormalities occur with each of these 3 categories of infection, which although not specific, are often highly suggestive of the diagnosis, especially with herpes simplex infection. The MRI findings of cortical hyperintensity in the temporal lobes and insula, often bilateral and with some hemorrhage, is highly characteristic of HSV infection. Prion diseases are rare. They are uniformly fatal, regardless of treatment. The great value of imaging is the accuracy and rapidity of diagnosis, obviating a large number of other tests, some with increased risk to the health care providers. Human forms of prion infection include sporadic, familial, iatrogenic and new variant CJD, Gerstmann-Strassler-Scheinker syndrome (GSS), sporadic and familial fatal insomnia and kuru. Sporadic CJD (sCJD) accounts for approximately 85% of human disease with the remainder being predominantly hereditary including familial CJD, GSS, and familial fatal insomnia. New variant CJD (vCJD) gained widespread recognition from a public health perspective in the late 1990’s, but has now virtually disappeared. Typical findings of sCJD include symmetric T2 hyperintensity involving the basal ganglia, in particular, the corpus striatum, or ribbon-like lesions in the cortex. The new variant form of CJD shows distinctive imaging findings, in particular symmetric high signal involving the pulvinar. The remainder of the human forms of prion disease have only limited reports detailing the imaging findings.

REFERENCES:
PURPOSE
Factor analysis is a useful statistical tool for the interpretation of multiple related variables in terms of a smaller number of factors. In this study, factor analysis was applied to proton MR spectroscopy imaging (MRSI) data from a cohort of HIV positive patients and control subjects with the aims of: 1) determining regional metabolism changes induced by HIV infection, 2) comparing to neuropsychologic evaluations, and 3) comparing to clinical and immunologic markers for HIV dementia.

MATERIALS & METHODS
Seventy-four HIV+ (34 with cognitive impairment and 40 without) and 20 seronegative control subjects underwent high-resolution brain 2D MRSI using a 1.5 T MR scanner. N-acetyl aspartate (NAA), choline (Cho) and creatine (Cr) concentrations were estimated in seven brain regions: thalamus, basal ganglia, frontal white matter (WM), centrum semiovale, parietal white matter, frontal gray matter (GM), and parietal gray matter, yielding 21 variables in total. Factor analysis was performed on the 21 variables and generated three main significant factors related to cognitive dysfunction and HIV status. Each subject was assigned a score for each rotated factor based on the loadings of the subject’s original 21 variable levels. ANOVA, two-tailed least squares means (LSM) t-tests and nonparametric Spearman correlation coefficients were performed to identify significant differences between cohorts based on HIV and cognitive status and to determine correlations between the three factors with the viral loads, immunologic markers, or neurocognitive tests.

RESULTS
Examination of the loadings in each factor indicated major contributions of specific metabolites. Thus, one was named a “choline factor” (dependent on WM and deep GM Cho levels), one an “NAA factor”, (frontal and parietal WM, parietal GM), and a “creatine factor” (parietal and frontal WM). Choline factor scores differentiated between HIV- and HIV+ subjects, with higher scores in HIV+ subjects. The choline factor weightings were strongest in WM and deep GM regions. The NAA factor differentiated between subjects with and without cognitive impairment (ANOVA, p=0.02). Specifically, NAA concentrations in WM regions were affected most by cognitive impairment, with lower NAA scores in subjects with cognitive impairment. A factor correlating to creatine levels across the white matter regions also was observed, but was not significantly associated with HIV status or cognitive impairment (p = 0.09). Scores on tests of psychomotor (Rs =0.41, p<0.0005) and executive function (Rs =0.32, p<0.007) correlated with subjects’ NAA factor scores. MCP-1 in the CSF correlated with subjects’ Cr factor scores (Rs =0.45, P = 0.0008), while CD4+ T-cell levels in the plasma correlated best with Cho factor scores (Rs = -0.44, P = 0.0002).

CONCLUSION
These results indicate the importance of early white matter involvement in HAD, and support the model of early glial cell proliferation (Cho and Cr elevations) in HIV infection, and later neuronal dysfunction (NAA decrease) associated with dementia. Choline scores were more elevated in subjects whose health was worse (as indicated by CD4 T cell levels). Through factor analysis of MRSI data, spatially dependent metabolite patterns were revealed that were associated with differences in HIV status, and severity of HIV-associated cognitive impairment.

KEY WORDS: HIV, MRSI, factor analysis

Paper 8 Starting at 10:53 AM, Ending at 11:01 AM
Neuronal Metabolism in HIV+ Subjects Lacking Immune Control Correlates to M-CSF Levels in Cerebrospinal Fluid

Lentz, M. R.1 · Mohamed, M. A.2 · Degaonkar, M.3 · Kim, H.1 · Halpern, E.1 · Sacktor, N.1 · Conant, K.2 · Barker, P. B.3 · Pomper, M. G.1
1Massachusetts General Hospital, Charlestown, MA, 2Johns Hopkins University, Baltimore, MD

PURPOSE
Macrophage colony stimulating factor (M-CSF) is a cytokine responsible for maturation and survival of macrophages and may amplify virus production in HIV infected cells. Both monocytes and M-CSF are believed to have potentially deleterious roles in HIV associated demen-
tia (HAD). The purpose of this study was to explore the relationship between the marker of monocyte/macrophage activity (M-CSF), and neuronal metabolism in HIV+ subjects who lacked immune control.

**Materials & Methods**

Forty-nine HIV+ subjects (24 with HAD, 25 without) underwent MRSI at study entry, and at 3 and 10 months after initiating ART. Multislice, proton 2D-MRSI at long echo time was performed at 1.5T. NAA concentrations were calculated in seven brain regions. Blood and CSF samples were obtained at each time point. Subjects had lack of immune control at baseline (CD4+ T cells50,000 copies/mL). Cerebrospinal fluid samples were obtained to determine levels of M-CSF. ANOVA and nonparametric Spearman correlation were used to determine differences in NAA concentrations between HIV+ subjects with and without HAD and to explore associations between M-CSF and regional NAA levels (N=49). Repeated-measures ANOVA was used to determine changes in NAA levels (N=36) and immunologic markers at 3 and 10 months post ART initiation.

**Results**

Baseline NAA levels were lower in HAD+ subjects (compared to HAD-) in all brain regions, but were only significantly in the centrum semiovale, basal ganglia, parietal gray and white matter. M-CSF levels were negatively correlated to NAA levels in six of the seven brain regions at baseline. The strongest correlations were seen in the thalamus, basal ganglia, and centrum semiovale (p=0.00007, 0.00004, 0.0002 respectively). Upon HRT therapy adherence, the association was found to have dissolved. This occurred slowly at first, with the correlation lasting longest in the deeper gray matter regions, but all correlations were lost at 10 months after new therapy initiation. After therapy initiation, CD4+ T cell levels improved (p<0.002), while M-CSF (p=0.003) and plasma and CSF viral levels of the subject declined (p = 2x10^-8, p=0.0003) indicating the overall health of the subjects’ improved, and consequently neuronal dys-function receded. NAA levels began to recover with therapy, with the significant increases seen in the parietal gray matter, frontal white matter, and parietal white matter (p<0.02, p=0.001, p=0.001, respectively). Student’s LSM t-tests showed significant increases in these areas at the two time-points as compared to initial baseline levels (*: p<0.05; **: p<0.01; ***: p=0.005). Cognitive status did not improve over the 10 months (p=0.50).

**Conclusion**

These results suggest that NAA is capable of recovery before improvements in cognitive function. Both NAA (in some regions) and M-CSF were able to distinguish between HIV+ subjects with and without dementia. The M-CSF cytokine marker was negatively associated with NAA concentrations in almost every region of the brain at baseline. After ART therapy initiation, this association decreased gradually over time.

**Key Words:** HIV, M-CSF, MRSI

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**Paper 9 Starting at 11:01 AM, Ending at 11:09 AM**

**NAA Factor Scores Predict Neuronal Recovery During Antiretroviral Therapy: An MRS Imaging Study**

Lentz, M. R.1 · Mohamed, M. A.2 · Lee, V.1 · Halpern, E.1 · Sacktor, N.2 · Selnes, O.2 · Barker, P. B.2 · Pomper, M. G.2

1Massachusetts General Hospital, Charlestown, MA, 2Johns Hopkins University, Baltimore, MD

**Purpose**

Longitudinal studies are grossly lacking with respect to the effects of antiretroviral therapy (ART) use in chronically HIV-infected patients. The aims of this study were: 1) to determine if MRS imaging (MRSI) metabolites could detect an improvement in brain metabolism after the initiation of a new antiretroviral regimen and 2) to determine the longitudinal effects of antiretroviral regimens on cognition over 10 months of therapy use.

**Materials & Methods**

Fifty-one HIV+ patients underwent MRSI before starting a new antiretroviral regimen change, and underwent repeat imaging 3 and 10 months afterwards. N-acetyl aspartate (NAA), choline and creatine concentrations were calculated in seven brain regions. Factor analysis resulted in the formation of three factors: a “choline factor”, a “creatinine”, and a “NAA factor”. Blood and cerebrospinal fluid (CSF) samples were obtained for viral quantification and analysis for CD4+ T cells. Subjects also underwent neurocognitive testing. Repeated-measures ANOVA and least-mean squares (LSM) Student’s t-tests were performed to identify significant changes across the three time points and isolate changes between groups.

**Results**

Subjects demonstrated signs of a positive response to the HAART regimen over this time period. CD4+ T cell counts were elevated after 3 and 10 months (RM ANOVA, P = 0.0006). In addition, plasma and CSF viral loads were decreased significantly from baseline values (RM ANOVA: P = 3.7x10^-12 and P = 9.7x10^-5, respectively). RM ANOVA revealed that the NAA factor scores rebound significantly 3 months after the initiation of a new therapy regimen and are maintained even after 10 months. Neither the “choline factor” nor the “creatinine” factors of the subjects changed significantly with therapy usage. MSK scores during this time period did not change (P = 0.4). The grooved pegboard nondominant hand task was the only test to exhibit signs of improvement after therapeutic intervention (RM ANOVA, P < 0.05), and did so only after 10 months of therapy (P = 0.03).

**Conclusion**

Within this study, the NAA factor previously found to be predictive of dementia at study entry was found to indicate improvement of NAA scores in the brain after 3 and 10 months of ART indicating a reprieve of neuronal dysfunction (especially in white matter regions) induced by the HIV in the setting of therapy. However, “glial” metabolism represented by increased choline levels measured at baseline was not found to change, implying that the effects induced by low-level viral infection or possibly inflammation/repair mechanisms are on-going in the brain after 10 months of therapy. Interestingly, the lack of MSK improvement rein-
forces the idea that recovery of cognitive function is much slower than that of metabolism perhaps due to the persistent low-level infection/inflammation. Cognitive domains did not improve after 10 months of ART, with the exception of fine-motor function. It is possible that these cognitive domains recover in a specific manner, but over a longer time period than presently studied.

**KEY WORDS:** HIV timecourse, MRSI, NAA factor

**Paper 10 Starting at 11:09 AM, Ending at 11:17 AM**

**MR Imaging Using Ferumoxytol and Gadoteridol in Patients with Central Nervous System Inflammatory Diseases: Preliminary Results**

Dosa, E. · Gahramanov, S. · Muldoon, L. · Varallyay, C. · Njus, J. · Rooney, W. · Haluska, M. · Hamilton, B. · Nesbit, G. · Neuwelt, E. A.

Oregon Health & Science University
Portland, OR

**PURPOSE**
The primary objective of this study is to compare anatomical MR imaging, dynamic susceptibility contrast (DSC) MR imaging and time of flight (TOF) MR angiography (MRA) using ultrasmall superparamagnetic iron oxide contrast agent ferumoxytol and the "gold standard" gadolinium-based contrast agent (GBCA) in patients with inflammatory diseases or ischemic stroke on a 3T MR imaging instrument.

**MATERIALS & METHODS**
Twenty-five patients were involved in an IRB-approved imaging study of CNS inflammation. All participants had anatomical and (DSC) MR imaging with GBCA on the first day and the same MR exam on the second day with ferumoxytol. Twenty-four hours after ferumoxytol injection anatomical imaging was acquired followed by an additional Gd-enhanced MR image.

**RESULTS**
Gadolinium-based contrast agent enhancement differed from ferumoxytol-enhancement in time and distribution. Early enhancement is seen essentially immediately after GBCA injection. By contrast ferumoxytol enhancement was seen 24 hours after administration, and not at early times, suggesting that ferumoxytol is a blood pool agent at early time points. As a result, relative cerebral blood volume (rCBV) measurements may be simpler to perform with ferumoxytol due to no need for leakiness correction as after GBCA. Better vessel visualization was observed with ferumoxytol than GBCA on TOF MRA.

**CONCLUSION**
Ferumoxytol is a better blood pool agent than GBCA as it does not cross the blood brain barrier immediately following injection, and thus provides superior quality TOF MRA and simplifies rCBV measurement than studies based on GBCA. Assessment of inflammatory disease and stroke, however, requires a 24-hour delay or longer for optimal detection compared to GBCA MR imaging.

**KEY WORDS:** MR imaging, ferumoxytol, central nervous system inflammatory diseases

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

**Clinical Outcomes in Three Patients with Pyogenic Ventriculitis: The Importance of Early MR Imaging Diagnosis**

Boyd, J. E. · Jacobson, J. P.

Loma Linda University School of Medicine
Loma Linda, CA

**PURPOSE**
To review the clinical course of pyogenic ventriculitis (PV) in two cases of delayed MR imaging diagnosis and one case of early MR imaging diagnosis.

**MATERIALS & METHODS**
Three cases of PV were reviewed retrospectively by examining medical record. The MR images and reports were reviewed to determine visibility of PV findings and presence or absence of PV diagnosis in the MR imaging report. The patients’ medical records were reviewed to determine the following outcomes: time to resolution of infection, number of admissions for infection, and number of courses of IV antibiotics.

**RESULTS**
Case 1. A 75-year-old male presented with fever, altered level of consciousness, and rhinorrhea 5 days after transphenoidal resection of a parasellar mass. On admission, he was not diagnosed with PV on two MR images despite clearly visible findings retrospectively (Figure: enhancing, diffusion-restricted sediment in occipital horns on axial: a) postcontrast T1-weighted imaging; b) FLAIR; c) diffusion-weighted imaging; and d) ADC). His infection resolved during his first admission over a period of 5 months during which he was treated with at least five courses of IV antibiotics. Case 2. A 54-year-old male presented with fever and headache 1 day after suboccipital craniotomy and fenestration of an arachnoid cyst. He was not diagnosed with PV on four MR imagings despite clearly visible findings retrospectively. His infection resolved after three admissions and three courses of IV antibiotics over a period of 6 months. Case 3. A 46-year-old male developed fever 3 days after partial left temporal lobectomy for seizures. He was diagnosed with PV on the first MR imaging, 8 days after onset of fever, leading to immediate operative ventricular lavage. His infection resolved over 1 month during his initial admission during which he received two courses of IV antibiotics.

**KEY WORDS:** MR imaging, ferumoxytol, central nervous system inflammatory diseases

![Image](a.png)
Pyogenic Ventriculitis: Clinical Endpoints versus MRI diagnosis status

<table>
<thead>
<tr>
<th></th>
<th>Early MRI diagnosis</th>
<th>Delayed MRI diagnosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Months to fever resolution</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Number of admissions</td>
<td>1</td>
<td>1-3</td>
</tr>
<tr>
<td>Courses of IV antibiotics</td>
<td>2</td>
<td>3-5</td>
</tr>
</tbody>
</table>

### RESULTS

Diffusion-weighted imaging was the most sensitive sequence, with 100% of cases having either Cx or DGN involvement. Regionally, DWI showed 39.3% of regions positive, compared to ADC (21.9%), or FLAIR (23.7%). Cortical involvement was more frequent than DGN. Cortical involvement was detected on DWI in 13/14 (93%) patients (9 frontal, 5 temporal, 12 parietal, and 9 occipital). Deep gray nuclei involvement was observed in 8/14 (57%) cases (8 caudate, 4 putamen, 2 globus pallidus, and 3 thalamus). Seven cases (50%) demonstrated both Cx and DGN, 6 (43%) Cx only, 1 (7%) DGN only. Anatomical involvement of both sides was common, but a degree of asymmetry was often seen. Pathologic involvement in all cases was much more widespread than MR findings. Each case generally displayed at least some spongiform change in all assessed Cx and DGN regions. There was no evident relationship between qualitative amount of spongiform change and MRI regional signal changes. The only significant correlation of MR signal and clinical variables, was an association (p = 0.02) of duration of disease and presence of cortical FLAIR, but not DWI findings.

### CONCLUSION

Pyogenic ventriculitis is not rare and is simple to diagnose on MR imaging but awareness is low. Less than 10 papers describe the MR findings in the literature. Early recognition on MR imaging allows targeted treatment (ventricular lavage) that appears to reduce an otherwise prolonged and recurrent clinical course of fever work ups and intensive broad-spectrum antibiotic therapy.

### KEY WORDS:

Pyogenic ventriculitis, intraventricular abscess, diffusion-weighted imaging

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**Paper 12 Starting at 11:25 AM, Ending at 11:33 AM**

**MR Imaging of Creutzfeldt-Jakob Disease in Autopsied Cases**

Lignelli, A. · Cavanagh, L. · Kaplan, I. · Khandji, A. G. · Vonsattel, J. · Honig, L. S.

Columbia University
New York, NY

**PURPOSE**

Creutzfeldt-Jakob Disease (CJD) originally was thought to have no neuroimaging correlate but now is recognized to frequently show MRI abnormalities, with hyperintense DWI, and sometimes T2 FLAIR signal in the cortical ribbon (Cx) and in deep gray nuclei (DGN). However, ascertainment of CJD-specific signal abnormalities is still challenging. Here we describe MRI findings in a series of autopsy-proved CJD, and compare MRI and pathologic findings.

**MATERIALS & METHODS**

Consecutive cases from 6 years of autopsy-proved CJD with available MRI included 10 males (71%), 4 females; 71% white, 14% black, and 14% Hispanic. Ages at onset and death were 63.2±9.0SD (range 51-79) and 64.1±8.9(52-80) years respectively, with average duration 8.1±6.2 (1-18) months from first symptoms to death. Images from DWI and FLAIR sequences as well as ADC maps were evaluated retrospectively by three neuroradiologists, with rating of abnormal signal in frontal, temporal, parietal, and occipital cortices, and deep nuclei including caudate, putamen, globus pallidus, and thalamus as positive (abnormal), negative (normal), or equivocal. Overall inter-rater reliability was excellent, with for example, 96% complete concordance for caudate DWI signal between raters, and 82% complete concordance for occipital cortex DWI signal (with the 18% non-concordance having 2/3 raters identical). Eight regions were assessed, left and right, for each case, on the three sequences, for a total of 48 assessments (8x2x3) per case. Neuropathologic spongiform change was tabulated using independent regional ratings by the neuropathologist from hematoxylin and eosin-stained paraffin sections: spongiform change was rated as none-minimal, mild-moderate, or severe.

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**RESULTS**

Diffusion-weighted imaging was the most sensitive sequence, with 100% of cases having either Cx or DGN involvement. Regionally, DWI showed 39.3% of regions positive, compared to ADC (21.9%), or FLAIR (23.7%). Cortical involvement was more frequent than DGN. Cortical involvement was detected on DWI in 13/14 (93%) patients (9 frontal, 5 temporal, 12 parietal, and 9 occipital). Deep gray nuclei involvement was observed in 8/14 (57%) cases (8 caudate, 4 putamen, 2 globus pallidus, and 3 thalamus). Seven cases (50%) demonstrated both Cx and DGN, 6 (43%) Cx only, 1 (7%) DGN only. Anatomical involvement of both sides was common, but a degree of asymmetry was often seen. Pathologic involvement in all cases was much more widespread than MR findings. Each case generally displayed at least some spongiform change in all assessed Cx and DGN regions. There was no evident relationship between qualitative amount of spongiform change and MRI regional signal changes. The only significant correlation of MR signal and clinical variables, was an association (p = 0.02) of duration of disease and presence of cortical FLAIR, but not DWI findings.

**CONCLUSION**

MR imaging findings in CJD may involve Cx or DGN. Cortical DWI involvement was the most frequent finding in patients with CJD. No direct correlation was found between the pathologic spongiform change and MRI regional signal abnormalities. Possible explanation may be the rapid progression of CJD, with severe diffuse brain involvement at death. Diffusion-weighted imaging signal was overall most sensitive, but cortical FLAIR signal appears to relate to duration of disease.

**KEY WORDS:** CJD, MRI, DWI

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**Paper 13 Starting at 11:33 AM, Ending at 11:41 AM**

**MR Imaging of Central Nervous System Whipple’s Disease: A 15-Year-Review**

Black, D. F. · Morris, J. · Aksamit, A. J.

Mayo Clinic
Rochester, MN

**PURPOSE**

Whipple’s disease is a rare bacterial infectious illness that is fatal if untreated. Limited knowledge exists regarding the variable MRI appearance of central nervous system (CNS) involvement. Our purpose is to review the neuroradiographic appearance of primary and secondary CNS Whipple’s disease seen over a 15-year period at our institution.

**MATERIALS & METHODS**

With institutional review board approval we searched our institutions medical record database for terms including Whipple’s disease and encephalopathy over a 15-year period. This resulted in 140 initial records. After review this was reduced to 20 patients with CNS Whipple’s, presumed CNS Whipple’s, or Whipple’s disease with possibly unrelated CNS symptoms. Eight patients had undergone some form of neuroimaging (CT, MRI, MRA, and cerebral angiogram). One staff neuroradiologist and one radiology resident who is also a board certified neurologist reviewed the findings.
RESULTS
Of those with definite CNS Whipple’s, eight had MR images and four had MRI findings thought to be directly due to Whipple’s disease. Diagnostic laboratory data and small bowel biopsy results for the four patients are listed in Table 1. MR Imaging results were as follows. Patient 1: Infiltrative enhancing T2 hyperintensity and mild mass effect involving the medial thalamus, hypothalamus, mammillary bodies, periaqueductal gray matter and 3rd cranial nerve nuclei region. No restricted diffusion. Patient 2: Bilateral 9 mm foci of enhancing T2 hyperintensity within the inferomedial aspect of the hypothalamus with extension into the left cerebral peduncle. 3 mm ovoid focus of nonenhancing T2 hyperintensity within the subcortical white matter of the right frontal lobe. No restricted diffusion. Patient 3: Bilaterally symmetric T2 hyperintensity without mass effect or restricted diffusion involving the cortical spinal tracts, brain stem, and brachium pontis with faint enhancement along the ventral aspect of the cerebral peduncles. Patient 4: Enhancing T2 hyperintensity in the hypothalamus and anteromedial aspect of the right temporal lobe, including the hippocampal head with mild mass effect.

Table 1: Diagnostic Evaluation Summary

<table>
<thead>
<tr>
<th>Patient</th>
<th>Gender</th>
<th>Age</th>
<th>Primary Diagnosis</th>
<th>PCR</th>
<th>PCR Small Bowel</th>
<th>PCR Serum</th>
<th>Small Bowel Biopsy</th>
<th>Histology (PAS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>M</td>
<td>68</td>
<td>Isolated CNS</td>
<td>Negative</td>
<td>Negative</td>
<td>Positive</td>
<td>Not Performed</td>
<td>Negative</td>
</tr>
<tr>
<td>2</td>
<td>M</td>
<td>54</td>
<td>Isolated CNS</td>
<td>Negative</td>
<td>Negative</td>
<td>Positive</td>
<td>Positive</td>
<td>Negative</td>
</tr>
<tr>
<td>3</td>
<td>M</td>
<td>59</td>
<td>CNS presentation</td>
<td>Positive</td>
<td>Positive</td>
<td>Negative</td>
<td>Negative</td>
<td>Negative</td>
</tr>
<tr>
<td>4</td>
<td>M</td>
<td>38</td>
<td>CNS relapse</td>
<td>Positive</td>
<td>Not Performed</td>
<td>Negative</td>
<td>Negative</td>
<td>Negative</td>
</tr>
</tbody>
</table>

CONCLUSION
There is no pathognomonic pattern of radiologic involvement for Whipple’s disease though most imaging findings, including our current study, correlate with pathologic studies showing predominate involvement of the basilar telencephalon, thalamus, hypothalamus, quadrigeminal plate, periaqueductal gray and basal ganglia. To our knowledge the cortical spinal tract involvement in patient 3 is a new and unpublished appearance. Because CNS Whipple’s is both fatal if untreated and a diagnostic challenge the neuroradiologist should be familiar with the varied MRI findings. Given that more invasive diagnostic tests for Whipple’s disease may be falsely negative, as in patient 1, the MRI may be essential to alerting the clinician that Whipple’s disease is a diagnostic possibility and empiric antibiotics may be started.

KEY WORDS: Whipple’s encephalitis, MRI, tropheryma whipplei

MATERIALS & METHODS
MR examinations, clinical and histopathologic data of six patients with proved idiopathic inflammatory demyelinating diseases (IIDLD) were collected from three institutions. Two patients had biopsy proved Balo-type lesions (Balo concentric sclerosis-BCS), two patients were diagnosed as infiltrative type of MS, and two patients had megacistic-like lesions. T2-weighted imaging, pre and postcontrast T1-weighted imaging, DWI, FLAIR, and SWI and were performed either on 1.5 or 3.0 T units in all patients. Chemical shift imaging (CSI) was acquired in two patients. Lesion size, signal intensities, margins, enhancement pattern, and mass effect were evaluated on conventional MR sequences. Apparent diffusion coefficient (ADC) measurements were obtained with region-of-interest (ROIs) placed in the lesion center, in multiple inner and outer layers, in the surrounding edema and in the normal appearing white matter (NAWM). The presence or absence of dilated venous structures was evaluated on the SW images. Choline/creatinine, and choline/NAA ratios, and the presence of lactate peak were evaluated with MR spectroscopy.

RESULTS
Apparent diffusion coefficient values of the enhancing outer layers of the lesions in Balo-type lesions ranged between 0.57 and 0.98 x10^-3 mm²/s. Disappearance of enhancement under therapy was followed by an ADC raise to values between 1.08 and 1.26 x10^-3 mm²/s. The central parts of the BCS lesions showed elevated diffusivity (between 0.97 and 2.36 x10^-3 mm²/s). Cho/Cr disproportion, reduced NAA levels and lactate peaks were visible in all BCS lesions. Patients with infiltrative type of MS showed slightly elevated diffusivity in the larger nonenhancing plaques, with Cho/Cr and Cho/NAA disproportion on CSI. Susceptibility-weighted imaging did not show dilated perilesional veins or other abnormalities.

Correlation of Histopathologic and Imaging Findings Using Advanced MR Imaging Techniques in Atypical Idiopathic Inflammatory Demyelinating Diseases of the Brain

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1Medical University of Vienna, Vienna, AUSTRIA, 2Medical University of Graz, Graz, AUSTRIA, 3University of Antwerp, Antwerp, BELGIUM

PURPOSE
To evaluate imaging characteristics on diffusion-weighted-
**CONCLUSION**

Restricted diffusion observed in outer, enhancing layers of BCS lesions probably corresponds to the areas of increased inflammatory and demyelinating activity. Elevated diffusivity in MS lesions of the Marburg variant could represent a destructive nature of the disease.

**KEY WORDS:** MS, IIDL

**Paper 15 Starting at 11:49 AM, Ending at 11:57 AM**

Seizure-Induced Reversible or Partially Reversible Brain MR Imaging Signal Abnormalities: Multicentric Experience on 19 Consecutive Patients

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**PURPOSE**

To show the wide range of possible appearance of seizure-induced brain MR abnormalities. To raise the awareness of seizure-induced brain changes, in order to avoid false diagnosis of lesional epilepsy.

**MATERIALS & METHODS**

Retrospective review of MR imaging and clinical charts of 19 consecutive patients, 8 males, 11 females, age range 5 months to 78 years old, average 58 years old, studied in three academic institutions, during 5 years, without clinical and laboratory evidence of encephalitis, showing transient or at least partially resolving brain MR imaging signal abnormalities following seizures. MR imaging was performed with 1.5 T magnets, including FSE T1-, T2-weighted, FLAIR and contrast-enhanced images; in nine cases diffusion-weighted imaging was performed. All patients underwent serial MR imaging, with imaging follow-up duration between 3 and 72 months.

**RESULTS**

In our series we observed single and multiple, unilateral and bilateral, reversible and partially reversible, focal signal abnormalities, in the following locations: hippocampus/mesial temporal lobe (11), nonhippocampal cortex (6), deep gray nuclei (3), corpus callosum (1), cerebellum (1). The lesions were better visible on FSE and FLAIR T2-weighted images, and none showed contrast enhancement; among nine patients imaged with diffusion-weighted imaging, three showed restricted diffusion at presentation. All of the abnormalities had some degree of swelling and mass effect in the acute phase. The resolution, at least partially, of the focal signal changes was observed at follow-up imaging obtained between 25 and 60 days. The abnormality resolution was complete in 14/19 cases, and partial with residual gliosis or encephalomalacia in 5/19.

**CONCLUSION**

Transient neuroimaging abnormalities after seizure, of unknown pathophysiology, have been reported, especially in the hippocampus. We report a series of patients with a wide range of possible appearance of seizure-induced MR imaging signal changes of the brain. These changes have variable and nonspecific features, and can simulate a variety of diseases; comparison, when available, with baseline studies, and imaging follow up are strongly recommended for a correct differential diagnosis, and to avoid false diagnosis of lesional epilepsy.

**KEY WORDS:** Epilepsy, MRI, seizure-induced

**Paper 16 Starting at 11:57 AM, Ending at 12:05 PM**

Ipsilateral Temporal Pole Abnormality in the Patients with Hippocampal Sclerosis: Comparison MR Imaging, FDG-PET and Pathology

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Los Angeles, CA

**PURPOSE**

Ipsilateral temporal pole (TP) MR imaging abnormality can be observed in more than 50% of hippocampal sclerosis (HS) patients (1), as high T2 and FLAIR signal in the white matter with gray-white matter blurring. The aim of our study was to investigate the pathology of TP abnormality in the adult patients with HS and retrospectively correlate between preoperative findings of MR imaging and fluoro-deoxyglucose positron emission tomography (FDG-PET) metabolism.

**MATERIALS & METHODS**

Fifty-two patients (29 males and 23 females; mean age, 32.1 years) in the UCLA Epilepsy program with temporal lobe epilepsy underwent anterior temporal lobectomy with the clinical and imaging diagnosis consistent with hippocampal sclerosis between 2004 and 2007. In each patient, the TP MR imaging findings were categorized as either present or absent. Hypometabolism on FDG-PET was categorized as either normal or abnormal. MR imaging and FDG-PET fusion also was analyzed to evaluate TP hypometabolism. The length of time between the onset of seizures and surgery was noted for all patients. The histological assessment of temporal lobe specimens outside the hippocampus was compared to the preoperative imaging. The pathology evaluation includes hematoxylin & eosin staining, glial fibrillary acidic protein staining.

**RESULTS**

Temporal pole MR signal abnormality was noted in 27 cases (51%). Positron emission tomography was read as abnormal in 45 cases (86%). Positron emission tomography MR imaging fusion showed 90% hypometabolism in the temporal pole. Eighteen patients (34%) had cortical dysplasia (CD) in the TP (1 severe CD, 17 subtle CD). Twenty-eight patients had gliosis and six patients had normal TP histopathology. In 25 patients with normal TP MRI findings, five cases had CD, when the MR imaging was abnormal in TP, CD was found in 44%. In seven patients with normal PET, three cases had CD. There was no correlation between the length of time from onset of seizure to surgery and CD in the TP.

**CONCLUSION**

Temporal pole abnormality was found in both MR imaging and PET in this preoperative study. Positron emission tomography-MR fusion is more sensitive for identifying TP findings; however, it does predict the presence of CD. When abnormalities are seen in the ipsilateral TP on MR imaging
or PET, in MTS, anterior temporal lobectomy is necessary to confirm the presence of CD.

REFERENCES


KEY WORDS: Temporal pole, hippocampal sclerosis, FDG PET

Paper 17 Starting at 12:05 PM, Ending at 12:13 PM
Side Matters: Diffusion Tensor Imaging Tractography in Left and Right Temporal Lobe Epilepsy

Ahmadi, M. E. · Hagler, D. J. · McDonald, C. R. · Tecoma, E. · Iragui, V. · Dale, A. M. · Halgren, E.
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PURPOSE
Diffusion tensor imaging tractography was used to quantify the extent of white matter pathology in right and temporal lobe epilepsy (TLE) patients and to determine if the information could assist in lateralization of the seizure focus.

MATERIALS & METHODS
Twenty-one TLE patients (11 right TLE, 10 left TLE), and 21 controls were enrolled. In all 21 patients, the diagnosis of left versus right TLE was based on the presence of ictal and interictal temporal-lobe epileptiform activity by video-EEG telemetry using scalp and foramen ovale electrodes as well as magnetoencephalogram. In 16 of the patients, seizure lateralization was supported by the presence of unilateral mesial temporal sclerosis (MTS). A 1.5 T MR scanner was used to obtain 51 diffusion gradient direction images per subject. Eight pairs of white matter fiber tracts were traced and fiber fractional anisotropy (FA) was calculated and compared to controls. The following fibers were traced; cingulum fibers within cingulate gyrus (CG), parahippocampal fibers within parahippocampal gyrus (PH), superior longitudinal fasciculus (SLF), inferior longitudinal fasciculus (ILF), uncinate fasciculus (UF), fornix (FORX), anterior thalamic radiations (ATR), and inferior fronto-occipital fasciculus (IFOF). Within subject fiber FA asymmetry was evaluated in right and left TLE patients. Discriminant function analysis (DFA) with a “leave one out” function was performed.

RESULTS
In right TLE patients, six out of eight fiber tracts ipsilateral to the seizure focus had significant drop in fiber FA compared to controls with none of contralateral fibers being affected. In left TLE patients however, not only all of the ipsilateral fibers had decreased FA, but six out of eight contralateral fibers also demonstrated a reduction. Right-sided fiber FA asymmetry was demonstrated in the right TLEs for five fiber tracts and left fiber asymmetry in the left TLE for only one fiber tract (p-values provided in table). Discriminant function analysis demonstrated correct categorization of patients to left or right TLE in 90% of cases, with correct lateralization in all patients without hippocampal sclerosis ($\chi^2 = 18.2, p < .003$).

CONCLUSION
Patients with right TLE showed changes that were primarily ipsilateral to the side of the seizure focus and consequently demonstrated a primarily asymmetric pattern of fiber damage that was lateralizing. Left TLE patients had greater, more diffuse changes and hence demonstrated little fiber asymmetry due to bilateral damage. Disease was lateralized to a high degree independent of identifiable hippocampal pathology as noted on conventional MR imaging.

KEY WORDS: Diffusion, epilepsy, tractography

Paper 18 Starting at 12:13 PM, Ending at 12:21 PM
Prediction of Visual Field Deficits by Diffusion Tensor Imaging in Temporal Lobe Epilepsy Surgery

Chen, X.1,2 · Weigel, D.2 · Ganslandt, O.2 · Buchfelder, M.3 · Nimsy, C.2
1First Affiliated Hospital, Sun Yat-sen University, Guangzhou, CHINA, 2University Erlangen-Nuernberg, Erlangen, GERMANY

PURPOSE
Visual field deficit (VFD) due to optic radiation injury is a common complication of temporal lobectomy in epilepsy surgery. It offers us an ideal model to evaluate the validity of depicting the optic radiation with diffusion tensor imaging (DTI)-based fiber tracking. If the postoperative visual field deficits can be precisely predicted by comparing the pre- and post-operative fiber tracking results, the accuracy and validity of depicting optic radiation with fiber tracking can be proved.

MATERIALS & METHODS
In this prospective study, DTI-based fiber tracking was performed on 48 patients who had total temporal lobectomy for pharmacos-resistant epilepsy. Pre and intraoperative DTI-based fiber tracking was used to visualize the optic radiation. Prediction of postoperative VFD based on the fiber tracking results was compared with the clinical outcome of visual field examination.

RESULTS
In all the cases, the full courses of the optic radiation could be reconstructed successfully by DTI-based fiber tracking. There was significant correlation between the fiber tracking estimation and the clinical outcome of VFDs after surgery. The receiver operating characteristic curve analysis confirmed the accuracy and validity of prediction of the postoperative VFDs with fiber tracking results.

CONCLUSION
Diffusion tensor imaging-based fiber tracking can precisely and reliably depict the optic radiation. It also can accurately predict the VFD caused by anterior temporal lobectomy. We
anticipate that intraoperative visualization of the optic radiation by fiber tracking navigation in the surgical field may reduce postoperative VFD.

**KEY WORDS:** Diffusion tensor imaging, optic radiation, epilepsy surgery

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

**Temporal Anteroinferior Encephalocele: An Unrecognized Causative Mechanism for Temporal Lobe Epilepsy?**

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**PURPOSE**
Congenital encephaloceles are brain parenchymal herniations through dura mater and bone defects. Encephalocele-related seizures have been reported mainly with anterior fossa or occipital locations. Literature regarding temporal encephaloceles is scant. The following anatomical classification has been proposed: lateral; anterior; anteromedial; posteroinferior; and anteroinferior. The anteroinferior type projects into infratemporal region, and may be associated with complex or simple partial seizures. The previously reported temporal anteroinferior encephaloceles are mainly case reports, largest material constituting three patients (Leblanc 1991). Previously, encephaloceles have been diagnosed mainly by conventional computed tomography (CT) or only intraoperatively while preoperative imaging studies have been interpreted as normal. There are no previous reports concentrating on imaging characteristics of these lesions. Indeed, it is probable that this condition may remain unrecognized by radiologists interpreting imaging studies of patients with epilepsy. Our aim was to evaluate and illustrate imaging characteristics of temporal anteroinferior encephaloceles by modern MR imaging units and multidetector CT in patients with epilepsy.

**MATERIALS & METHODS**
During 2007-2008, altogether five patients were diagnosed with temporal anteroinferior encephalocele in our tertiary care epilepsy center. All diagnoses were made initially in MR imaging (three 1.5T, two 3T); three patients also underwent multidetector CT, one interictal SPET and one interictal PET. An experienced neuroradiologist assessed imaging characteristics in all modalities.

**RESULTS**
Temporal encephaloceles (two left-sided, three right-sided, maximal diameter 13mm, range 11-14mm, bony defect orifice 8mm, range 3-9mm) were located inside the anteroinferior sphenoid wing, projecting antero-inferio-medially to pterygomaxillary fossa. All showed minor cystic portions. Brain parenchyma inside dura did not show evidence of signal pathology indicative of gliosis, nor were there signs of hippocampal sclerosis. Thin slice thickness (1-2mm) proved to be important for lesion recognition. Two lesions were missed in initial 1.5T MR imaging with 4-5mm thick slices. Three-dimensional T1-weighted and FLAIR sequences with small isotropic voxel size enabled postprocessing the data in oblique directions to visualize thin abnormal tip of the gyrus stretching into bony defect. Thin T2-weighted slices (especially CISS- or IR-sequences) tilted along the long axis of temporal lobe enabled superior detection of CSF and cystic components inside lesions. Thin-slice multidetector CT-examination (3 patients) documented the bony defect in more detail than MR imaging. Two patients were male, three female, mean age was 37 years (range 17-63 years). Three patients had drug-resistant epilepsy and two were newly diagnosed, mean age at onset of epilepsy was 32 years (range 17-62 years). Two patients showed bitemporal, one rightsided, one left-sided interictal epileptiform activity, one patient had normal interictal EEG. Thus far, two of the patients have been operated on (standard Spencer-type anterior temporal lobe resection including amygdalohippocampectomy) and are seizure-free since the operation.

**CONCLUSION**
Congenital temporal anteroinferior encephaloceles constitute a rare entity in patients with simple or complex partial seizures. No systematic evaluation of the frequency of this condition or the imaging characteristics have been published. A high index of suspicion and high-quality, thin-slice (1-2mm), preferably 3D MR and CT studies facilitate correct detection. Thorough preoperative planning and meticulous surgical treatment can ensure good functional outcome.

**KEY WORDS:** Epilepsy, encephalocele, temporal

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**Monday Morning**

**10:45 AM – 12:30 PM**

**Ballroom B**

**(4b) Interventional: Aneurysms I**
(Scientific Papers 20 – 32)

See also Parallel Sessions

(4a) Adult Brain: Inflammatory/Infectious Diseases and Epilepsy

(4c) Adult Brain: New Techniques/Post Processing

(4d) Spine: Neoplasia, Trauma & Functional Imaging

(4e) Excerpta Extraordinaire: Adult Brain

Moderators: Colin P. Derdeyn, MD
Gary M. Nesbit, MD
Remodeling Technique for Endovascular Treatment of Unruptured Intracranial Aneurysms Is as Safe as the Standard Coiling Technique: Analysis in the ATENA Series

Pierot, L.1 · Spelle, L.2 · Cognard, C.3 · Leclerc, X.4 · Moret, J.2 · and ATENA investigators
1Hopital Maison-Blanche, Reims, FRANCE, 2Fondation Rothschild, Paris, FRANCE, 3Centre Hospitalier Universitaire de Toulouse, Toulouse, FRANCE, 4Centre Hospitalier Universitaire de Lille, Lille, FRANCE

PURPOSE
To analyze the safety of the remodeling technique compared to the standard coiling technique in a large multicenter series concerning the endovascular treatment of unruptured intracranial aneurysms (ATENA).

MATERIALS & METHODS
In the ATENA series, performed in 27 institutions, 547 patients (383 females and 164 males; age: 22-83 years, mean: 51.0±11.1 years) having a total of 572 aneurysms were treated by coiling alone in 325 patients, and by the remodeling technique in 222 patients. For each patient group, we recorded aneurysms characteristics, rate of adverse events related to the treatment, and patient outcome.

RESULTS
The overall rate of adverse events related to the treatment (regardless of whether they lead to clinical consequences or not) was 10.8% (35/325) for coiling, and 11.7% (26/222) for remodeling. Thromboembolic events, intraoperative rupture, and device-related problems were encountered in 6.2% (20/325), 2.2% (7/325), and 2.5% (8/325) in the coiling group, and 5.4% (12/222), 3.2% (7/222), and 3.2% (7/222) in the remodeling group, respectively. The morbidity and mortality rates did not differ significantly between groups: 2.2% (7/325) and 0.9% (3/325) in the coiling group and 2.3% (5/222) and 1.4% (3/222) in the remodeling group, respectively.

CONCLUSION
In this large prospective, multicenter study, the remodelling technique was associated with a similar rate of adverse events and morbimortality compared to the standard coiling technique.

KEY WORDS: Aneurysms, endovascular treatment, remodeling technique

Midterm Angiographic Follow Up from an Initial Series of 200 Consecutive Cerebral Aneurysms Treated with Hydrogel Coated Aneurysm Coils

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1Emory University School of Medicine, Atlanta, GA, 2McMaster University Hospital, Hamilton, ON, CANADA

PURPOSE
Higher volume coil packing in intracranial aneurysms is believed to result in lower recanalization rates. Hydrogel coated expandable coils (Hydrocoil, MicroVention, Aliso Viejo, CA) improve volumetric packing of aneurysms in animal models and clinical studies but data from large clinical series are limited. The objective of this retrospective analysis was to analyze immediate and follow-up angiographic results as well as complications in a large consecutive series of patients treated with Hydrocoil at a single institution.

MATERIALS & METHODS
Retrospective analysis of the first 200 consecutive intracranial aneurysms treated at Emory University Hospital. Periprocedural complications, immediate and follow-up angiograms were analyzed.

RESULTS
One hundred eighty-seven patients with 200 intracranial aneurysms were treated with Hydrocoils over a 3-year period. Immediate angiograms showed complete aneurysmal obliteration in 58.4% of small aneurysms and 42.7% of large aneurysms. Periprocedural complications included early rebleeding and thromboembolic events resulting in permanent neurologic morbidity and mortality occurred in 6% of cases. Follow-up angiography of more than 5-months duration was available for 121 aneurysms (60.5%). The average follow-up period for these aneurysms was 16.3 months demonstrating recanalization in 15.2% of small aneurysms and 28.6% of large aneurysms, requiring retreatment in 6.3% and 19.0% of cases respectively. Over the same time period there was angiographic improvement in aneurysm obliteration in 39.2% of small aneurysms and 26.2% of large aneurysms.

CONCLUSION
Hydrocoil treatment of intracranial aneurysms has similar rates of recanalization and complication compared to most large series of pure platinum coils. Progressive angiographic improvement can be seen in the posttreatment period.

KEY WORDS: Aneurysm, coil, hydrocoil
Predictors of Clinical Outcome after Aneurysmal Subarachnoid Hemorrhage: A Multivariate Analysis. One-Year follow-up Study

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PURPOSE
In the present arena of treatment after aneurysmal subarachnoid hemorrhage, meta-analyses evidenced that, if an aneurysm is suitable for both neurosurgical clipping and endovascular coiling, the latter as well as some therapies against secondary ischemia are associated with better results. To elucidate the effects of early coiling followed by nimodipine administration and cautious circulatory volume expansion, retrospective statistical analysis was performed on a subgroup of patients extracted from our database encompassing 297 coiled intracranial aneurysms. Sampling was aimed to minimize the role of confounding variables and performed in accordance with the following criteria: series of consecutive patients; treatment performed employing the same materials and by experienced interventionalists; real life clinical setting. One-year follow-up data are reported here.

MATERIALS & METHODS
From May 2006 to June 2007, 26 consecutive patients (M: 15, F: 11; age: 26-79 years) had a ruptured intracranial aneurysm secured with detachable coils. Medical therapy against secondary ischemia followed immediately thereafter. Sixteen patients (M: 9, F: 7; age: 26-79 years) were treated within 72 hours and 10 (M: 6, F: 4; age: 27-79 years) from 4 to 30 days after subarachnoid hemorrhage. Delayed treatment was never due to clinical decision but to logistic factors. Upon admission and discharge, clinical data were supplemented by the modified Rankin disability scale score (mRS; 0 = no symptoms, 6 = dead), as it has become the most commonly used endpoint for clinical trials involving stroke. Admission Hunt and Hess stroke scale grade (HH) was used to evaluate clinical condition. Outcomes were assessed comparing scores upon admission and discharge. Follow-up clinical visits were scheduled every 6 months. Multivariate analysis of variance (MANOVA) was employed as a statistical method. It was carried out in both parametric and nonparametric ways; the latter based on rankings. Thereafter, factor and binary logistic regression analyses followed for variables identified as predictive on MANOVA.

RESULTS
Interval to treatment, admission HH grade and initial mRS score were identified as predictors of clinical outcome by MANOVA performed in parametric (p < 0.01) and nonparametric (p < 0.05) ways. Subsequent analyses pinpointed two latent variables. The first one was composed of mRS score and HH grade. It could be regarded as a patient’s clinical condition after aneurysmal subarachnoid hemorrhage. The other latent variable was the timing of treatment. One drop out subject was lost to follow-up survey.

CONCLUSION
Clinical outcome obviously is influenced by a patient’s initial condition, which is beyond the reach of therapeutic interventions. On the other hand, interval to treatment is a modifiable factor. Our data identify early endovascular securing of ruptured intracranial aneurysm as a predictor of better clinical outcome.

REFERENCES

KEY WORDS: Aneurysmal subarachnoid hemorrhage, endovascular coiling, clinical outcome of ruptured intracranial aneurysm
Yearly digital subtraction angiography and midpoint MR angiography also were performed. As ordinal measurements are to be analyzed by nonparametric statistical methods, the Mann-Whitney U test was employed to evaluate data.

RESULTS
Upon admission, the two interval-to-treatment groups did not differ in mRS score (early coiling group: 2.3 95% CI 1.7-2.9; late coiling group: 1.6 95% CI 0.3-2.9; p = 0.09). There were no deaths or procedure-related complications. On average, endovascular coiling followed by proactive medical therapy elicited an improvement of disability (mRS score: from 2.0 95% CI 1.4-2.6 to 0.5 95% CI 0.1-0.9; p < 0.001). Such an improvement was greater when endovascular coiling was performed within 72 hours after subarachnoid hemorrhage (early coiling group: -2.0 95% CI from -1.6 to -2.4; late coiling group: -0.8 95% CI from -0.3 to -1.3; p < 0.01). Follow-up survey confirmed such findings with the exception of one drop out subject.

CONCLUSION
In 2002, van Loon and coworkers reported favorable outcomes in more than half of the patients who underwent early endovascular treatment after subarachnoid hemorrhage. But, they considered only cases in very poor neurologic conditions (World Federation of Neurosurgical Societies Grade V). Our data corroborate and broaden such a demonstration and support a policy of early endovascular coiling in all patients.

REFERENCES

KEY WORDS: Aneurysmal subarachnoid hemorrhage, endovascular coiling, treatment timing

Paper 25 Starting at 11:25 AM, Ending at 11:33 AM
Clinical Outcomes in More than 470 Patients with Unruptured Cerebral Aneurysm Treated by Endovascular Coiling: A Meta-Analysis of the Hydrocoil Endovascular Packing Study and Cerecyte Coil Trial

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1Oxford University, Oxford, UNITED KINGDOM, 2Edinburgh University, Edinburgh, UNITED KINGDOM

PURPOSE
To examine the clinical outcomes at discharge and 6 months in patients prospectively enrolled in the Hydrocoil endovascular aneurysm packing study (HELPs) and the Cerecyte coil trial (CCT), to provide an accurate and objective assess-
MATERIALS & METHODS
Nine hundred ninety-nine patients were enrolled in the HELPS and Cerecyte prospective randomized trials, 222 in HELPS more than 250 patients in CCT were treated for a previously unruptured aneurysm. The primary purpose of the trials was to determine if active coils or coated coils led to improvements in angiographic outcomes at follow-up angiography. As a secondary outcome, clinical outcomes and any differences in outcome between the allocated groups also will be examined. These studies have provided the ideal environment to examine accurately in large multicenter trials the clinical outcomes associated with treating patients with current expertise and coil technologies. The patient demographics and aneurysm characteristics were prospectively collected and the clinical outcomes were determined at discharge and 6-month follow up by a validated self reported modified Rankin Scale of dependency, similar to the one used in the international subarachnoid aneurysm trial. The pooled data of both trials was analyzed to examine procedural complications, discharge outcomes, lengths of stay and dependency at 6 months.

RESULTS
The patient and aneurysm characteristics will be analyzed and presented together with the discharge and 6-month clinical outcomes, the procedure-related complications and adverse events and a multivariate analysis of the predictors of adverse outcomes presented. The Cerecyte trial will complete enrolment in early 2009, combined available data will be analyzed immediately prior to the meeting and presented which will report complete discharge outcome data and more than 95% of the 6-month outcome data.

CONCLUSION
The combined data from the two studies will provide for the first time. Large volume randomized trial data on the complication rate of endovascular coil treatment of unruptured cerebral aneurysms are from a wide range of high-volume interventional centers utilizing current technologies.

KEY WORDS: Cerebral aneurysm, unruptured, clinical outcomes

Paper 26 Starting at 11:33 AM, Ending at 11:41 AM
Cerecyte Coil Trial: Patient and Aneurysm Characteristics, Discharge and 6-Month Outcomes in 500 Patients Randomized to Bare Platinum Coils or Cerecyte Coils with Ruptured and Unruptured Cerebral Aneurysms
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1Sheffield University Hospitals NHS Trust, Sheffield, UNITED KINGDOM, 2Oxford Radcliffe Hospitals NHS Trust, Oxford, UNITED KINGDOM, 3University of Oxford, Oxford, UNITED KINGDOM

PURPOSE
To report the patient and aneurysm characteristics of patients enrolled in this trial and the discharge and 6-month clinical outcomes in patients recruited in 23 centers worldwide with ruptured and unruptured cerebral aneurysms.

MATERIALS & METHODS
The Cerecyte Coil Trial is a prospective randomized clinical trial of 500 patients undergoing endovascular coiling of cerebral aneurysms. The primary outcome is designed to determine if the use of Cerecyte polymer loaded coils improve the angiographic outcome at 6 months as assessed by the core lab. The secondary outcome is to compare the safety in the two groups and report the current clinical outcomes at discharge and 6 months of patients undergoing coiling of both recently ruptured aneurysms and unruptured aneurysms.

RESULTS
Twenty-three centers in six countries enrolled at total of 500 patients over a 3-year period. The trial will complete recruitment in early 2009. At the time of preparation of the abstract 227 patients with ruptured aneurysms and 250 patients with unruptured aneurysms have been enrolled. Discharge data are available for 404 patients. In patients with ruptured aneurysms two died before discharge, 194 of 201 had a good WFNS score at discharge and 142 of 157 alive at 6 months were mRS 0-2. In those with unruptured aneurysms 199 of 203 were discharged home, there were no deaths in hospital, three patients went to another hospital and one went to rehabilitation. At 6 months one patient in the unruptured group had died. Complete discharge data and near complete 6-month clinical outcome data in both groups will be analyzed immediately prior to the meeting for presentation.

CONCLUSION
The safety profile of modern coil techniques appear good and the trial will provide reliable clinical outcome data for patients with ruptured and unruptured aneurysms. It remains to be seen if Cerecyte polymer-loaded coils improve angiographic outcomes.

KEY WORDS: Cerebral aneurysm, clinical outcome, randomized trial

Paper 27 Starting at 11:41 AM, Ending at 11:49 AM
Safety of the Endovascular Treatment of Unruptured Intracranial Aneurysms Is Similar in Low- and High-Volume Centers: Analysis in the ATENA Study
Pierot, L.1 · Spelle, L.2 · Vitry, F.1 · ATENA investigators
1Hopital Maison-Blanche, Reims, FRANCE, 2Fondation Rothschild, Paris, FRANCE

PURPOSE
To analyze the modalities of treatment, the rate of adverse events, the morbidity and mortality rates, and the length of hospital stay for patients treated for unruptured intracranial aneurysms by endovascular approach in relation to the volume of patients treated in the centers. The analysis was conducted in a large multicenter series concerning the endovascular treatment of unruptured intracranial aneurysms (ATENA).

MATERIALS & METHODS
In ATENA series, 649 patients harboring 739 unruptured aneurysms were prospectively and consecutively treated by endovascular coil embolization in 27 Canadian and French neurointerventional centers. The centers of ATENA study
were classified into two groups according to the number of patients included during the study period. In group A were included 13 centers in which 20 patients or less were treated, and in group B, 14 centers in which more than 20 patients were treated. According to sex, age, risk factors (smoking and HTA), and aneurysm characteristics (location, aneurysm size, dome-to-neck ratio), both groups of patients and aneurysms were not significantly different.

RESULTS
Modalities of endovascular treatment were significantly different in both groups with a more frequent use of the standard coiling technique in group A and of the stenting in group B. The global rate of adverse events was not significantly different in groups A and B (respectively 16.0% and 14.4%). Similarly the rate of specific adverse events (Thromboembolism + intraoperative rupture + device related problem) was not significantly different in groups A and B (respectively 12.8% and 12.5%). Only intraoperative rupture was significantly more frequent in group A than in group B (respectively 3.7% and 2.1%; p=0.03). One month mortality and morbidity rates were not significantly different in groups A (respectively 2.3% and 1.8%) and B (respectively 1.0% and 1.7%). The length of hospital stay was not significantly different in both groups.

CONCLUSION
In this subgroup analysis of ATENA series, the safety of the endovascular treatment of unruptured intracranial aneurysms is similar in low- and high-volume centers.

KEY WORDS: Aneurysms, endovascular treatment

Paper 28 Starting at 11:49 AM, Ending at 11:57 AM
Interobserver Variability for Aneurysm Retreatment

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PURPOSE
Following endovascular treatment, aneurysms typically undergo surveillance imaging in order to detect and possibly treat recurrences. There exists no data regarding interobserver variability for recommendations about retreating recurrent aneurysms.

MATERIALS & METHODS
Following IRB approval, an existing MR angiography (MRA) database was reviewed in order to identify aneurysms with residual or recurrent filling. Among 60 patients, 12 residual or recurrent aneurysms were identified. Four experienced endovascular therapists blindly and independently rated on a 5-point graded response scale (1, definitely do not retreat to 5, definitely retreat). The readers also categorized their recommended technique for retreatment (1, coil alone; 2, coil with balloon assist; 3, coil with stent assist; or 4, clip). Kappa statistics were calculated to assess interobserver variability.

RESULTS
Only one (8%) of 12 cases resulted in total agreement among the raters. Nine (75%) cases showed at least a 1-point difference between at least two raters, while 8 (66%) had at least a 2-point difference between at least 2 readers. A 4-point difference was found among 16% of the cases and 42% had at least a 3-point difference. Interobserver agreement was poor between all four readers (Kappa range .06 to .33). Interobserver agreement was also poor between all readers for the specific recommended retreatment technique (Kappa .263).

CONCLUSION
There is wide interobserver variability regarding whether and how a specific aneurysm remnant or recurrence should be retreated. In two thirds of cases, at least two of four readers differed by at least two points, which implies clinical recommendations ranging from “definitely do/do not treat” to “not sure,” or from “probably do not treat” to “probably retreat.” These findings suggest not only that patient care decisions likely vary widely between operators, but also that retreatment as an outcome in clinical trials is suspect.

KEY WORDS: Aneurysm, retreatment

Paper 29 Starting at 11:57 AM, Ending at 12:05 PM
Redefining the Difficult Aneurysm: Over-Wide or Under-Tall?

Brinjikji, W. · Cloft, H. · Kallmes, D. F.
Mayo Clinic
Rochester, MN

PURPOSE
We carried out a systematic study examining which thresholds of dome-to-neck ratio, maximum neck width, and aspect ratio of intracranial aneurysms best predict the need for adjunctive techniques in endovascular management.

MATERIALS & METHODS
One hundred seventy-five consecutive patients who were selected for attempted embolization of 185 intracranial aneurysms were included in this study. Aneurysm dome-to-neck ratio (maximum dome width/maximum neck width), maximum neck width and aspect ratio (dome height/maximum neck width) were measured on 2D digital subtraction angiography. Statistical analysis was conducted to determine which thresholds of dome-to-neck ratio, maximum neck width, and aspect ratio were most predictive of the need for adjunctive devices in endovascular management of these aneurysms.

RESULTS
We demonstrated that 75% of aneurysms with dome-to-neck ratios greater than 1.6 (p<.0001), 75% of aneurysms with aspect ratios greater than 1.6 (p<.0001) and 70% of aneurysms with neck diameters less than 4.0mm (p<.0001) did not need adjunctive techniques in their management. Adjunctive techniques were essential to treatment of 80% of aneurysms with dome-to-neck ratios less than 1.2 (p=.02) and 89% of aneurysms with aspect ratios less than 1.2 (p<.0001). Multivariate logistic regression analysis demonstrated that aspect ratio was the best predictor of need for an adjunctive device (p=.0004).

CONCLUSION
Aneurysms with aspect and dome-to-neck ratios greater than
1.6 usually did not require adjunctive techniques, while those with aspect and dome-to-neck ratios less than 1.2 almost always required adjunctive techniques. Aspect ratio is the best independent predictor of need for adjunctive techniques in the endovascular management of intracranial aneurysms.

**KEY WORDS:** Aneurysm geometry, endovascular coiling

**Paper 30 Starting at 12:05 PM, Ending at 12:13 PM**

**Novel Retractable Stent Device for Treatment of Wide Neck Aneurysms**

Yuki, I. · Kan, I. · Vinuela, F. A. · Kim, R. H. · Vinters, H. V. · Vinuela, F.

University of California Los Angeles
Los Angeles, CA

**PURPOSE**

To evaluate the performance of a new retractable stent, a device designed for assisting a coil embolization of wide neck aneurysm, using an experimental swine aneurysm model.

**MATERIALS & METHODS**

A retractable stent device was tested using 12 experimental aneurysms in six swine. Each device was deployed via a microcatheter and placed across the neck of wide neck aneurysm (surgically created aneurysm) created on a common carotid artery. Coil materials (bare platinum coils) were deployed into the aneurysm through a microcatheter which was placed in the aneurysm with jailing technique. After confirming the occlusion of the aneurysm, the retractable stent was resheathed and removed. Angiographic assessment as well as histological analysis was made to evaluate the mechanical performance during the aneurysm embolization.

**RESULTS**

In every case the stent device effectively prevented the coil migration into the parent artery. Repetitive angiograms showed consistently patent blood flow in the artery throughout the procedure. The tip of the microcatheter placed in the aneurysm was stabilized by the stent without losing the ability of repositioning. In two cases, slight thrombus formation was observed on the surface of the stents. It increased resistance in resheathing process and consequently caused instability of deployed coil materials. Postprocedure angiogram showed no sign of dissection or significant vasospasm. Histological analysis showed no intimal damage associated with the procedure.

**CONCLUSION**

The retractable stent device effectively assisted the coil deployment and prevented the coil migration into the parent artery without blocking the blood flow of the parent artery. To avoid the thrombus formation on the surface of the device and to elicit the proper resheathing process, appropriate antiplatelet and anticoagulant treatment seems to be mandatory prior to the procedure.

**KEY WORDS:** Intracranial stent, wide neck aneurysm, endovascular treatment

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**Paper 31 Starting at 12:13 PM, Ending at 12:21 PM**

**Aneurysms Amenable to Flow Diverters: Common or Rare?**

Brinjikji, W. · Cloft, H. · Lanzino, G. · Kallmes, D. F.

Mayo Clinic
Rochester, MN

**PURPOSE**

The purpose of this study was to estimate the fraction of typical aneurysms that might be amenable to treatment with current flow diverter devices and to inform the interventional community regarding the types of aneurysms not amenable to treatment with these devices.

**MATERIALS & METHODS**

A retrospective analysis of 179 patients with 200 intracranial aneurysms who underwent 3D rotational angiography for evaluation of previously untreated aneurysms was conducted. Each aneurysm was scored for its amenability to treatment with a flow diverter device. Amenability to treatment was graded on a five-point scale. The grades were as follows: Grade 1) Side-wall aneurysms along vessels in which intended treatment expanse includes no branch vessels, thus multiple devices could be used; Grade 2) Side-wall aneurysms along vessels in which anticipated treatment expanse includes branch vessels that could be occluded without substantial risk (i.e., ophthalmic artery), thus multiple devices could be used; Grade 3) Side-wall aneurysm along vessel in which anticipated treatment expanse includes branch vessels that would pose significant risk of neurologic deficit (i.e., anterior choroidal artery or perforating arteries of the basilar artery where a single device would be recommended; Grade 4) Side-wall aneurysm along vessels with maximum dimension <3mm, thus not amenable to current device; Grade 5) Non-side-wall morphology, thus not amenable to current device. Three independent observers independently evaluated each aneurysm. A kappa value was calculated to determine interobserver agreement.

**RESULTS**

Overall 45% (95% CI=38% to 52%) of the aneurysms in this study would have been amenable to treatment with current flow diverter devices, that is, Grades 1-3. Twenty-nine percent (95% CI=23% to 35%) would have been amenable to treatment with multiple devices (Grade 1 or 2), and 16% (95% CI=12% to 22%) would be amenable to treatment with a single device (Grade 3). There was a significant relationship between the location of the aneurysm and the grade of the aneurysm (p<.0001). By location, 89% (95% CI=80% to 95%) of ICA aneurysms, 56% (95% CI=34% to 75%) of posterior communicating aneurysms, 12% (95% CI=3% to 30%) of aneurysms on the basilar tip, 44% (95% CI=25% to 66%) of aneurysms on the vertebrobasilar system excluding the basilar tip, 5% (95% CI=0% to 26%) of aneurysms on MCA, and 5% (95% CI=0.4% to 15%) of aneurysms on ACOM and ACA were amenable to treatment with current flow diverter devices. There was no relationship between the sizes of the aneurysms and their grades. The kappa values between observers ranged from 0.70 to 0.85, indicating good to excellent agreement.

**CONCLUSION**

Nearly one half of consecutive aneurysms in this study
would have been amenable to treatment with current flow
diverter devices, with 28% amenable to treatment with mul-
tiple devices and 16% amenable to treatment with one
device. In addition, the location of the aneurysm plays a sig-
nificant role in amenability to treatment with current flow
diverter devices.

**KEY WORDS:** Aneurysm, flow diverter

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

**Measurement of Flow Speed of In Vitro Aneurysm Models with Coils Using Particle Image Velocimetry**

Matsumoto, K.¹ · Noda, S.² · Fukasaku, K.² · Himeno, R.² · Ohta, M.¹
¹Tohoku University, Sendai, JAPAN, ²Riken, Wako, JAPAN

**PURPOSE**
The coil embolization for cerebral aneurysm is one of the
effective treatments for repairing the aneurysm with stop-
ping flow in the aneurysm cavity. However, recanalization or
growth of the aneurysm sometimes occurs because the flow
may not be reduced. The flow and the flow pattern in the
aneurysm may be affected by the coil geometry and the
aneurysm. Therefore, the measurements of flow speed with
coils in aneurysm are necessary for analyzing the effect of
coil on the flow in the aneurysm. In this study, we measured
flow speed in an in vitro aneurysm model using particle
image velocimetry (PIV) method.

**MATERIALS & METHODS**
A 3D idealized model aneurysm (manufactured by R’Tech)
made of silicone was prepared to have a straight parent
artery of 4 mm diameter and a spherical aneurysm of 10 mm
diameter. Four models with the same geometries were pre-
pared. Six coils made of stainless steal with 0.25 mm diam-
er were prepared and one coil was inserted into the first
aneurysm. Next, two coils were inserted into the second
aneurysm and three coils also were inserted into the third
aneurysm. The rest of the aneurysms without coils were used
as a control. Water mixed with glycerin with specific gravi-
ty of 1.138 at 25°C and viscosity of 1.11×10⁻² [Pa s] was used
as a working fluid. The flow was steady and the Reynolds
number was 300 using the diameter. The flow was visualized
using reflection of tracer particles (Bright 6GNR30, Nippon
Chemical Industrial) in the working fluid by an Argon laser
sheet with 1mm thickness (543-A-A01, MELLES GRIOT)
and was taking sequential photos using CCD camera (FAST-
CAM-1024PCI, Photron). The visualization was performed
at 9 cross sections in each aneurysm. Arrows for flow veloc-
ity was drawn using PIV software (Concert ver. 1.0, Seika
Corporation).

**RESULTS**
All flows in the center section in all aneurysms compose a
vortex in the aneurysms. The center of vortex is formed at
the distal position and near the neck. The vortex pattern
gradually is disturbed and the speed increased, when the
number of coils increases. The flow speeds at the distal
neck are the fastest in all aneurysm areas. The flow speeds of all
aneurysms at the center cross section are the fastest in all
cross sections and the flow speed decreases at the edge of the
aneurysm. The flow speeds at several local places of three
coil samples are faster than that of the control.

The coils change the flow patterns in the aneurysms and
increase the flow speed at several areas.

**CONCLUSION**
The flow speed in an in vitro aneurysm model is measured
using particle image velocimetry (PIV) method. The flow
patterns in the aneurysms are disturbed by coils and the flow
speeds at several areas increase.

**KEY WORDS:** Aneurysm, coil, PIV

**Monday Morning**

**10:45 AM – 12:30 PM**

**Ballroom A**

(4c) Adult Brain: New Techniques/Post
Processing
(Scientific Papers 33 – 45)

**See also Parallel Sessions**
(4a) Head and Neck: Temporal Bone and
Miscellaneous
(4b) Interventional: Aneurysms I
(4d) Spine: Neoplasia, Trauma & Functional
Imaging
(4e) Excerpta Extraordinaire: Adult Brain

**Moderators:** Pia Maly Sundgren, MD, PhD
TBD

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

**Utility of Multi-Modal CT Imaging in the Endovascular
Management of Acute Ischemic Stroke**

English, J. D. · Smith, W. S.
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San Francisco, CA

**PURPOSE**
Patient selection for endovascular therapy of acute ischemic
stroke, whether in clinical practice or therapeutic trials, is
often based upon presenting stroke symptoms (e.g., IMS III: NIH stroke scale >= 10), time of onset and non-contrast CT
imaging. These selection criteria might include patients
without a large vessel target for endovascular revasculariza-
tion and also exclude patients with such target lesions. We
used the STOP-Stroke Study to evaluate the potential impact
of CT angiography on patient selection for endovascular
acute stroke therapy.

**MATERIALS & METHODS**
The STOP-Stroke Study was a prospective imaging-based
study of stroke outcomes compiled at two academic medical
centers. Patients with suspected acute stroke who presented within 24 hours of symptom onset and who underwent multimodality CT/CTA were approached for consent for 6 month follow-up. Demographic variables, presenting NIHSS and 6-month modified Rankin scores were extracted along with blinded interpretation of the CTA data. All variables were tested by univariate and multivariate modeling using Stata, Version 10.

Results
Over a 33 month period, 832 suspected stroke patients were enrolled. Of these, 621 were adjudicated as stroke by a stroke neurologist evaluating all data up to the point of hospital discharge. CT angiographic confirmation of an intracranial large vessel occlusion (LVO) responsible for the stroke was found in 283 (46%). The mean NIHSS for LVO was 12.4 +/- 7.71, compared to 5.07 +/- 4.79 in patients without LVO. Fifteen percent of patients with an NIHSS of 10 or greater had a normal CTA. Forty percent of patients with LVO had an NIHSS of 10 or less.

Conclusion
Large vessel intracranial occlusion accounted for 46% of patients with acute ischemic stroke in unselected patients presenting to academic medical centers. In this population, selection criteria for endovascular therapy based upon a NIHSS of 10 or more would include 15% of patients with no evidence of LVO and would also miss approximately 40% of patients with a target LVO for revascularization. CT angiographic imaging can likely enhance patient selection for endovascular acute stroke therapy by identifying patients with target LVOs for revascularization.

Comparison of CT 3D Volumetric Analysis of Ventricular Size to Visual Radiologic Assessment

Mann, S. A. · Wilkinson, J. S. · Fourney, D. R. · Stoneham, G. W.
University of Saskatchewan
Saskatoon, SK, CANADA

Purpose
Interpretation of ventricular volume on CT scans of hydrocephalus patients is usually subjective. The objective of this study was to determine whether radiologic assessment of interval change correlates better with an objective calculated volume change, or with other objective 2D estimates of ventricle volume change.

Materials & Methods
Ventricular volume, Evan’s ratio, and F/O Horn ratio were assessed retrospectively on 95 pairs of CT scans from patients with a ventriculoperitoneal shunt. Ventricle volume was assessed through a new volume determination technique that employs standard 3D CT reconstruction software. To determine ventricle volume, all voxels of CSF density were isolated on a 3D reconstructed CT scan. Voxels of fluid density contiguous with one another in the ventricular system then were isolated. (Note: The accuracy of this technique was assessed against a phantom over a 0 - 330 mL range at 15 mL increments. The technique had an average error of -0.46% with a Pearson correlation coefficient between true and calculated volume of 0.99. ) Radiologic assessments of

Results
Significant overlap was found in the confidence intervals for objectively calculated volume change between the different categories of radiologic assessment (Figure A, B, C). The F/O Horn ratio had the most consistent correlation with the radiologic assessment, followed by the Evan’s ratio. Objectively calculated volume change correlated poorly with radiologic assessment (Figure D).

Conclusion
A volume determination technique using standard 3D CT reconstruction tools was validated. Using this technique, it was shown that radiologic interpretation does not correlate well with objectively calculated volume changes, but correlates more closely with other 2D parameters that approximate volume, and which are likely used by radiologists to visually evaluate interval change. We recommend that ventricle volume be measured objectively to increase consistency between radiologic interpretation and actual interval changes.

Key Words: Ventricle volume, computed tomography, ventriculoperitoneal shunt
**PURPOSE**

Recent advances in accelerated acquisition and constrained reconstruction provide unprecedented temporal and spatial resolution and open the possibility of extending MRA to include functional information such as velocity, flow, estimated wall shear stress (eWSS), streamlines, and pressure gradients. The time-resolved anatomical and physiologic data derived from the highly accelerated functional MRA (fMRA) methods expand the characterization of brain vascular malformations.

**MATERIALS & METHODS**

Functional MRA employs a multi-echo 3D radial readout (ME VIPR) to obtain whole brain MRA images every half second during the first pass of a contrast bolus followed by 5 minutes of 3D phase contrast radial velocity encoding (PC VIPR, total 6 min.). The time resolved images are reconstructed using the HYPR LR technique (1). Functional MRA was performed on 10 normal subjects and 12 patients with AVMs. The fMRA acquisition produced 4D CE MRA whole brain images with half-second temporal resolution and sub-millimeter isotropic spatial resolution as well as the velocity and eWSS. Quantitative measurements of velocity and eWSS were conducted and compared between control and patient groups. Imaging parameters for the dynamic ME VIPR were: TR/TE = 3.1/0.4 ms, BW = 125 kHz, read out points were 128 for each projection, frame update time was 0.5s. The scan parameters for the PC VIPR were: FOV = 22x22x22 cm^3, BW = 62.5 kHz, 7000 projections with 320 readout points were 128 for each projection. In the event of subject motion, image registration between the dynamic series and readout points for each projection. In the event of subject motion, image registration between the dynamic series and readout points for each projection.

**RESULTS**

Figure 1 shows a time series of whole brain fMRA images of an AVM patient with the corresponding time following the start of contrast injection. Quantitative measurements of velocity, relative pressure, eWSS, and streamline flow (in a different patient) are shown in the images. Analysis of the 12 AVM patients revealed that eWSS is slightly elevated in the vessels supplying the AVM when compared to the contralateral arteries (p = <0.05).

**CONCLUSION**

Functional MRA provides whole brain 4D CE MRA images with both high temporal resolution and isotropic spatial resolution. Image quality scores were highest for image reconstruction using HYPR LR and the phase contrast data. Our observations indicate that flow and eWSS are increased in arteries supplying the AVMs compared to contralateral arteries.

**REFERENCES**


**KEY WORDS:** HYPR, MRA, AVM
CONCLUSION
The MPO-sensitive MR contrast agent, di-5-HT-GdDTPA, is sensitive and specific for active inflammation in the rabbit elastase model of cerebrovascular aneurysm. Myeloperoxidase, a biomarker of active inflammation in vascular disease, could serve as a biomarker for aneurysm instability and can be visualized using 3T MR imaging.

KEY WORDS: Molecular imaging, inflammation, aneurysm

Paper 37 Starting at 11:17 AM, Ending at 11:25 AM
Determining the Age of Greatest Vulnerability to Lead Exposure: Relationship with Adult Gray Matter Volume

Brubaker, C. J.1 · Cecil, K. M.1 · Hornung, R. W.1 · Dietrich, K. N.2 · Lanphear, B. P.3
1Cincinnati Children’s Hospital Medical Center, Cincinnati, OH, 2University of Cincinnati College of Medicine, Cincinnati, OH, 3British Columbia Children’s Hospital, Vancouver, BC

PURPOSE
Vulnerability to lead exposure usually is regarded to be the greatest during early childhood, for example at 2 years of age. However, recent work suggests that blood lead concentrations obtained at approximately 5 to 7 years of age are more strongly associated with IQ. Significant associations between the mean of childhood blood lead levels collected from 3 months to 78 months of life and adult gray matter volume have been reported previously using voxel-based morphometric analyses. This study is an investigation of the differential effects of blood lead levels collected from 1 to 6 years of age on adult gray matter volume.

MATERIALS & METHODS
Adult participants (N=157, 20.8 ± 1.5 years, 83 male) of a longitudinal birth cohort evaluating the effects of low to moderate lead exposure were recruited to undergo high-resolution volumetric imaging (3D IR FSPGR) at 1.5 T. Blood lead levels were collected every 3 months for the first 5 years of life and every 6 months from 5 - 6.5 years. For the studied cohort, the mean childhood blood lead level ranged from 4.7 to 37 μg/dL. Adjusted voxel-wise regression analyses examining associations between yearly mean blood lead levels (1 to 6 years of age) and adult gray matter volume were conducted using Statistical Parameter Mapping (SPM) software. Significance thresholds were set at p<0.001 with a cluster threshold of 700 voxels.

RESULTS
Significant associations were found for the entire cohort between adult gray matter volumes and yearly mean blood lead levels from 3 to 6 years of age (Figure). The amount of associated brain involvement increased with age, particularly in the frontal cortex. Analyses of men alone resulted in significant gray matter associations for all yearly blood lead levels. Specifically, robust associations were found for years 3 to 6 in the frontal lobes of men. Analyses of women yielded significantly weaker associations between gray matter volume at all ages upon comparison with males and the entire cohort, respectively.

![Figure. Adult gray matter volume loss associated with annual blood lead levels.](image)

CONCLUSION
Lead levels obtained at later ages during childhood provide a better measure of lead-associated gray matter volume loss than those acquired early in childhood. Women may be protected intrinsically from the effects of childhood lead exposure on gray matter volume.

KEY WORDS: Volumetric, age effects, neurotoxicant

Paper 38 Starting at 11:25 AM, Ending at 11:33 AM
Cranial CT Angiography with Automated Bone Subtraction: Comparison of Dual Energy and Image Registration-Based Algorithms

Lell, M. M.1 · Klotz, E.2 · Ruehm, S. G.3 · Villablanca, P.3
1University Erlangen, Erlangen, GERMANY, 2Siemens Healthcare, Forchheim, GERMANY, 3University of California Los Angeles, Los Angeles, CA

PURPOSE
Computed tomography angiography (CTA) is a well accepted imaging modality to evaluate cerebral vessels. To alleviate the assessment of vessels at or within the skull base, different techniques to suppress bone in the final CTA image have been developed. Aim of this study was to compare the performance of fully automated bone removal based on dual energy (DE) and image registration (bone subtraction CTA, BSCTA).

MATERIALS & METHODS
Twenty-six patients underwent cranial CT angiography on a dual source CT system. Two scans were performed, one before and one after contrast agent injection in dual energy mode (simultaneous acquisition of 80kV and 140kV scans). For each patient, data sets were reconstructed for postprocessing with DE and BSCTA. Two examiners evaluated overall bone suppression and image quality regarding integrity of the vessel lumen of different vessel segments with a 5-point scale (1= poor, 5= excellent), CTA source data served as the reference. Wilcoxon signed rank test was used to determine differences between the techniques.
RESULTS
Both bone suppression techniques could be applied successfully in 25 patients with high overall image quality. One patient was excluded from the evaluation because of severe motion during the CTA scan. Interobserver agreement was excellent (κ=0.85). Mean score for overall bone removal was 4.7 for DE and 4.9 for BSCTA (p=0.01). Mean score for vessel integrity was 4.35 for DE and 4.89 for BSCTA (p=0.008).

CONCLUSION
Both techniques provided bone suppression in a fully automated way. Bone subtraction CTA showed excellent results for overall bone removal and vessel integrity and was superior to DE in most of the vessels in or at the skull base.

KEY WORDS: Arteries, intracranial, bone subtraction, CTA

Paper 39 Starting at 11:33 AM, Ending at 11:41 AM
In Vitro Evaluation of Dual Energy CT for Distinguishing Hemorrhage from Iodinated Contrast

Gupta, R.1 · Mehdiniratta, A.1 · Leidecker, C.2 · Sapkota, B. H.1 · Phan, C.1
1Massachusetts General Hospital, Boston, MA, 2Siemens Medical Solutions, Malvern, PA

PURPOSE
Extravasation of iodinated contrast into an intracranial hematoma (ICH) recently has been reported as a prognosticator sign for subsequent hematoma expansion. Dual energy CT (DE CT) potentially can be used to distinguish a hyperdensity from acute hemorrhage from that due to contrast extravasation. The purpose of this study was to quantitatively evaluate, in vitro, the feasibility of DE CT-based discrimination between ICH and iodinated contrast.

MATERIALS & METHODS
A Dual source Definition (Siemens Medical Solutions, Erlangen, Germany) was used for acquiring dual energy CT images of a custom-build phantom. The phantom consisted of a 6x6 matrix of plastic tubes containing precalibrated mixtures of iodinated contrast (Isovue 370, Bracco Diagnostics), heparinized swine blood, and normal saline. The concentration of blood increased from 0% to 50%, in increments of 10%, as one moved up the matrix from row to row. Similarly, the concentration of iodine increased from 0% to 50%, in increments of 10%, as one moved from right to left, column by column. Two additional tubes containing undiluted blood and iodinated contrast also were imaged. For dual energy imaging, the two x-ray sources were operated at 80kV and 140kV simultaneously with 499mA and 118mA tube current (effective mAs of 714 and 168), respectively. These tube currents were chosen so that the total dose was split approximately evenly between the two imaging chains. Using the postprocessing software (Leonardo, Siemens), the 80kV and 140kV image sets were converted into a virtual noncontrast (VNC) image and a contrast-overlay image. These images then were analyzed to see if the system was able to deduce the proportion of blood and iodinated contrast in each tube.

RESULTS
Expected increase in the CT numbers was seen as the tube voltage decreased from 140kV to 80kV. However, this increase in the CT numbers saturated at a value of 3071. This is because a conventional CT scanner has a dynamic range of 12-bits (0 to 4095) which spans the interval -1024 (air) to 3071 (densest observable object). As the concentration of iodine increased, the 80kV imaging chain was first to saturate. This point was reached for all tubes containing 10% or more of iodinated contrast. The virtual noncontrast and iodine overlay data were not reliable for an iodine concentration more than 1 part in 10.

CONCLUSION
Dual energy CT is unable to reliably distinguish hemorrhage from iodinated contrast when the iodine concentration is more than 37 mOsm. This will not pose a problem for intracranial evaluation after IV contrast administration because, by the time contrast reaches the brain, the dilution factor is much higher than 1:10. However, near the aortic arch, in the cervical region, or during intraarterial catheter-assisted delivery of contrast, the 1:10 dilution factor may not be reached making DE CT unreliable.

KEY WORDS: Dual energy CT, intracranial hemorrhage, iodinated contrast

Paper 40 Starting at 11:41 AM, Ending at 11:49 AM
Development of a Novel Filtered Back-Projection Algorithm Designed to Improve Contrast-Resolution in Noncontrast Head CT Imaging

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PURPOSE
The specific aim of the present study is to develop a novel filtered back-projection algorithm intended to reduce noise, increase contrast resolution, and decrease radiation dose for brain CT imaging. CT reconstruction algorithms use a filtered back-projection process wherein the filter strength is selected to offer images that trade-off noise with spatial resolution. We developed a novel post-reconstruction algorithm with the objective of suppressing the noise in the image without degrading spatial resolution.

MATERIALS & METHODS
Fifty brain CTs were reviewed with conventional filter back-projection images and the novel algorithm. The new post-reconstruction algorithm differs from conventional approaches in that it first segments the image into groups of pixels and then filters within each group. Two CAQ certified neuroradiologists qualitatively evaluated the spatial and contrast resolution of the images.

RESULTS
The image database included a broad spectrum of pathology, including stroke, intracranial hemorrhage and other mass lesions. The novel algorithm resulted in images that were appreciably different from those processed conventionally. Qualitative assessment of the images suggested that spatial resolution was preserved and that contrast resolution was at least equivalent to conventional processing in 48 of the 50 cases.

CONCLUSION
The novel filtered back-projection algorithm produces
images that are appreciably different from those generated by conventional techniques. Further studies are warranted to determine whether the algorithm offers a significant reduction in noise and/or improvement in contrast resolution. If so, the application of this algorithm may ultimately allow for CT images to be acquired at lower radiation doses without compromising image quality.

**Key Words:** Filtered back-projection algorithms, noise reduction, noncontrast brain CT

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**Paper 41 Starting at 11:49 AM, Ending at 11:57 AM**

**Comparison of Quantitative CT Perfusion Data Using Three Different Perfusion Processing Programs**

Hoeffner, E. G. · Rivas, F. · Myles, J.
University of Michigan Health System
Ann Arbor, MI

**Purpose**
Correlate quantitative CT perfusion (CTP) values for cerebral blood flow (CBF), cerebral blood volume (CBV) and mean transit time (MTT) using three processing software programs.

**Materials & Methods**
Eighteen CTP exams were processed using Perfusion 3 software on an Advantage Workstation (GE Healthcare, Buckinghamshire, England), Vitrea 2 CT Brain Perfusion conventional singular value decomposition (SVD) software and Vitrea 2 CT Brain Perfusion delay-insensitive SVD (SVD+) software (Vital Images, Minnetonka, MN). Cerebral blood flow, CBV and MTT maps were generated with each software program. Up to 12 circular regions of interest (ROIs) were placed around the cortex on each CT perfusion slice and ROI were drawn around the basal ganglia on the slices that were present. Regression analysis was performed for the cortical and the basal ganglia ROI for each perfusion parameter. The SVD values were regressed on the Perfusion 3 values and the SVD+ values were regressed on the Perfusion 3 values. Good agreement between the two assessments would result in slopes and correlations (R) around 1.

**Results**
Regression analysis revealed variable agreement between perfusion parameter values measured using the 3 processing techniques. Cerebral blood volume showed best correlation, for both cortical and basal ganglia ROI. Slope estimates were consistently different from 0 with all slopes greater than 0.7. The R values were all above 0.7, indicating high correlation. There also was high correlation for cortical MTT values when comparing Perfusion 3 to Vitrea SVD (slope of 0.676, correlation coefficient of 0.735). There was poorer correlation for basal ganglia MTT values when comparing Perfusion 3 to Vitrea SVD and for both cortical and basal ganglia MTT values when comparing Perfusion 3 to SVD+ (slopes from 0.229 to 0.551 and correlation coefficients from 0.120 to 0.482). There was moderate to poor correlation for CBF, for both cortical and basal ganglia ROI (slopes from 0.161 to 0.409 and correlation coefficients from 0.444 to 0.650).

**Conclusion**
Only CBV values showed high correlation among the three processing programs, with CBF and MTT having moderate to poor correlation. Caution should be used when trying to compare quantitative perfusion results obtained with different CT perfusion software programs.

**Key Words:** CT, perfusion, brain

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**Paper 42 Starting at 11:57 AM, Ending at 12:05 PM**

**Validation of Quantitative Cerebral Blood Flow Measurements by MR Imaging and the Bookend Technique Using Positron Emission Tomography**

Lee, J. J. · Parikh, V. · Shin, W. · Mouannes, J. · Snyder, A. Z. · Carroll, T. J. · Dedeyn, C. P.
1Washington University School of Medicine, St. Louis, MO, 2Northwestern University, Evanston, IL, 3National Institutes of Health, Baltimore, MD, 4Northwestern University, Chicago, IL

**Purpose**
Quantitative, accurate cerebral blood flow (CBF) measurements with MR imaging would have great impact in imaging cerebrovascular disease. When added to standard dynamic susceptibility contrast (DSC) MR imaging, the Bookends technique (1-3) can produce reliable and reproducible measurements of CBF and cerebral blood volume (CBV) using difference measurements of T1 and T2 before and after contrast. Our goal was to compare the accuracy of Bookends against positron emission tomography (PET) and also against DSC MR imaging with rescaling to normal-appearing white matter.

**Materials & Methods**
Seven patients with angiographically confirmed cerebrovascular disease were enrolled for this study in accordance with the guidelines of the institutional review board of the Washington University School of Medicine. H2[15O] PET were performed and CBF maps generated using the Kety autoradiographic method. High-resolution MP-RAGE, Bookends inversion-recovery and dynamic susceptibility contrast with EPI gradient echoes were performed at 3T, then analyzed with singular value decomposition and Bookends processing. Images were coregistered and matched for resolution using 3D Gaussian filters at 10 mm FWHH. Large ROIs were drawn manually.

**Results**
Regression analyses were performed on PET CBF, quantitative Bookends CBF and MR CBF rescaled to normal-appearing white matter assumed to have flow = 22 mL/min/100g. Bookends CBF showed Pearson’s r = 0.74 (p < 10⁻⁴), slope = 0.98 and intercept = -7.5 mL/min/100g with Pearson’s r = 0.74. MR CBF rescaled to white matter showed Pearson’s r = 0.94, slope = 1.4 and intercept = -12 mL/min/100 g.
CONCLUSION
Our regression analysis shows that the Bookend technique gives a fit with slope that is closer to the desired line of unity. The assumption that white-matter blood flow is a constant 22 ml/min/100g was not consistent with CBF measurements by quantitative Bookends CBF nor with PET CBF. Discrepancies between Bookends CBF and PET CBF may be related to differences in tracer kinetics for intravascular gadolinium versus semidiffusible radio-labeled water.

REFERENCES

KEY WORDS: CBF, MR, PET

Paper 43 Starting at 12:05 PM, Ending at 12:13 PM

**Novel Postprocessing Algorithm for Whole Brain CT Perfusion on a 320 Multislice CT Scanner**

Shankar, J. J. S.1 · Khalatbari, A.2 · Hogan, M.1 · Sharma, M.1 · Chakraborty, S.1 · Nugyen, T. B.1 · Dos Santos, M.1 · Miller, W.1 · Lum, C.1

1The Ottawa Hospital, Ottawa, ON, CANADA, 2University of Ottawa, Ottawa, ON, CANADA

PURPOSE
With new 320 slice CT scanners, perfusion of whole brain is possible. There is a reduction in radiation dose compared to older generation scanners. With the singular value decomposition plus method there is underestimation of the cerebral blood flow which is addressed by obtaining relative values instead of absolute values. Our objective is to further reduce the radiation dose by increasing the sampling interval.

MATERIALS & METHODS
We retrospectively reviewed 20 perfusion studies on 19 patients performed on Toshiba 320-slice CT scanner for various clinical indications. CT perfusion was performed using 50 ml of contrast at the rate of 4 ml/sec. Twenty volumes of the brain were acquired at the rate of one volume every 2 seconds for 24 seconds followed by one volume every 5 seconds for another 20 seconds with an acquisition delay of 7 seconds. The acquisition parameters were 80 KV and 100 mA with a rotation time of 1 second. The postprocessing of all perfusion studies was performed on a Vitrea fx, version 1.0 workstation(Vital Images Inc., Minnesota) using singular value decomposition (SVD) plus method. We first performed the postprocessing using the standard algorithm by choosing all the volumes acquired every 2 seconds. For our novel postprocessing algorithm, we increased the sampling interval two fold by choosing the alternate volumes. We placed five regions of interest (ROI), each measuring more than 5 mm² in bilateral frontal gray and white matter, putamen, and temporal gray and white matter. Mean and standard deviation of cerebral blood flow (CBF), cerebral blood volume (CBV) and mean transit time (MTT) values were calculated. The expected radiation dose for our new postprocessing algorithm was calculated. A Pearson correlation coefficient was calculated to assess the statistical correlation between the parameters obtained by the two algorithms. A p value of less that 0.05 was taken as significant.

RESULTS
The correlation coefficients obtained for the perfusion parameters of the two different postprocessing algorithm showed excellent correlation (Table). P values were less that 0.0001 for all the comparisons. The radiation dose for our novel postprocessing algorithm resulted in a radiation dose reduction of approximately 900 DLP.

**Table 1**

<table>
<thead>
<tr>
<th>Parameters</th>
<th>ROI</th>
<th>Mean (standard)</th>
<th>Mean (Novel)</th>
<th>Correlation coefficient</th>
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<td>Lt BG</td>
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<td></td>
<td>Lt TGM</td>
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<td>Lt TWM</td>
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<td>Rt FWM</td>
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<td></td>
<td>Rt BG</td>
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<tr>
<td></td>
<td>Rt TGM</td>
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<tr>
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<td>Rt TWM</td>
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<td>6.86</td>
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<tr>
<td></td>
<td>Lt BG</td>
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<td>Lt TGM</td>
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<td></td>
<td>Lt TWM</td>
<td>6.19</td>
<td>6.28</td>
<td>0.819</td>
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</table>

CONCLUSION
Our novel postprocessing algorithm results in similar perfusion parameters compared to the standard algorithm. The novel algorithm results in a reduction of radiation dose by approximately 900 DLP, approximately half the normal dose as it requires only half the samples.

KEY WORDS: CT perfusion, postprocessing algorithm, whole brain perfusion

Paper 44 Starting at 12:13 PM, Ending at 12:21 PM

**Scale Perfusion-Weighted Imaging: A Pulse Sequence for Quantitative Cerebral Perfusion Imaging**

Mouannes, J. J.1 · Shah, S.2 · Shin, W.3 · Biris, O.1 · Hurley, M.1 · Eddleman, C.1 · Carroll, T. J.1

1Northwestern University, Chicago, IL, 2Siemens Medical Solutions USA, Inc., Chicago, IL, 3National Institute of Health, Baltimore, MD

PURPOSE
The “Bookend” technique allows quantification of cerebral perfusion with dynamic susceptibility contrast (DSC) MR
imaging and fast T1 measurements before and after DSC, in a reproducible and reliable manner. The current implementation consists of 3 MR scans performed sequentially requiring a cumulative scan time of 5 minutes. Our goal was to come up with a “single” MR pulse sequence that produces quantitative images of cerebral perfusion without need for multiple scans, and is less prone to motion artifacts. This will allow “online” implementation of our automatic postprocessing algorithm, and facilitate utilization of our technique in emergency settings, such as acute stroke, to obtain immediate and accurate diagnosis.

MATERIALS & METHODS
Self-calibrated epi perfusion-weighted imaging (SCALE PWI) consists of a 3-step gradient-echo (GRE) single-shot echo-planar imaging (EPI) sequence, based on the Bookend technique. It produces an absolute scale for cerebral perfusion quantification. Nineteen healthy volunteers were scanned on a 1.5 T MR scanner (MAGNETOM Espree, Siemens AG Healthcare Sector, Erlangen, Germany) to compare SCALE PWI to the Bookend technique protocol, which served as a reference. The total scan time of SCALE PWI is under 2 minutes. Image processing was done using a fully automatic reconstruction program developed in MATLAB V7.2 (Mathworks, Natick, MA, USA).

RESULTS
We found excellent agreement between the perfusion values obtained with the SCALE PWI sequence and the reference protocol. Table shows the comparison between mean quantitative cerebral blood flow (qCBF) and quantitative cerebral blood volume (qCBV) values for white matter (WM) and gray matter (GM); the p and r values are also given. Figure (A,B) shows the comparison between representative qCBF images. The correlation analysis for qCBF and qCBV in WM and GM resulted in: (a) qCBF: slope = 0.98, offset = 1.35, r = 0.97 and p < 10^-3, and (b) qCBV: slope = 0.94, offset = 0.17, r = 0.93 and p < 10^-3.

<table>
<thead>
<tr>
<th>Tissue</th>
<th>qCBF (ml/(100g-min))</th>
<th>qCBV (ml/100g)</th>
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</thead>
<tbody>
<tr>
<td>Mean/Standard Deviation</td>
<td></td>
<td></td>
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<tr>
<td>WM</td>
<td>SCALE-PWI</td>
<td>20.7/4.9</td>
</tr>
<tr>
<td></td>
<td>REFERENCE</td>
<td>20.5/5.2</td>
</tr>
<tr>
<td>GM</td>
<td>SCALE-PWI</td>
<td>75.5/16.1</td>
</tr>
<tr>
<td></td>
<td>REFERENCE</td>
<td>75.0/16.0</td>
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<tr>
<td>p-value/Correlation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>WM</td>
<td>0.72/0.87</td>
<td>0.90/0.76</td>
</tr>
<tr>
<td>GM</td>
<td>0.78/0.83</td>
<td>0.57/0.43</td>
</tr>
</tbody>
</table>

Comparison of qCBF and qCBV values obtained with SCALE-PWI and Reference protocol

Figure 1. A and B are representative qCBF images for a brain slice obtained with the REFERENCE protocol and SCALE-PWI, respectively.

CONCLUSION
We have validated the accuracy of the new sequence for perfusion quantification in healthy volunteers, by comparing it to our reference Bookend protocol, which has been validated through direct comparison with H2[O15] PET (the “gold standard” for perfusion imaging).

KEY WORDS: Perfusion, quantitative, brain


Ahmad, T. · Lo, Y. · Zoarski, G. · Shekhar, R. · Siegel, E.
University of Maryland Baltimore, MD

PURPOSE
A computer-aided detection (CAD) tool was developed to enhance and streamline imaging assessment and measure interval change between baseline and serial MR scans in patients with multiple sclerosis (MS).

MATERIALS & METHODS
Twenty MR studies on 10 patients (2 per patient) with known MS were selected randomly from existing clinical trial databases (axial FLAIR sequences, 5 patients; axial proton density (PD), 5 patients). All baseline and follow-up studies were acquired using identical protocols, and all patients had either stable or progressive disease. All sequences were acquired using a 3 mm slice thickness with a 3 mm gap. A nonrigid (deformable) registration technique developed at our institution was used to anatomically “align” the follow-up study with the baseline. Alignment was checked manually to ensure precision and avoid artifacts. The registered version of the follow-up image then was subtracted from the baseline. All images subsequently were reconverted to DICOM format and displayed using an Osirix workstation. The CAD program was designed to null all areas that remain stable between the two studies and provide a bright signal only in areas of positive or negative change in plaque burden. Outlines of normal structures that remained visible on the subtracted images served as anatomic landmarks.

RESULTS
Computer-aided detection sensitivity and specificity in this small sample population were 83% and 96%, respectively, using an experienced neuroradiologists reading as the current gold standard. It was 100% and 94% for FLAIR and 81% and 98% for PD imaging, respectively. All of the new lesions not detected by the CAD software were less than 4 mm in size.

CONCLUSION
The utilization of CAD tools is relatively new in neuroimaging. The study suggests that our automated image registration and subtraction technique had high sensitivity and specificity for the detection of change in plaque burden, especially in FLAIR images. We believe that the higher sensitivity in FLAIR images was the result of higher inherent contrast and conspicuity of lesions compared with PD. One limitation identified during initial development was in the variability in overall signal intensity values from one study to another. Although these variations are minimized in clinical practice by adjusting window and level settings, we needed to develop...
op an algorithm to normalize pixel intensity values among studies. The current version of the CAD assumes identical acquisition protocols on follow-up scans. In addition, the analysis of thinner slice thickness with no gap using a volumetric acquisition protocol would likely increase our ability to more precisely register images. At present, differences are displayed only visually; we plan to implement fully automated quantitative analysis of plaque volume. Refinements and improvements to increase the accuracy of the tool are planned along with improvements in the display interface. Our subtraction CAD algorithm may ultimately increase accuracy and speed of interpretation, particularly for general radiologists and help clinicians visualize changes in the burden of disease “at a glance” in the clinic setting.

**KEY WORDS:** Computer aided detection, multiple sclerosis

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**Monday Morning**

**10:45 AM – 12:30 PM**

**Room 1**

(4d) Spine: Neoplasia, Trauma & Functional Imaging

(Scientific Papers 46 – 58)

See also Parallel Sessions
(4a) Head and Neck: Temporal Bone and Miscellaneous
(4b) Interventional: Aneurysms I
(4c) Adult Brain: New Techniques/Post Processing
(4e) Excerpta Extraordinaire: Adult Brain

Moderators: Robert M. Quencer, MD
Erin S. Schwartz, MD

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**Paper 46 Starting at 10:45 AM, Ending at 10:53 AM**

**Spinal Cord Intramedullary Tumor Microstructure: Emerging New Biomarkers on Diffusion Tensor Imaging and Tractography for Characterization**

Vadapalli, R.1 · Rammohan, V.2 · Perera, S.1 · Manas, P.3

1Asiri Surgical Hospitals, Colombo, SRI LANKA, 2Vijaya Diagnostics and Research Hyderabad, Hyderabad AP India, INDIA, 3Nizam’s Institute of Medical Sciences, Hyderabad AP India, INDIA

**PURPOSE**

To assess the role of diffusion tensor imaging (DTI) indices and tractographic characteristics of intramedullary spinal cord tumors.

**MATERIALS & METHODS**

Thirty-two consecutive patients in the age range of 25-52 years and M:F ratio of 2:1 and 15 normal controls were included in the study after informed consent. All patients were examined on a 3.0T/1.5 T (17/15) using EPI DTI sequence (in addition to routine post ontrast tumor protocol) with a multichannel coil with sequence parameters as follows: TR9772 TE 88msec B values of 0 and 2000, 3000, 25 directions, matrix 256/256 SENSE factor of 2. The data then were processed using fiber tracking software. Clinical categories included astrocytomas (n=11), ependymomas (n=9), hemangioblastomas (n=3), metastases (n=7), cavernous angiomas (n=2). The data then were processed using fiber tracking software and FA maps were generated and measure over the tumor matrix, tumor periphery at the cord tumor interface.

**RESULTS**

A rim of high FA value zone was seen bordering the cord tumor interface in ependymomas and hemangioblastomas (n=9) with sharp narrow transition zone of FA values with a mean of 0.57 called as High FA rind sign at both poles of the lesion with matrix FA and peritumoral FA ratio of >2. Astrocytomas (n=9) showed absent high FA rind all round with a wide transition zone of FA value loss at the cord and tumor interface with a mean of 0.21 with an advancing edge pattern with matrix FA and peritumoral FA ratio of <1. Metastases (n=4) showed no advancing edge pattern. Cord edema showed higher ADC and FA values than the tumor matrix (n=6) with partial interruption of high FA rind with matrix FA and peritumoral FA ratio of 1-1.5. All results were correlated with surgery and histopathology.
Figure A: 1-4 -Astrocytoma with wide transition zone of reduced FA values. With absent high FA rind sign at periphery at superior pole. Matrix FA and peritumoral FA ratio of <1 with tract infiltration at interface of cord and tumor.

CONCLUSION
High-resolution DTI helps to assess tumor microstructure with an emerging role to characterize intramedullary spinal cord tumors especially astrocytomas and ependymomas.

KEY WORDS: High FA rind sign, interface FA, matrix FA and peritumoral FA ratio

Paper 47 Starting at 10:53 AM, Ending at 11:01 AM
Proton MR Spectroscopy of Cervical Spinal Cord Tumors at 3 T
Vadapalli, R.1,2 · Pottal, K.2 · Mandapal, T.3 · Chinapuvvula, N.1
1Asiri Surgical Hospitals, Colombo, SRI LANKA, 2Vijaya Diagnostics and Research, Hyderabad AP, INDIA, 3MNH Cancer Hospitals, Hyderabad AP, INDIA

PURPOSE
To assess the role of MRS in the management and diagnostic characterization of cord tumors in cervical spine.

MATERIALS & METHODS
Twenty-two normal age- and sex-matched controls and 17 patients in the age range of 25 to 67 years with M:F distribution of 3:2 were included in the study. All the patients had undergone comprehensive tumor protocol (Localizer,T1 sag,T2 sag,T1 and T2 axial, STIR coronal, postcontrast T1 sag axial coronals) on a 3 T Philips Achieva System with a multichannel spine coil followed by 2D PRESS MR spectroscopy sequence single and multivoxel with following parameters: single voxel water suppression,TR 2000 TE 44 matrix 18x18. The spectral data for multivoxel were obtained from an 8 mL voxel (2 x 2 x 2 cm 2,000/144; 18 x 18 matrix size; slice thickness, 1 cm; 18 x 18 cm field of view. The MR spectra of intramedullary tumor categories astrocytomas (7), ependymomas (n=5), hemangioblastoma (n=2), metastases (n=3) were obtained from matrix and peritumoral zone from each case from the matrix and peritumoral zone as evident on postcontrast sequences. The spectra then were overlaid on postcontrast and T2 image data sets and following data were analyzed for ch/cr ratio, Lipid lactate resonances, NAA, myoinositol and color metabolite maps were generated.

RESULTS
The mean choline creatine ratio was 2.8. Choline/NAA ratio was 1.9. Myoinositol/choline ratio was 0.8. Lipids (n=2), aminoacids (n=3), lactate (n=7) peaks were identified and a tumor-specific metabolite map pattern was created. Matrix choline ann peritumoral zone choline ratio was >2 in ependymomas and hemangioblastomas, 1.3-1.8 in metastases with edema, <1 in astrocytomas.

CONCLUSION
Proton MR spectroscopy (single and multivoxel) at 3T can be used routinely as a mainstay tool in the diagnostic characterization and management of cervical cord tumors using matrix and peritumoral spectral metabolite ratios at 3 T.

KEY WORDS: MR spectroscopy, choline creatine ratio, PRESS sequence

Paper 48 Starting at 11:01 AM, Ending at 11:09 AM
Accuracy of On-Call Resident’s Interpretation of Total Spine MR Imaging Performed for Evaluation of Cord Compression
Booya, F. · Bhadelia, R. · Rojas, R. · Hochberg, A.
Beth Israel Deaconess Medical Center Boston, MA

PURPOSE
To evaluate the accuracy of on-call resident’s interpretation of total spine MR imaging performed for evaluation of cord compression.

MATERIALS & METHODS
We reviewed total spine MR cases performed from January 2007 to September 2008 in our emergency department requested for the evaluation of cord compression. We compared the preliminary reading provided by the on-call resident during off hours with the final reading by an attending. We recorded the accuracy of resident reading for evaluation of cord compression and other significant findings.

RESULTS
There were 66 cases that had preliminary reading provided by an on-call resident. Forty-six cases were performed for new onset neurologic symptoms, 13 for excruciating back pain, four for high risk spinal fractures, two cases for evaluation of metastatic disease and one case was performed for sudden loss of distal pulses. Resident readings were concordant with the final readings in 65/66 cases for cord compression. In four patients, significant findings were not called in the preliminary reading that affected subsequent clinical management. We recorded the accuracy of resident reading for evaluation of cord compression and other significant findings.
detect paraspinal masses (3) arachnoiditis (1) and bilateral hydronephrosis (1).

CONCLUSION
There is high degree of concordance between resident preliminary reading and final attending reading for evaluation of cord compression. However, in about six percent of cases resident readings did not include important spinal and extraspinal findings that affected subsequent clinical management. Elucidation of the patterns may prevent future occurrences.

KEY WORDS: Cord compression, spine MRI, wet read

Paper 49 Starting at 11:09 AM, Ending at 11:17 AM
Patterns of Epidural Spinal Disease on Axial Imaging: Malignant versus Nonmalignant Entities
Kim, D. H. · Lui, Y. W. · Miller, T.
Albert Einstein College of Medicine Montefiore Medical Center
Bronx, NY

PURPOSE
To compare axial CT and MR characteristics of patients with malignant and nonmalignant anterior epidural disease of the spine. In particular, to evaluate the relationship of such lesions to the posterior longitudinal ligament (PLL).

MATERIALS & METHODS
Patients were included who had epidural lesions in the anterior spinal canal determined by CT or MR imaging and underwent biopsy of the lesion with diagnostic histology and/or microbiology. Patients with nondiagnostic biopsies were excluded. Cross-sectional images were reviewed by a blinded observer. Patients were categorized into two groups based on the shape of the lesion and whether the normal anatomical attachments of the PLL were maintained. A chart review was performed including pathology and microbiology. Using histology as the gold standard, sensitivity and specificity were calculated for the axial imaging appearance of malignant epidural disease. Two-tailed Fisher exact test was used with a significance level of p<0.05.

RESULTS
Twenty-seven patients who had a diagnostic biopsy of epidural spine mass (16M, 11F, mean age 68). Fourteen patients had malignant epidural disease (2 renal cell, 1 CLL, 1 breast, 1 prostate, 5 lung, 1 multiple myeloma, 1 diffuse large B cell lymphoma, 1 poorly differentiated carcinoma NOS, and 1 thyroid.) Thirteen patients had nonmalignant epidural disease: 8/13 patients had hematoma by histology and 5/13 patients had spinal infection by microbiology. Two patients were evaluated by contrast-enhanced CT and 25 patients were evaluated by contrast-enhanced MR imaging. Ten of 14 patients with biopsy proved malignant anterior epidural disease and zero of 13 patients with nonmalignant disease were found to have epidural lesions that respected the normal anatomical attachments of the PLL. Lesions that respected the attachments of the PLL had a characteristic “curtain” appearance. In our sample, this appearance yielded sensitivity of 71% and specificity of 100% for malignant epidural disease. The findings were statistically significant (p=0.0001.)

CONCLUSION
Epidural lesions of the anterior spinal canal that respect the normal anatomical attachments of the posterior longitudinal ligament have a characteristic “curtain” appearance on axial imaging. Preliminary data show this sign to be highly specific for neoplastic disease in this location and may assist in making correct preprocedural diagnoses.

KEY WORDS: Spine, epidural, neoplasm

Paper 50 Starting at 11:17 AM, Ending at 11:25 AM
Dynamic Contrast-Enhanced MR Imaging of Vertebral Bone Marrow: Evaluation of Hypervascular vs Hypovascular Metastases and Normal Marrow
Slater, G. M. · Karimi, S. · Peck, K. · Lis, E. · Bilsky, M. · Yamada, J.
Memorial Sloan Kettering Cancer Center
New York, NY

PURPOSE
Dynamic contrast-enhanced MRI (DCE MRI) of vertebal bone marrow, unlike perfusion imaging of the brain, is not a fully established investigative modality. A noninvasive evaluation of tumor vascularity could have significant implications for diagnosis, prognosis and treatment, particularly in the era of antiangiogenic therapy. A few prior studies have evaluated the utility of DCE MRI in malignant infiltration of the bone marrow. However, vascularity of the primary tumor was not a principal consideration. Our goal was to compare DCE MRI of hypovascular and hypervascular metastases using normal marrow as a control.

MATERIALS & METHODS
Twenty subjects referred for MR imaging of the spine underwent DCE MRI. T1 and T2 precontrast sequences were obtained. DCE MRI was performed using a T1-weighted fast gradient-echo sequence following rapid Gd-DTPA injection. Automated processing of dynamic images was performed using Matlab (Mathworks, MA). Perfusion indices, including peak enhancement, signal percentage change [signalmax-signalbase]/signalbase×100%, and enhancement slope [signalmax - signalbase]/time-rise were measured pixel by pixel (signalmax = maximum signal intensity; signalbase = baseline value; time-rise = contrast enhancement rise time). Patients were divided into three categories based on the appearance of their bone marrow and their primary tumor diagnosis: five hypervascular (renal, thyroid), five hypovascular (breast, prostate) and 10 normal marrow.

RESULTS
Enhancement signal percentage change of hypervascular and hypovascular tumors demonstrated statistically significant differences (p<0.05). A trend showing statistical differences was found using enhancement slope measurement (p<0.08). No significant enhancement signals were identified in normal marrow. Additionally, several patients demonstrated compression fractures, both osteoporotic and pathologic. Enhancement slopes were significantly different between pathologic and osteoporotic fractures. Biopsy results confirmed the pathologic diagnosis of several patients.
PURPOSE
Galveston, TX
University of Texas Medical Branch
Interpreted independently by a first year radiology resident

MATERIALS & METHODS
Records from 120 trauma patients from a level I trauma center were reviewed to determine if there is a discrepancy between the preliminary read by the on call second and third year radiology residents and final read by faculty in this retrospective study. Also, all 120 exams were reviewed and interpreted independently by a first year radiology resident and another faculty. The results of all four interpretations were compared to the gold standard for accuracy of interpretation. The gold standard, the final accurate read, was determined by two other faculty. All cervical spine studies were performed on a 64 multidetector CT scanner and the images were acquired at 0.6 mm and displayed at 2.5 mm axial images with coronal and sagittal reformatted views.

RESULTS
No difference is seen between the ER on-call resident and ER faculty for detection of cervical fractures when compared to the gold standard, both were 76.19% sensitive. No statistically significant difference was seen in the sensitivity of the second year radiologist and non-ER faculty with a sensitivity of 71.43% and 66.67%. When the ER resident and ER faculty were compared to the first year resident and non-ER faculty together there is a slight difference but the p-value is only 0.10. There is a difference between the ER on-call resident and first year resident. However, upon averaging the residents together and faculty together, no significant statistical difference is seen between the residents and faculty in detection of cervical fractures.

CONCLUSION
Upon averaging the two groups together, residents and faculty, no statistically significant difference is seen between the radiology residents and faculty in detection of the cervical spine fractures using a 64 multidetector CT scanner. There is a difference between the first year resident and the second year ER on-call resident which may be attributed to experience. At the current time, controversy exists on the overnight radiology coverage in the Emergency Room by residents. In our study we found no difference in detection of cervical spine fractures between the radiology resident and faculty. A second year radiology resident is sufficient to detect cervical fractures in the ER.

KEY WORDS: Cervical, spine, fracture

Paper 51 Starting at 11:25 AM, Ending at 11:33 AM
How Does Experience Affect Detection of Cervical Spine Lesions Using 64 Multidetector CT in the Emergency Room?

Praisoody, S. · Riascos, R. · Vu, L. · Uribe, T. · Nishino, T.
University of Texas Medical Branch
Galveston, TX

PURPOSE
To review how the experience level between a radiology resident and faculty affects identification of cervical spine fractures on a 64 multidetector CT scanner.

MATERIALS & METHODS
Records from 120 trauma patients from a level I trauma center were reviewed to determine if there is a discrepancy between the preliminary read by the on call second and third year radiology residents and final read by faculty in this retrospective study. Also, all 120 exams were reviewed and interpreted independently by a first year radiology resident and another faculty. The results of all four interpretations were compared to the gold standard for accuracy of interpretation. The gold standard, the final accurate read, was determined by two other faculty. All cervical spine studies were performed on a 64 multidetector CT scanner and the images were acquired at 0.6 mm and displayed at 2.5 mm axial images with coronal and sagittal reformatted views.

RESULTS
No difference is seen between the ER on-call resident and ER faculty for detection of cervical fractures when compared to the gold standard, both were 76.19% sensitive. No statistically significant difference was seen in the sensitivity of the second year radiologist and non-ER faculty with a sensitivity of 71.43% and 66.67%. When the ER resident and ER faculty were compared to the first year resident and non-ER faculty together there is a slight difference but the p-value is only 0.10. There is a difference between the ER on-call resident and first year resident. However, upon averaging the residents together and faculty together, no significant statistical difference is seen between the residents and faculty in detection of cervical fractures.

CONCLUSION
Upon averaging the two groups together, residents and faculty, no statistically significant difference is seen between the radiology residents and faculty in detection of the cervical spine fractures using a 64 multidetector CT scanner. There is a difference between the first year resident and the second year ER on-call resident which may be attributed to experience. At the current time, controversy exists on the overnight radiology coverage in the Emergency Room by residents. In our study we found no difference in detection of cervical spine fractures between the radiology resident and faculty. A second year radiology resident is sufficient to detect cervical fractures in the ER.

KEY WORDS: Cervical, spine, fracture

Paper 52 Starting at 11:33 AM, Ending at 11:41 AM
Mapping Human Spinal Cord Injury with Diffusion Tensor Imaging

Mathews, J. · Dresner, M. A. · Techavipoo, U. · Lai, S. · Schwartz, E. D. · Marino, R. · Harrop, J. · Flanders, A. E.
1 Thomas Jefferson University Hospital, Philadelphia, PA, 2 Philips Healthcare, Philadelphia, PA, 3 University of Pittsburgh Medical Center, Pittsburgh, PA

PURPOSE
Experimental and preliminary human studies have shown that cord diffusion characteristics have been shown to change markedly in the setting of spinal cord injury (1) and track with functional recovery in lesioned animals (2). It has been postulated that diffusion characteristics may prove to be a more reliable biomarker in assessment of human spinal cord function. The purpose of this study is to map diffusion characteristics of injured human spinal cord to physiologic dysfunction.

MATERIALS & METHODS
Sixteen patients were evaluated with MR imaging within 24 hours after sustaining acute traumatic spinal cord injury according to site clinical protocol. The patient cohort includ-
ed a range of neurologic deficits: ASIA A (6), ASIA B (3), ASIA C (3) and ASIA D (4). A multielement spine coil or a neurovascular array coil at 1.5T (Achieva, Philips Healthcare, Netherlands) was used. In addition to the standard clinical protocol, a rapid axial spin-echo, echo-planar imaging DTI acquisition (TR/TE: 2500/75 msec, FOV 22 cm, 4 mm slice) was performed sensitized to 6 directions (1) and employing four signal averages, using 128x128 resolution (0.95 mm voxels). The DTI sequence required less than four additional minutes of scan time and evaluated the entire length of the cervical spinal cord using 24 to 36 contiguous axial slices. The mean FA and apparent diffusion coefficient (ADC) from 2D regions of interest (ROIs) encompassing the entire cross-sectional area of the spinal cord were used for quantitative comparison at each of the slice locations. Slices were mapped to anatomical location and referenced against location of spinal cord edema. Values were compared to 12 normal control datasets and stratified by neurologic deficit.

Map of average ADC values in ASIA A SCI relative to normals.

RESULTS
The mean diffusion values stratified by each ASIA group (A-D) and normals (N) were - FA: (A) 0.64+/-0.07, (B) 0.62+/-0.07, (C) 0.59+/-0.07, (D) 0.64+/-0.07, (N) 0.57+/-0.08 and ADC: (A) 1.17+/-0.3, (B) 1.18+/-0.4, (C) 1.49+/-0.3, (D) 1.19+/-0.3, (N) 1.76+/-0.4. There was significant reduction in ADC values and elevation in FA values for the spinal cord injured patients in all four injury classifications relative to normals, (p<.001). Diffusion tensor imaging measures mapped to areas of spinal cord edema showed reduction in ADC.

CONCLUSION
Diffusion characteristics can serve as a physiologic surrogate for degree of functional deficit in spinal cord injury.

REFERENCES

KEY WORDS: Spinal cord injury, diffusion tensor imaging, functional recovery

Paper 53 Starting at 11:41 AM, Ending at 11:49 AM
Prospective Diagnosis of Vertebral Artery Fistula with CTA: A Quantitative Analysis of Relative Vascular Attenuation
Kilani, R. K. · Smith, L. O. · Powers, C. J. · Britz, G. W. · Enterline, D. S.
Duke University
Durham, NC

PURPOSE
The prospective diagnosis of arteriovenous fistula (AVF) by CTA or MRA can be difficult in the early posttraumatic period when the fistula may be small. We present a case of AVF diagnosed following a comminuted C2 fracture. We demonstrate how analysis of relative attenuation within the vertebral artery and adjacent venous structures in the setting of posttraumatic vertebral artery fistula yields predictive diagnostic information. These findings would allow for a prompt definitive diagnosis and therapeutic angiographic procedure while the fistula is small.

MATERIALS & METHODS
Quantitative analysis of a vertebral artery fistula resulting from a comminuted C2 vertebral fracture was performed. On CTA, mean region of interest attenuation measurements of the vertebral arteries, epidural venous plexus, bilateral paravertebral venous plexus, and bilateral internal jugular vein were obtained in the example fistula case and in 10 CTA controls with variable bolus timing. The control CTAs were divided into two groups: 1) well-timed predominantly arterial phase scans and 2) later acquisition scans with significant venous enhancement. Within each scan the attenuation values were normalized to allow for comparison of relative attenuations.

RESULTS
In the case of high vertebral artery fistula to the adjacent venous plexus, the attenuation within the injured vertebral artery and the adjacent epidural and ipsilateral paravertebral venous plexus is identical. The attenuation within these fistulized venous structures is 1.75 times greater than the ipsilateral jugular vein. The jugular vein is nearly identical in attenuation bilaterally. Additionally, the paravertebral venous structures on the side of the arterial injury were greater than two times the density of the contralateral side. In well-timed arterial phase control scans, mean normalized arterial attenuation is three times that of the jugular veins and four to eight times that of the venous plexus structures. The jugular veins were one and a half to three times denser than the epidural and paravertebral plexus in all cases. Paravertebral venous attenuation was not significantly asymmetric in any of the cases. In later acquisition control scans with more venous timing, mean normalized arterial attenuation is approximately equal to jugular veins. The mean normalized jugular venous attenuation ranged from 1.0 to 1.7 times denser than the epidural and paravertebral plexus in all of these cases. It was never less than that of the epidural or paravertebral plexus. Paravertebral venous attenuation was not significantly asymmetric in any of the cases. Venous reflux from contrast injection was observed in some scans of both control groups, but was easily identified.
CONCLUSION
Vertebral artery fistula produced a quantifiable pattern of relative vascular attenuation on CTA that was not reproducible on normal control scans, regardless of timing of the contrast bolus. In the setting of trauma, if venous plexus attenuation is equal to that of the vertebral artery or greater than that of the jugular veins, or if there is asymmetry of the paravertebral venous plexus at the level of a vertebral fracture, a fistula should be suspected. Noninvasive diagnosis of this lesion may allow for prompt treatment with endovascular therapy.

KEY WORDS: Vertebral artery fistula, CTA, quantification

Paper 54 Starting at 11:49 AM, Ending at 11:57 AM
Gadolinium Enhancement of the Rat Sciatic Nerve after Crush Injury

Hill, B. J.
Jackson Memorial Hospital, University of Miami
Miami, FL

PURPOSE
Acute peripheral nerve injury is common after trauma, and often results in loss of function and/or the development of neuropathic pain. Recent advances in MR imaging allow for improved evaluation of peripheral nerve lesions. The goals of this study were to (1) determine whether acutely injured peripheral nerves demonstrate gadolinium enhancement on MR imaging, and if so, to (2) characterize the enhancement pattern over time.

MATERIALS & METHODS
In 20 male Sprague-Dawley rats, the sciatic nerve was exposed and crushed using jewelers forceps for 60 seconds. Animals were longitudinally imaged on a 4.7 T magnet up to 21 days after injury. T1- and T2-weighted imaging was performed both before and after the administration of gadolinium contrast agent.

RESULTS
During the first 2 days after injury, no gadolinium enhancement was observed. By day 3, intense gadolinium enhancement was observed in the injured nerve in the region of, and distal to, the site of injury. This contrast enhancement peaked at 7 days and persisted up to 21 days after injury.

CONCLUSION
Gadolinium enhancement occurs in acutely injured peripheral nerves, and is presumed to represent breakdown of the blood-nerve barrier. Enhancement data could prove useful in the grading and management of traumatic peripheral nerve injury.

KEY WORDS: Sciatic, enhancement, crush

Paper 55 Starting at 11:57 AM, Ending at 12:05 PM
Measuring Diffusion Tensor Metrics of the Cervical Spinal Cord at 3 T: Axial versus Sagittal Imaging Planes

Mueller-Mang, C.1 · Koelblinger, C.1 · Mang, T.1 · Law, M.2 · Thurnher, M.1
1Medical University of Vienna, Vienna, AUSTRIA, 2Mount Sinai Medical Center, New York, NY

PURPOSE
Diffusion tensor imaging (DTI) of the cervical spinal cord is performed increasingly with the use of either axial or sagittal DTI technique. The purpose of this study was to compare fractional anisotropy (FA) and apparent diffusion coefficient (ADC) values of healthy subjects who underwent both axial and sagittal DTI of the cervical spinal cord.

MATERIALS & METHODS
Twenty healthy volunteers (8 males, 12 females) underwent MR imaging at 3.0 T. Both transverse and sagittal DTI were performed using single-shot spin-echo echo-planar imaging. At C2-3 level in both axial and sagittal images average FA and ADC were calculated within three regions of interest (ROIs) at central, right, and left white matter regions of the spinal cord. For statistical analysis, a multivariance test and a paired student t test were performed (p< .05 was considered statistically significant).

RESULTS
The mean FA values with axial DTI were 0.65±0.05 (right ROI), 0.76±0.04 (central ROI), and 0.67±0.06 (left ROI), respectively. The mean FA values with sagittal DTI were 0.68±0.08 (right ROI), 0.67±0.12 (central ROI), and 0.70±0.1 (left ROI), respectively. The FA values of the central cord were significantly higher with axial imaging than with sagittal imaging (p=0.01). The ADC values were not significantly different between axial and sagittal DTI. Standard deviations (SDs) of FA and ADC values were significantly higher with sagittal DTI in all measured regions, except for the FA value of the central ROIs.

CONCLUSION
Fractional anisotropy values of the cervical spinal cord were significantly higher with axial DTI than with sagittal DTI in the central cord. Given the higher SDs of FA and ADC values with sagittal DTI in all measured regions, axial DTI may
provide more accurate values and may be more desirable for comparative studies between patients and healthy controls.

**KEY WORDS:** Diffusion tensor imaging, fraction anisotropy, apparent diffusion coefficient

**Paper 56 Starting at 12:05 PM, Ending at 12:13 PM**

**Diffusion Tensor Imaging Can Help Evaluation of Cervical Spondylotic Myelopathy**

Kouo, T. · Holly, L. · Sayer, J. · Salamon, N.
David Geffen School of Medicine, University of California Los Angeles
Los Angeles, CA

**PURPOSE**
Cervical spondylotic myelopathy (CSM) is a common and disabling condition causing significant morbidity in the United States. Currently, conventional MR imaging utilizing T1- and T2-weighted sequences enables evaluation of the presence and degree of cervical spinal canal stenosis and spinal cord signal abnormality reflecting cord injury. However, many patients without cord signal abnormality may present with severe clinical disability. The appropriate time of intervention is still difficult to assess by conventional imaging. Diffusion tensor imaging has been utilized to evaluate tissue microstructure in a variety of pathologic processes. The purpose of this study was to evaluate spinal cord integrity using DTI parameters, apparent diffusion coefficient (ADC) and fractional anisotropy (FA), in patients with symptomatic CSM. Furthermore, DTI parameters were compared to conventional MR imaging to determine if changes in DTI parameters may allow for earlier detection of spinal cord changes and impending irreversible injury, thus enabling earlier intervention.

**MATERIALS & METHODS**
Twenty-five patients with clinical and radiographic evidence of CSM were prospectively enrolled. All patients underwent functional assessment using Japanese orthopedic scale and MR imaging. Sagittal T1, T2 and Axial T2 and diffusion tensor imaging were obtained. An axial 2D EPI based diffusion-weighted sequence (Siemens Sonata 1.5 T, Slice thickness 2mm) was acquired with diffusion gradients along six directions at two b values of b=0 and 600 sec/mm². Regions of interest (ROIs) were measured at four locations: lower medulla, cervical spine proximal to maximal stenosis, level of maximal stenosis, and distal to maximal stenosis.

**RESULTS**
Apparent diffusion coefficient was elevated at levels of maximal stenosis and proximally as compared with the medulla and distal to stenosis in patients with and without corresponding T2 signal abnormality. In patients with multifocal or long segment stenosis, ADC was higher proximally than at levels of maximal stenosis whereas in patients with focal stenosis, ADC was higher at the level of stenosis. In patients with T2 spinal cord signal abnormality, patients more often had higher ADC at the level of stenosis. FA was more reduced at the maximal level of stenosis than proximally in the majority of both patients with multifocal/long segment and focal stenoses. Similarly, in patients with T2 signal abnormality, a majority of patients demonstrated lower FA at the maximal level of stenosis than proximally.

**Key Words:** DTI, spinal cord, cervical myelopathy

**Paper 57 Starting at 12:13 PM, Ending at 12:21 PM**

**Withdrawn**

**Paper 58 Starting at 12:21 PM, Ending at 12:29 PM**

**Practical Diffusion Tensor Imaging of the Cervical Spinal Cord in Routine Clinical Practice**

Dresner, M. A. · Mathews, J. · Lai, S. · Flanders, A. E.

1Philips Healthcare, Philadelphia, PA, 2Thomas Jefferson University Hospital, Philadelphia, PA

**PURPOSE**
Conventional MR imaging is currently used to assess the integrity of the spinal cord and to measure and characterize the extent of spinal cord edema and hemorrhage. Prior work has shown that changes in diffusion anisotropy have a high correlation with functional recovery in experimentally produced SCI in animal models. Anisotropy has been shown to decrease markedly in SCI (1) and it increases proportionally with functional recovery in experimentally lesioned animals. We sought to test the feasibility of using diffusion tensor imaging (DTI) as a prognostic biomarker in spinal cord injury by establishing a streamlined protocol that could be performed without disrupting normal care.

**MATERIALS & METHODS**
Patients were scanned according to site clinical protocol, with either a multielement spine coil or a neurovascular array coil at 1.5 or 3T (Achieva, Philips Healthcare, Netherlands). Structural scans including T1- and proton density-weighted turbo spin-echo and fat-suppressed T2-weighted scans were performed in the sagittal plane. Axial scans included a fat-suppressed balanced scan, a T2-weighted scan and the DTI acquisition; additional sequences were added depending on the cause for MR imaging referral, such as a T2-weighted gradient-echo scan for trauma patients or contrast-enhanced scans for tumor patients. The DTI acquisition was approximately 90 seconds at 3T with sensitization to 15 directions and was 3:40 at 1.5T using six directions (1) and four signal averages, using 128x128 resolution (0.95 mm voxels). Data from the first 30 patients were included for analysis. Fiber tracking from a single 3D-connected seed was used for initial evaluation of the data quality; the mean FA and ADC from the resulting fiber bundles was used for comparison.

**RESULTS**
The FA values derived from fiber tracking using publicly available software (0.619 +/- 0.17) are commensurate with
PUBLISHED VALUES (1,2). FIBER TRACKING WAS POSSIBLE IN SCANS EVEN THOUGH THE SCANS WERE NOT RESPIRATORY- OR CARDIAC-GATED (3). THE PROTOCOL RESULTED IN HIGH SNR AND FEW EXAMS LOST DUE TO BULK MOTION ARTIFACT. CLINICAL IMAGES FROM TWO PATIENTS WITH PATHOLOGY ARE SHOWN WITH FIBER TRACKING RESULTS. SIGNIFICANT DIFFERENCES IN FA AND MEAN ADC WITHIN TRACTS WERE NOT DETECTED RELATIVE TO PATIENTS WITHOUT MR-VISIBLE PATHOLOGY, BUT ROI MEASUREMENTS ON THE WHOLE CORD MAY ELIMINATE THE SELECTION BIAS FOR INTACT FIBERS. FOLLOW UP OF THESE PATIENTS COULD ALSO HELP DETERMINE THE SENSITIVITY OF DTI- DERIVED PARAMETERS TO PATHOLOGY THAT IS NOT APPARENT ON STANDARD MR STRUCTURAL IMAGING.

CONCLUSION
With less than 4 additional minutes, DTI can be incorporated into routine clinical scanning and could provide another method for evaluation of SCI, leading to more functional assessment and greater potential for quantitation of therapy response.

REFERENCES

KEY WORDS: Spinal cord injury, diffusion tensor imaging

Monday Morning
10:45 AM – 12:30 PM
Room 12

(4e) Excerpta Extraordinaire: Adult Brain
(Scientific Papers 59 – 79)

See also Parallel Sessions
(4a) Head and Neck: Temporal Bone and Miscellaneous
(4b) Interventional: Aneurysms I
(4c) Adult Brain: New Techniques/Post Processing
(4d) Spine: Neoplasia, Trauma & Functional Imaging

Moderators: Joel R. Meyer, MD
John F. Hiehle, Jr, MD

Paper 59 Starting at 10:45 AM, Ending at 10:50 AM
Persistent Trigeminal Artery: In Situ Thrombosis and Associated Perforating Vessel Infarction
Gaughen, J. R. · Jensen, M. E. · Evans, A. J. · Mukherjee, S. · Raghavan, P.
University of Virginia
Charlottesville, VA

PURPOSE
To illustrate the rare occurrence of in situ thrombosis of a persistent fetal trigeminal artery and associated perforating vessels, with resultant brainstem infarction.

CASE REPORT
A 56-year-old male initially presented to his local emergency department with new onset of transient diplopia and right-sided numbness, with symptom resolution in 15 minutes. Physical and neurologic exam at the time of presentation was normal. MR imaging performed during his emergency room visit demonstrated small areas of restricted diffusion in the left ventral pons and left superior cerebellar peduncle, with MRA imaging demonstrating segmental narrowing of the mid basilar artery as well as a saccular outpouching arising from the distal genu of the cavernous segment of the left internal carotid artery. The patient was discharged to home on aspirin and Plavix with an appointment made with the Interventional Neuroradiology Clinic for further evaluation of the basilar artery stenosis. The patient returned to his local emergency department 2 days later, with recurrent diplopia, right-sided weakness, headache, and palpitations, which persisted. The patient subsequently was transferred to our institution for further evaluation and treatment as necessary. Physical exam performed upon arrival at our institution elicited horizontal nystagmus and diplopia, right hemisensory loss, rightward tongue deviation, decreased fine motor in the right hand, mild left arm dysmetria, a positive Romberg sign, and a positive Babinski sign.

IMAGING FINDINGS
MR imaging performed at this time demonstrated progressive areas of infarction in the left pons and midbrain. Unenhanced CT demonstrated areas of low density in the left midbrain and pons, with note made of a tubular structure coursing from the dorsal aspect of the left cavernous sinus to communicate with the basilar artery. CT angiography demonstrated a saccular outpouching arising from the dorsal aspect of the left cavernous internal carotid artery. Adjacent to the dome of this outpouching, there is a crescentic calcific and fibrofatty plaque. As seen previously, there was segmental narrowing of the mid basilar artery, beginning just distal to the anterior inferior cerebellar arteries. There was abnormal contour of the left wall of the basilar artery at the distal end of this narrowing, appearing to represent a truncated vessel, with a meniscus sign. The distal basilar artery was normal in caliber, with a normal appearance of the posterior cerebral and superior cerebellar arteries. Findings are most consistent with in situ thrombosis of a persistent left trigeminal artery, with associated left pontine and midbrain infarction.

SUMMARY
The persistent fetal trigeminal artery is the most common of the persistent carotico-basilar anastomoses. Although usual-
ly asymptomatic, the persistent fetal trigeminal artery can rarely result in various abnormalities including aneurysms, carotid cavernous fistulas, trigeminal neuralgia, isolated abducens nerve palsy, vascular steal, and hyperprolactinemia from compression of the pituitary gland. The abnormal communication between the anterior and posterior circulations can also lead to atypical distributions of embolic strokes. We believe this case to represent the unusual occurrence of in situ thrombosis of a persistent trigeminal artery, with associated infarction possibly related to occlusion of aberrant perforating branches arising from the PTA itself.

**Key Words:** Persistent trigeminal artery, cerebrovascular disease, intracranial atherosclerosis

**Paper 60 Starting at 10:50 AM, Ending at 10:55 AM**

**Imaging of Lower Motor Neuron Disease: A New Radiologic Sign**

Mohan, S.1 · Verma, A.2 · Jain, K. K.2 · Hui, F.1 · Kumar, S.2

1National Neuroscience Institute, Singapore, SINGAPORE, 2Sanjay Gandhi Postgraduate Institute of Medical Sciences, Lucknow, INDIA

**Purpose**

A disruption in signal from lower motor neuron (nerve cell in brain stem and spinal cord) leads to a disruption of control of movements in the arms, legs, chest, face, throat, and tongue, resulting in gradual weakening, muscle wasting, and fasciculations. The motor neuron diseases (MNDs) are a group of progressive neurologic disorders that destroy motor neurons. Common MNDs include amyotrophic lateral sclerosis, which affects both upper (nerve cells in the brain) and lower motor neurons. Progressive bulbar palsy and progressive muscular atrophy affects only the lower motor neurons of the brainstem and spinal cord respectively. These, and a group of other heterogeneous disorders involving only the lower motor neurons are collectively labeled as lower motor neuron disease (LMND). The diagnosis in this disease is made entirely on clinical and electromyographic criterion. Advanced MR imaging is however being increasingly used as a corroborative technique. The purpose of our study was to further enrich literature regarding the imaging findings in a group of established cases of LMND and to suggest a new imaging sign for further clinical use.

**Case Report**

We describe the MR imaging findings in a group of established cases of LMND (n=7) and describe a new sign, “The Spectacle Sign”, which we consistently observed in all patients.

**Imaging Findings**

MR imaging of the brain and spine was done in five male and two female subjects, diagnosed as LMND. The clinical and EMG criterion showed involvement of upper limb and girdle musculature in n=6, while initial involvement was of upper limb which was followed subsequently by involvement of lower limb and girdle in n=1. Imaging of the brain was normal in all cases. Symmetrical T2 hyperintensities were seen in the region of anterior horn cells in cervical spine at various levels. On coronal T2-weighted sequences these were seen as tram track type lesions with a “spectacle”-like appearance on axial T2 images.

**Summary**

Although the described findings have been mentioned by earlier workers also, we have tried to consolidate the observation into an organized nomenclature which may be of use in routine clinical practice.

**Key Words:** Lower motor neuron disease, spectacle sign, MR imaging

**Paper 61 Starting at 10:55 AM, Ending at 11:00 AM**

**Arterial Spin Labeled MR Imaging in Tumefactive Multiple Sclerosis**

Cuda, J.1 · Pollock, J.3 · Simonds, J.1 · Kraft, R.1 · Tan, H.1 · Maldjian, J.1 · Burdette, J.1

1Wake Forest University School of Medicine, Winston Salem, NC, 3Oregon Health and Science University, Portland, OR

**Purpose**

The tumefactive form of multiple sclerosis (MS) frequently is confused with a neoplastic process on conventional MR sequences. We present a spectrum of perfusion abnormalities associated with tumefactive demyelinating lesions using pulsed arterial spin labeled (PASL) perfusion MR imaging. Tumefactive MS lesions have not been evaluated previously with the PASL technique.

**Case Report**

We performed a 24-month retrospective analysis of MR exams in patients radiographically or clinically suspected to have multiple sclerosis. Of these 295 patients, five were clinically and radiographically suspected of having tumefactive MS by conventional imaging and also were evaluated by the PASL technique. Case 1: A 26-year-old female presented with acute onset of right leg weakness. Conventional imaging revealed two supratentorial lesions. The larger lesion located within the right periventricular parietal lobe, had incomplete ring enhancement, surrounding vasogenic edema, and mild diffusion restriction. PASL showed a ring of hyperperfusion within the adjacent white matter. The smaller lesion within the left parietal white matter strongly restricted diffusion, had minimal enhancement, and showed normal white matter perfusion on PASL. Case 2: A 38-year-old female presents with progressive left hemiplegia, dysarthria, and dysphagia. Three dominant lesions ring enhanced, restricted diffusion, and were associated with vasogenic edema. The largest lesion showed a rim of avid hyperperfusion on PASL. Biopsy revealed a demyelinating lesion. PASL demonstrated normal perfusion of the smaller left occipital and left perirarial rim enhancing lesions. Case 3: A 50-year-old female complained of long-standing numbness and tingling in her lower extremities. Conventional imaging showed patchy white matter disease with enhancement along the atrium of the left lateral ventricle. A larger ring enhancing lesion within the right parietal periventricular white matter did not restrict diffusion and was normal on PASL. Case 4: A 37-year-old male followed for a sellar/suprasellar dermoid with incidental ring enhancing lesion in the right parietal lobe periventricular white matter. The lesion restricted diffusion and measured 1.3 x 1.2 x 1.2 cm. PASL revealed a ring of hyperperfusion within the right parietal lobe white matter. A subsequent biopsy was consistent with demyelination and CSF was positive for oligoclonal
A 27-year-old HIV positive male presented with mental status changes, increasing seizure activity, and auditory hallucinations. Two years prior, he was diagnosed with chronic cryptococcal meningitis. Admission laboratory values indicated a positive response to antiretroviral medication with an increasing CD4 count. Cerebrospinal fluid was negative for gram stain, India ink, standard and fungal cultures, and acid fast bacilli. The patient underwent a brain biopsy for left temporal abnormality seen on admission MR imaging, with temporal hypo-perfusion and enhancing rim. A spectrum of perfusion abnormalities can be seen with demyelination ranging from hypoperfusion to hyper-perfusion. Hyper-perfusion is associated more frequently with diffusion restriction and ring enhancement.

**SUMMARY**

Demyelination-associated perfusion anomalies have been described. However, PASL offers a safe and reproducible means of acquiring physiologic perfusion information without the use of potentially dangerous contrast agents and ionizing radiation. A spectrum of perfusion abnormalities can be seen with demyelination ranging from hypoperfusion to hyperperfusion. Hyperperfusion is associated more frequently with diffusion restriction and ring enhancement.

**KEY WORDS:** PASL, demyelination, multiple sclerosis

**Paper 62 Starting at 11:00 AM, Ending at 11:05 AM**

**Highly Active Antiretroviral Therapy-Induced Immune Reactivation Inflammatory Syndrome in a Case of Cerebral Cryptococcoma**

Green, D. A.¹ · Imbesi, S. G.²

¹University of California San Diego HIV Neurobehavioral Research Center, San Diego, CA, ²University of California, San Diego Medical Center, San Diego, CA

**PURPOSE**

To describe the neuroradiographic findings of AIDS-related immune reactivation inflammatory syndrome (IRIS) in a case of cerebral cryptococcoma, a new entity following treatment with highly active antiretroviral therapy (HAART).

**CASE REPORT**

A 27-year-old HIV positive male presented with mental status changes, increasing seizure activity, and auditory hallucinations. Two years prior, he was diagnosed with chronic cryptococcal meningitis. Admission laboratory values indicated a positive response to antiretroviral medication with an increasing CD4 count. Cerebrospinal fluid was negative for gram stain, India ink, standard and fungal cultures, and acid fast bacilli. The patient underwent a brain biopsy for left temporal abnormality seen on admission MR imaging, with tissue demonstrating chronic cryptococcal meningitis, cryptococcal granulomatous encephalitis, and areas of focally impressive gliosis. After stabilization, patient was discharged home with double the Fluconazole antimicrobial regimen. The patient continued to deteriorate neurologically. He presented again 3 months later with similar complaint of mental status changes. The admission CD4 count showed continued interval improvement, now 208, representing an increase of more than 100 in the previous 4 months. Blood, urine and CSF cultures were all negative. The CSF CRAG (cryptococcal antigen) was 1:4, elevated but stable from prior measurements and consistent with chronic cryptococcal meningitis. A diagnosis of IRIS was made and patient was started on high-dose steroids, with subsequent clinical and radiographic improvement.

**IMAGING FINDINGS**

Initial MR imaging demonstrated a 5 cm cystic lesion in the left temporal lobe with nodular rim enhancement and surrounding vasogenic edema. Focal regions of T2 prolongation also were present in the right basal ganglia, compatible with gelatinous pseudocysts. MR spectroscopy demonstrated elevated lactate/lipid and decreased NAA and MR perfusion showed decreased CBV/CBF, suggestive of an infectious process. Despite doubling of antimicrobial therapy, repeat MR imaging 3 months later demonstrated interval increase in size and worsening enhancement of left temporal cystic lesion with new left to right midline shift of 7 mm due to significantly increased perilesional vasogenic edema. The diagnosis of IRIS was made and patient was placed on steroids. Follow-up MR imaging obtained 2 months later demonstrated marked interval improvement with decreased size of the left temporal cystic mass, decreased enhancement/edema, and nearly resolved midline shift.

**SUMMARY**

We present a case of left temporal cryptococcoma, with radiographic and clinical progression of disease despite improving immune status and negative CSF for active disease. The patient’s condition paradoxically worsened after a doubling of antimicrobial treatment and improved after the administration of steroids. IRIS occurs when HAART-treated AIDS patients recover immune function and then mount an inflammatory response against previously latent opportunistic pathogens. Early imaging and diagnosis are critical. This phenomenon most frequently occurs within weeks after initiation of HAART, but can be noted as late as 10 months after treatment. It is important for radiologists to recognize this entity given the now common use of HAART, and to understand/communicate that radiographic decline after initiation of HAART implies IRIS and not necessarily a failure of antimicrobial therapy. Immediate treatment with high-dose steroids may be life saving.

**KEY WORDS:** HAART, IRIS, cryptococcoma

**Paper 63 Starting at 11:05 AM, Ending at 11:10 AM**

**3T MR Spectroscopic Metabolite Biomarkers of Intracranial Abscesses**

Vadapalli, R.¹,² · Manas, P.³

¹Vijaya Diagnostics and Research Hyderabad, Hyderabad AP India, INDIA, ²Asiri Surgical Hospitals, Colombo, SRI LANKA, ³Nizam’s Institute of Medical Sciences, Hyderabad AP India, INDIA

**PURPOSE**

To evaluate the new generation biomarkers on MR spectroscopy for characterization of intracranial abscesses at 3 T.

**CASE REPORT**

A retrospective study of MR spectra of 54 patients in age range of 32-56 years, M:F ratio of 3:2 with surgically proved brain abscesses was done with IRB approval. All patients have earlier undergone a comprehensive brain infection pro-
Protocol on a 3 T MR Achieva XR system with a 8-channel head coil using DWI with ADC, T1, FLAIR, T2, postcontrast 3D T1, DTI, MR spectroscopy with 2D PRESS: TR 2000 TE with short TE of 35 msec and long TE of 144 and 288 msec, NEX:1, FOV:100mm, acquisition matrix:10x10. All data then were evaluated for following: 1. presence of acetate at 1.9ppm; 2. presence of aminoacids at .9ppm; 3. presence of succinate at 2.4ppm; 4. presence of lactate at 1.2 ppm; 5. presence of trehalose at 3.6ppm. Following ratios were calculated: succinate/acetcate ratio, trehalose/lactate ratio, acetate/AA ratio, succinate lactate ratio, lipid/acete ratio. Based on these ratios spectral patterns then were created called MRS-B (AnAB, MRS-Aerab), MRS-T: Tuberculous MRS-F (fungal), MRS-P (Parasitic).

**IMAGING FINDINGS**

MRS-B (An Aero, Aero) Bacterial abscesses (n=24): showed acetate, succinate, lactate and lipids. The biomarker ratios are as follows: acetate-succinate ratio>2-aerobic (acetate dominance), <2-anaerobic (succinate dominance). MRS-P Parasitic abscesses: (n=14): showed succinate and lactate and lipids, with a succinate/lactate ratio of 0.5. MRS-T Tuberculous abscesses (n=7) show a lipid dominance with lipid acetate ratio >2. No succinate, lipid lactate ratio of 1.5 showing a lipid dominance, with elevated choline in five cases. MRS-F Fungal abscesses (n=9): showed lactate, lipids, trihalose with a lactate trihalose ratio of 1.8 to 2.0.

**SUMMARY**

Intracranial abscess Imaging with MRS at 3 T with aid of new generation spectroscopic biomarkers adds characterization information of abscesses of varied pathologies.

**KEY WORDS:** MRS, abscesses, biomarkers

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**Paper 64 Starting at 11:10 AM, Ending at 11:15 AM**

**Intracranial Foreign Body Granuloma Mimicking a Brain Tumor**

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1Khon Kaen University, Khon Kaen, THAILAND, 2University of California San Diego Medical Center, San Diego, CA

**PURPOSE**

To present a rare case of intracranial foreign body granuloma with CT and MRI findings that mimic a brain tumor.

**CASE REPORT**

A 52-year-old woman presented with 2 weeks of severe headache and bowel-bladder dysfunction, but no neurologic deficit on physical examination. She had no history of any underlying systemic disease or immunosuppressive therapy. She had previous traumatic brain injury 4 years ago and underwent a craniotomy with clot removal in the left frontal region. CT and MR imaging of the brain were performed. Imaging Findings CT demonstrated a large hyperdense mass lesion involving left frontal region with dense enhancement on postcontrast study, and encephalomalacia in the right frontal lobe from previous traumatic brain injury. MR imaging exhibited a densely enhancing mass lesion with a small central nonenhancing area, adjacent dural thickening on postcontrast study, and extensive white matter edema with subfalcine brain herniation on FLAIR images. High-grade glioma and meningioma were included in primary diagnosis. The patient had a craniotomy with tumor removal. A hardened mass was found, mainly extraxial but with adhesions to brain cortex. No fluid or pus could be aspirated from the central cavity. Microscopic examination confirmed granuloma with granulation tissue, mixed acute and chronic inflammation, fibrosis and suture material. Her headache resolved after the operation.

**SUMMARY**

Although rare, foreign body granuloma should be considered and included in the differential diagnosis for patients who present with a mass lesion if they have had a prior cranioto-
Central restricted diffusion in a peripherally enhancing intracranial mass has been the hallmark for the MR diagnosis of bacterial brain abscess. However, more recently investigators have found that certain fungal brain may restrict diffusion either eccentrically in the intracavitary projections of the fungal elements or more centrally, albeit often in a more patchy pattern. In our case we observed a large multiloculated peripherally enhancing lesion with restricted diffusion centrally and in the loculated portions. In patients immunosuppressed by chronic steroid use, long-term antibiotic therapy or underlying systemic diseases who develop acute neurologically symptoms and who exhibit these MR and diffusion features, we suggest inclusion of a fungal abscess in the differential diagnosis and the entertainment of a rare infection with fungi such as cladophialophora bantiana to ensure that efficacious medical therapy is instituted.

**IMAGING FINDINGS**

This 42-year-old female developed an acute onset of right hemiparesis and aphasia 1 week prior to admission at an outside hospital. Pertinent past history included chronic steroid usage for systemic lupus erythematosus, chronic renal failure and a triple antibiotic regimen for treatment of an atypical mycobacterial infection (the latter diagnosed 1 month earlier). After imaging identification of an intracranial lesion, the patient was transferred to our institution. On MR imaging a large multiloculated ring enhancing mass was identified with thick irregular peripheral enhancement in the left frontal lobe, surrounded by extensive edema. The periphery of the lesion was isointense to gray matter on the T2-weighted with contrast and with DWI/ADC imaging. Diagnosis was established by surgical resection and pathologic identification via culture.

**SUMMARY**

Central restricted diffusion in a peripherally enhancing intracranial mass has been the hallmark for the MR diagnosis of bacterial brain abscess. However, more recently investigators have found that certain fungal brain may restrict diffusion either eccentrically in the intracavitary projections of the fungal elements or more centrally, albeit often in a more patchy pattern. In our case we observed a large multiloculated peripherally enhancing lesion with restricted diffusion centrally and in the loculated portions. In patients immunosuppressed by chronic steroid use, long-term antibiotic therapy or underlying systemic diseases who develop acute neurologically symptoms and who exhibit these MR and diffusion features, we suggest inclusion of a fungal abscess in the differential diagnosis and the entertainment of a rare infection with fungi such as cladophialophora bantiana to ensure that efficacious medical therapy is instituted.
lesions, multifocal lesions are more common at presentation than a single lesion. Lesions had an irregular enhancement pattern and were predominantly supratentorial involving the cortical/subcortical and periventricular regions consistent with the literature. Literature pertaining to the MR imaging signal characteristics of CNS PTLD is incomplete; however, the lesions in our case closely followed the signal characteristics of primary CNS lymphoma in HIV/AIDS patients. The lesions were hyperintense on T2 and isointense to hypointense on T1-weighted sequences. Interestingly as the disease progressed several lesions became moderate to markedly hyperintense on the precontrast T1 sequence. The hyperintense T1 signal has been noted in the literature and may be secondary to hemorrhage. Hypercellularity was likely responsible for the isodense appearance on CT and mild hyperintensity on diffusion-weighted imaging. Vasogenic edema surrounding the enhancing lesions was manifested by T2 hyperintensity on MR imaging and hypodensity on CT.

**SUMMARY**

The diagnosis of CNS PTLD can be elusive to both the radiologist and pathologist. The radiographic findings are nonspecific and overlap encephalitis, vasculitis, and septic emboli. If a transplant recipient on immunosuppressive therapy presents with a new neurologic deficit and has imaging features as previously described then CNS PTLD should be considered.

**Key Words:** Posttransplant, lymphoproliferative, central nervous system

**Paper 67 Starting at 11:25 AM, Ending at 11:30 AM**

**Metastatic Renal Cell Carcinoma to a Meningioma**

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Spedali Civili Brescia

Brescia, ITALY

**Purpose**

Tumor-to-tumor metastasis is a rare event. Despite the low rate of occurrence, meningioma is the most common primary intracranial tumor to harbor metastases, the majority of which arise from breast and lung carcinomas. Although such cases already have been described, only few reports included imaging descriptions. We present the case of a metastatic renal cell carcinoma to an intracranial meningioma and describe imaging changes after 15 months.

**Case Report**

A 68-year-old man with a left frontal meningioma presented with progressing aphasia and depression in October 2006. The patient had a history of renal cell cancer, which was resected in 1999. MR imaging showed enlargement of the meningioma, with remarkable peritumoral edema. The tumor was removed surgically and pathologic examination revealed that clear cell carcinoma with widespread necrosis occupied the majority of the lesion and meningothelial meningioma was identifiable only at the peripheral rim. The patient had also metastases to mediastinum and chemotherapy was performed. No recurrence in the brain is found till now.

**Imaging Findings**

The first MR imaging showed a left frontal meningioma which was typically isointense to gray matter on T1- and T2-weighted images, with homogeneous enhancement, with “dural tail” sign and absent peritumoral edema. After 15 months the lesion was markedly enlarged with surrounding edema. On T2-weighted images the signal intensity became inhomogeneous with multiple intra and peritumoral flow voids and a central hyperintense area was identifiable with no enhancement after contrast administration, suggesting the development of intratumoral necrosis.

**Summary**

We present the case of metastatic renal cell carcinoma to a meningioma in which significant imaging changes had occurred. On the follow up of a patient with an intracranial meningioma and a history of malignant disease, changes in imaging findings may suggest the development of tumor-to-tumor metastasis.

**Key Words:** Tumor-to-tumor metastasis, meningioma, intratumoral flow voids

**Paper 68 Starting at 11:30 AM, Ending at 11:35 AM**

**Metastatic Intracranial Leiomyosarcoma Mimicking a Meningioma**

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Dearborn, MI

**Purpose**

We present a unique case of metastatic intracranial leiomyosarcoma in a patient with acquired immunodeficiency syndrome (AIDS), which mimicked a meningioma. Neuroradiologists should be familiar with imaging characteristics of this rare tumor and its similarities to meningiomas when evaluating patients with AIDS and intracranial lesions.

**Case Report**

A 35-year-old African American woman with AIDS presented to the ER with right hemicranial headaches beginning 1 month previously, along with nausea, photophobia and diplopia. Physical examination revealed decreased light touch sensation involving the right cheek. Noncontrast CT of head demonstrated a hyperdense mass at the temporal apex extending into the cavernous sinus. The patient was admitted to the hospital for further work up. Follow-up MR imaging with gadolinium contrast was performed and demonstrated a homogeneously enhancing lesion abutting the cavernous sinus along the tentorial edge continuing into the posterior fossa without an obvious dural tail. The lesion was felt to represent a meningioma or possibly lym-
phoma. Neurosurgery proceeded with operative intervention, describing mass as being separate from the dura, in region of the floor of the lateral aspect of the cavernous sinus, and not having the appearance of lymphoma or abscess. Pathology originally submitted was read as a meningioma, WHO grade I. Interestingly, subsequent CT of the abdomen for work up of abdominal pain demonstrated multiple hypodense masses within the liver as well as right adrenal gland. Liver and right adrenal gland biopsy revealed leiomyosarcoma in both organs. In retrospect, the pathologist confirmed that the previously diagnosed meningioma was actually a leiomyosarcoma involving the dura.

**IMAGING FINDINGS**
Noncontrast CT demonstrating hyperdense mass at the temporal apex extending into the cavernous sinus. Postgadolinium T1-weighted axial image demonstrates homogenous enhancement of the mass.

**SUMMARY**
Metastatic leiomyosarcoma presenting in the central nervous system are rare(1,2). There has been an increasing incidence of malignant LMS in immunocompromised patients(3). This case was interesting because it demonstrates how AIDS associated LMS from elsewhere in the body can present in a unique location mimicking a meningioma on imaging as well as pathology.

**REFERENCES**

**KEY WORDS:** Leiomyosarcoma, acquired immunodeficiency syndrome, intracranial
SUMMARY
Supratentorial hemangioblastomas are rare but have been reported in the cerebral hemispheres and within the ventricular system. Hemangioblastomas of the pituitary gland, meninges, corpus callosum and basal ganglia also have been reported. Sellar hemangioblastomas have been reported both in patients with and without von Hippel Lindau disease. Although only 20% of hemangioblastomas occur in patients with von Hippel Lindau disease, atypical locations of hemangioblastomas are more likely in these patients. In short, we present an unusual case of a hypervascular sellar hemangioblastoma with arteriovenous shunting in a patient without any clinical or radiographic stigmata of von Hippel Lindau disease which was subtotally resected secondary to its relationship to the anterior cerebral arteries and optic chiasm and complicated by intraoperative bleeding.

KEY WORDS: Hemangioblastoma, sella turcica

Paper 70 Starting at 11:40 AM, Ending at 11:45 AM
Sphenoid Bone Extensive Cavernous Hemangioma Presenting During Pregnancy
Robertson, H. · Rincon-Rosenbaum, C. · Jain, M.
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PURPOSE
Cavernous hemangioma primarily involving bone of the skull base is very rare. A patient with extensive sphenoid bone involvement with symptoms first noted during pregnancy is presented.

CASE REPORT
A 23-year-old previously healthy female first noted persistent headache early in the second trimester of her first pregnancy. Headache became severe and she noted progressive decrease in left eye vision. A CT brain scan obtained after a normal obstetric delivery showed infiltrative neoplasm of the body of the sphenoid bone. Attempted biopsy resulted in severe hemorrhage. Endovascular embolization of the tumor blood supply was done and subsequent transnasal deep anterior sphenoid bone biopsy resulted in a pathologic diagnosis of cavernous hemangioma. Biopsy excluded other aggressive neoplasms including hemangiendothelioma, histiocytosis, sphenoid sinus carcinoma and metastasis.

IMAGING FINDINGS
CT brain scan showed diffusely infiltrating contrast enhancing neoplasm with coarse bone trabeculae and bone expansion throughout the body of the sphenoid bone, clivus and proximal lesser wings and pterygoid processes. MR brain scan showed tumor extension into left posterior ethmoid air cells and throughout the sphenoid sinuses. Tumor extended through thinned bone onto the planum sphenoidale, around the left optic nerve and into submucosal tissues in the roof of the nasopharynx. The cavernous sinuses were displaced laterally with internal carotid arteries encased. The tumor blood supply at selective angiography was from bilateral ascending pharyngeal and sphenothmoidal arteries.

SUMMARY
Aggressive, rapidly expanding cavernous hemangioma involving much of the sphenoid bone with extension into adjacent tissues first became symptomatic in early second trimester of pregnancy. Endocrine changes during pregnancy previously have been noted to cause expansion of extraosseous cavernous sinus and vertebral cavernous hemangiomas.

KEY WORDS: Sphenoid bone, hemangioma, pregnancy

Paper 71 Starting at 11:45 AM, Ending at 11:50 AM
Posterior Fossa Hemangioblastoma Presenting as Acute Intracranial Subarachnoid Hemorrhage: Report of Two Cases
Fenton, D.1 · Heran, M.2 · Kavanagh, E.2 · Zakus, P.3 · Graeb, D.2
1St. Pauls Hospital, Vancouver, BC, CANADA, 2Vancouver General Hospital, Vancouver, BC, CANADA, 3University of British Columbia, Vancouver, BC, CANADA

PURPOSE
We present two unusual cases of posterior fossa hemangioblastomas presenting as acute intracranial subarachnoid hemorrhage.

CASE REPORT
Case 1. A 55-year-old woman presented to our institution with acute severe headache, meningismus, and right arm and leg weakness. Case 2. A 65-year-old male was transferred to our institution with a diagnosis from an outside hospital of acute subarachnoid hemorrhage.

IMAGING FINDINGS
Case 1: Noncontrast computed tomography (CT) scan of the head demonstrated focal acute subarachnoid blood posterior to the right dorsal medulla. The provisional diagnosis was a
ruptured right posterior inferior cerebellar artery (PICA) aneurysm. A CT angiogram (CTA) was performed. This showed an oval focus of enhancement in the region of hemorrhage; however, it also demonstrated the presence of two additional densely enhancing foci in the left cerebellum. A catheter angiogram was performed. This demonstrated three highly vascular nodular masses, with lacy internal vascular architecture, prolonged tumor blush and arteriovenous shunting. The feeding arteries for these lesions arose from the right PICA, left superior cerebellar artery and the left anterior inferior cerebellar artery (AICA) respectively. An MR imaging demonstrated two additional small lesions not seen on CTA or catheter angiography. A diagnosis of multiple cerebellar hemangioblastomas was made.

Case 2: Noncontrast CT of the head demonstrated a massive posterior fossa subarachnoid hemorrhage with a large volume of intraventricular blood in the fourth, third and lateral ventricles, as well as acute hydrocephalus. CT angiography revealed an ovoid extraaxial lesion immediately posterior to the medulla, demonstrating dense contrast enhancement. Catheter angiogram showed a vascular tumor blush at the level of the foramen magnum, fed by a tiny serpiginous artery arising from the left vertebral artery proximal to the PICA. Arteriovenous shunting was identified as a network of tiny early-draining veins draining towards the right internal jugular vein. A diagnosis of hemangioblastoma was made.

SUMMARY
Both of our patients presented with relatively small tumors. In this circumstance, subarachnoid hemorrhage may be indistinguishable from aneurysmal bleeding on noncontrast CT. Suspicion may be raised by an atypical location of blood. CT angiography may suggest the correct diagnosis by demonstrating a lacy tumor blush as well as small feeding arteries and draining veins. MR imaging has the highest sensitivity for small lesions and may demonstrate lesions not seen on noncontrast CT or CTA. Subtle intrasional flow voids as well as the feeding artery and draining vein may be appreciated, but can be mistaken for an arteriovenous malformation. The artery and vein of an AVM usually are enlarged due to the high flow state, which can be a distinguishing feature. Catheter angiography is the most specific modality for identifying vascular tumors due to its high spatial resolution, but this may not be necessary with high quality MRI/MRA or CT/CTA. Tissue diagnosis is necessary to definitively distinguish between hemangioblastoma and other vascular lesions such as metastases or vascular malformations. To our knowledge these are the first reported cases of intracranial subarachnoid hemorrhage resulting from posterior fossa hemangioblastomas.

KEY WORDS: Hemangioblastoma, subarachnoid hemorrhage

Case Report
The patient is a 43-year-old female complaining of 1-year history of headaches which worsened over a month before presentation. The patient had no neurologic deficits on physical exam. No hormonal deficits were identified.

IMAGING FINDINGS
The initial MR imaging showed an 8 mm enhancing lesion centered in the hypothalamic region extending to the pituitary stalk and superior extension to the recess of the third ventricle. The pituitary gland was normal and separate from the lesion. The mass was isointense to gray matter on T1- and T2-weighted images. Over the course of 1 year, follow-up MR imaging showed minimal interval enlargement of the lesion by a few millimeters without evidence of hydrocephalus. The patient underwent subtotal resection of the lesion and the patient’s headaches resolved.

SUMMARY
Ganglioneurocytomas are a rare variant of central neurocytomas and have histological characterizations of neurocytomas with ganglioid differentiation. These lesions are treated with surgical resection and are thought to have a favorable prognosis. Ganglioneurocytomas frequently present as cystic extraventricular masses usually intraparenchymal in
KEY WORDS: Ganglioneurocytoma

SUMMARY
We demonstrate the CT, CT perfusion and MR imaging findings of RFGNT, a newly defined and rare central nervous system tumor. Although a rare entity, one should be aware of RFGNT when considering the differential diagnoses of midline posterior fossa tumors in young adults.

KEY WORDS: Rosette-forming glioneuronal tumor, posterior fossa

Paper 74 Starting at 12:00 PM, Ending at 12:05 PM
Subarachnoid Hemorrhage: An Unusual Presentation of Pituitary Apoplexy

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PURPOSE
To report unusual presentation of pituitary macroadenoma as subarachnoid hemorrhage.

CASE REPORT
A 73-year-old African American female, presented to the emergency department, with 2 days of moderate constant frontal headache unassociated with fever, vision changes, and focal weakness. Her other pertinent medical history included recently diagnosed sellar/suprasellar mass at brain MR imaging at outside institution and final report and images were not available for evaluation at this hospital visit. Initial head CT in ER demonstrated 1.9 cm peripherally calcified soft tissue mass in the sellar/suprasellar region, with absence of the right carotid canal medial wall. Primary differential consideration was carotid artery aneurysm along with other considerations such as macro adenoma, craniopharyngioma, etc. However, patient's headache worsened while in hospital. A repeat head CT after 3 days again demonstrated suprasellar region mass along with new small preoptic and left ambient cistern subarachnoid hemorrhage, and was thought to be aneurysm rupture. Subsequent brain/sellar MR imaging and MRA demonstrated a sellar and suprasellar mass with peripheral enhancement and central heterogeneous signal intensity with susceptibility artifact suggesting central blood products. Also, large subarachnoid hemorrhage was noted in basilar cisterns and posterior fossa.

Head MRA demonstrated normal caliber intracranial internal carotid arteries with no evidence of aneurysm. In the mean time, comparison with outside MR demonstrated interval change from a large heterogeneous, diffusely enhancing sellar/suprasellar mass to mass with only peripheral nodular enhancement and central susceptibility artifacts and subarachnoid hemorrhage. Transsphenoidal surgery was performed for pituitary adenoma resection.

IMAGING FINDINGS
MR imaging demonstrated interval change from a large heterogeneous, diffusely enhancing sellar/suprasellar mass to mass with only peripheral nodular enhancement and central susceptibility artifacts and subarachnoid hemorrhage.

SUMMARY
We report a rare case of pituitary apoplexy with subarachnoid hemorrhage. Patient was considered as case of giant cavernous internal carotid artery aneurysm given subarachnoid hemorrhage and peripheral calcification. However, a normal MR angiogram and comparison with prior MR imaging confirmed the diagnosis, which demonstrated interval change from a large heterogeneous, diffusely enhancing sellar/suprasellar mass to mass with only peripheral nodular enhancement and central susceptibility artifacts and subarachnoid hemorrhage.

KEY WORDS: Pituitary apoplexy, subarachnoid hemorrhage
Opposite Cerebral Dominance for Reading and Sign Language

Komakula, S. T. · Burr, R. B. · Lee, J. N. · Anderson, J.
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Salt Lake City, UT

PURPOSE
We present a case of right hemispheric dominance for American sign language (ASL) but left hemispheric dominance for reading, in a deaf patient with epilepsy and left mesial temporal sclerosis. Atypical language laterality for ASL was determined by preoperative fMRI, and confirmed by WADA testing, and suggests that preoperative fMRI evaluation of ASL patients should include both reading and ASL evaluations.

CASE REPORT
A 15-year-old left-handed patient with refractory seizures and deafness was referred for preoperative mapping. The patient was developmentally normal until an episode of spinal meningitis and febrile seizures at age 15 months. Because of the ensuing deafness, she never regained oral speech and learned ASL. Current seizure frequency was estimated at two to three events per week. Video EEG monitoring did not show an identifiable seizure focus. Structural MR imaging revealed left mesial temporal sclerosis.

IMAGING FINDINGS
Functional MR imaging was performed at 3 T with block design paradigms that included: Passive story watching (ASL): The patient was shown a videotape of a story presented by ASL. Activation occurred within the right superior and middle temporal gyri and temporoparietal junction. Object/Action description (ASL): Activation occurred within the right superior and middle temporal gyri and temporoparietal junction (Figure 1). Sentence completion (Reading): Activation occurred in the bilateral inferior occipital poles, with lesser activation in the left temporoparietal junction, and absence of Broca’s area activation (Figure 2). Strong activation of right Wernicke’s area with little left-sided activation for ASL tasks and left lateralization for reading indicates crossed hemispheric dominance for ASL and reading. The fMRI right hemisphere dominance for ASL also was congruent with WADA test findings and is likely a pattern reflective of cortical reorganization related to early childhood illness and left-sided cortical injury. Following left temporal lobectomy, the patient demonstrated no sign language aphasia.

SUMMARY
Although language dominance in ASL patients is typically ipsilateral to that for reading, this case demonstrates that ASL and reading functions can have crossed dominance, and preoperative mapping should be considered for lesions potentially involving language areas in deaf patients. This is particularly true for patients with deafness arising from cortical injury during a formative period for language development.

KEY WORDS: Sign language, fMRI, language dominance

Ischemic Injury of Facial Nerve Due to Penetration of Onyx into the Vasa Nervosa: Anatomical and Intraoperative Observations in a Patient with Embolized Carotid Cavernous Fistula

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PURPOSE
To define and review the vascular anatomy of the facial nerve as it relates to endovascular specialists and illustrate the mechanism of facial nerve injury after transarterial embolization of a cavernous carotid fistula (CCF) with Onyx liquid embolic system.

CASE REPORT
A 26-year-old man with an indirect right cavernous carotid fistula (CCF) underwent transarterial embolization with Onyx at an outside institution. He developed a House-Brackmann grade IV facial nerve paralysis soon after the embolization. CT of the skull base suggested Onyx penetration in the right facial nerve canal. No significant recovery of facial function occurred over the next 6 months, prompting a surgical exploration. Intraoperative findings and pictures captured via operative microscope reveal Onyx penetration into the vasa nervosa (Figure 1).

IMAGING FINDINGS
Available DSA images suggest that the middle meningeal artery was utilized for transarterial embolization of the CCF at the outside institution. He developed a House-Brackmann grade IV facial nerve paralysis soon after the embolization. CT of the skull base suggested Onyx penetration in the right facial nerve canal. No significant recovery of facial function occurred over the next 6 months, prompting a surgical exploration. Intraoperative findings and pictures captured via operative microscope reveal Onyx penetration into the vasa nervosa (Figure 1).
SUMMARY
Onyx is a recent addition to the armamentarium of neurointerventional specialists and has been gaining popularity in the treatment of dural arteriovenous fistulas. An interesting property of this agent is to penetrate into small arterial vessels, sometimes remote from the site of the fistula (or in case of AVMs, the nidus). This remote penetration can be prevented, or at least limited, by terminating the injection promptly when filling of any such nontarget vessels are noted. Knowledge of the facial nerve vascular anatomy and close attention to the Onyx cast pathway are important for avoiding or reducing the extent of this type of injury.

KEY WORDS: Anatomy, facial nerve, Onyx

Paper 77 Starting at 12:15 PM, Ending at 12:20 PM
Signal Abnormalities in the Pontine Tegmentum on MR Imaging in a Patient with Paraneoplastic Opsoclonus-Myoclonus Syndrome

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1University of Antwerp, Antwerpen, BELGIUM, 2AZ KLINA, Brasschaat, BELGIUM

PURPOSE
Opsoclonus-myoclonus syndrome (OMS) is a rare neurologic disorder, which is characterized by chaotic eye movements and myoclonus; sometimes ataxia is present. It is associated with a variety of disorders, such as tumors (paraneoplastic) and infection. The syndrome may have an autoimmune pathophysiologic basis. Paraneoplastic OMS has been described in children with neuroblastoma; in adults, breast cancer and small-cell lung cancer are the most common primary tumors. Opsoclonus is the result of a dyskinesia of the saccadic oculomotor system consisting of three different neurons (burst, tonic, and pause cells), all located in the pontine tegmentum, more specifically in the paramedian pontine reticular formation. Only few cases with imaging abnormalities in the brain have been described. We report magnetic resonance (MR) imaging findings in a patient with paraneoplastic OMS.

CASE REPORT
A 49-year-old woman was referred for MR imaging of the brain because of progressive oscillopsia, dizziness and dysphagia. Anti-Ri antibodies in serum and CSF were markedly elevated, very suggestive for the presence of breast cancer. Mammography, however, was negative. CT of the thorax-abdomen as well as whole body FDG-PET were negative at that time. The patient’s symptoms improved with corticosteroids and plasma exchange. Three years later, the patient was diagnosed with bilateral breast carcinoma.

IMAGING FINDINGS
FLAIR- and T2-weighted sequences demonstrated high signal intensities in the tegmentum and periaqueductal gray matter. Diffusion-weighted imaging did not display diffusion restriction. There was no enhancement of the lesions after gadolinium injection.

SUMMARY
Opsoclonus-myoclonus syndrome may be the first manifestation of breast cancer and may precede the diagnosis of cancer by months or years and often have a rapidly progressive course. Most published cases show no imaging abnormalities. In our patient, MR imaging revealed nonspecific abnormalities in the pontine tegmentum which could explain the abnormal eye movements (opsoclonus) as a result of cross-reaction between neuronal antibodies and specific nerve cells.

KEY WORDS: Opsoclonus-myoclonus syndrome, MR abnormalities, paramedian pontine reticular formation

Paper 78 Starting at 12:20 PM, Ending at 12:25 PM
Case of Posterior Cerebral Artery Rete Mirabile

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PURPOSE
Rete mirabile, a physiologic network of arterial channels in lower mammals, is a rare anatomical variation in humans. Carotid and vertebral rete mirabile are well documented in literature. To our knowledge, rete compensation of posterior cerebral artery (PCA) has not been described. This article illustrates the angiographic features of this anatomical variation and explores the embryologic mechanisms.

CASE REPORT
A 49-year-old woman was referred for MR imaging of the brain because of progressive oscillopsia, dizziness and dysphagia. Anti-Ri antibodies in serum and CSF were markedly elevated, very suggestive for the presence of breast cancer. Mammography, however, was negative. CT of the thorax-abdomen as well as whole body FDG-PET were negative at that time. The patient’s symptoms improved with corticosteroids and plasma exchange. Three years later, the patient was diagnosed with bilateral breast carcinoma.

IMAGING FINDINGS
FLAIR- and T2-weighted sequences demonstrated high signal intensities in the tegmentum and periaqueductal gray matter. Diffusion-weighted imaging did not display diffusion restriction. There was no enhancement of the lesions after gadolinium injection.

SUMMARY
During fetal development, the origin of posterior cerebral artery circulation switches from internal carotid artery to the
basilar artery. It has been shown that the territory of the PCA is first provided by anterior choroidal artery and is later transferred to the cephalic end of the ipsilateral longitudinal neural artery (the future basilar artery) through the formation of a connection between the anterior choroidal artery and the posterior choroidal artery. It is possible that failure of development of this connection and the resulting variations in the embryologic anatomy lead to development of the posterior cerebral artery rete mirabile. As the P1 segment of the PCA is a portion of the posterior communicating artery distal to a connection with anterior choroidal artery, this remains normal, as illustrated by our case. Posterior cerebral artery rete mirabile is an exceptional anatomical variation and understanding the embryology is essential to make a diagnosis of this rare entity.

**KEY WORDS:** Posterior cerebral artery, rete mirabile, anatomy

**Paper 79 Starting at 12:25 PM, Ending at 12:30 PM**

**Gadolinium Encephalopathy Resulting from Accidental Intrathecal Administration**

Gibbs, W. N. · Opatowsky, M. J. · Bidiwala, S. B. · Massand, M. G.

Baylor University Medical Center
Dallas, TX

**PURPOSE**

To discuss dosage-related toxicity of intrathecal gadolinium and emphasize caution required for use in contrast epidurography for pain management procedures.

**CASE REPORT**

A 63-year-old woman was brought to our emergency department for hyperventilation, confusion, and neck pain. Earlier in the day she had received an epidural lidocaine/marcaine injection with fluoroscopic guidance using 6ml of gadolinium contrast at an outside facility for neck pain. Her only medical concern was hyperlipidemia. Soon after arrival her mental status deteriorated: she became ataxic, aphasic, then comatose.

**IMAGING FINDINGS**

CT images demonstrated scattered hyperdensity within the subarachnoid space, worrisome for subarachnoid hemorrhage. MR imaging of the cervical spine and brain and MRA of the brain were performed. Images were confounding, as abnormal CSF and brain parenchyma signal intensity appeared on all pulse sequences. MR images demonstrated T1 hyperintensity of CSF, subarachnoid space, and cerebral cortex, abnormal T1 hypointensity involving cerebral white matter (Figure), and significant susceptibility artifact on GRE images.

**SUMMARY**

Laboratory testing ruled out all other pathologic conditions and the patient’s severe neurologic condition was attributed to gadolinium toxicity from unintentional intrathecal injection. CT and MR findings were consistent with gadolinium present within the CSF and parenchyma. The patient remained obtunded for 1 week, and gradually regained function. Subsequent MR studies demonstrated progressive restoration of normal signal intensity within the CSF and parenchyma. No other neurologic process was identified. After 1 month in rehabilitation, the patient was released home with minimal residual deficit. Gadolinium toxicity resulting from intrathecal and intraventricular administration has been well described in animal studies. Neurologic complications include ataxia, seizure, and coma. Corresponding neuropathologic changes include focal glial necrosis and demyelination within the thalamus, brainstem, and spinal cord, and associated neuronal loss in more severe lesions. The purported safe dosage of intrathecal gadolinium extrapolated from animal studies and small human trials is 0.5 - 1.0 ml(500 mmol/l). There is a growing trend to use image-guided spinal interventions to alleviate pain. Contrast injection is necessary to delineate anatomy and assure correct needle placement. Doses up to 5ml of gadolinium are used for epidural injections in some institutions (1). This is significantly higher than the safe intrathecal dose described above. Our case demonstrates the need for caution as well as further investigation into dosage limits of intrathecal gadolinium.

**REFERENCES**


**KEY WORDS:** Gadolinium toxicity, intrathecal gadolinium, epidural injection
**Monday Morning**

10:45 AM – 12:15 PM
Room 11

(5) ELC Workshop: PowerPoint 2007

(80) PowerPoint 2007

— H. Christian Davidson, MD

**Monday Afternoon**

1:30 PM – 3:00 PM
Hall A

(6) (ASSR) Spine Interventions: Lessons for Imagers and Interventionalists

Audience Response Plus (AR+)*
Self Assessment Module (SAM)**

*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 and SAM session programming

**Programming is currently under review for qualification as a Self Assessment Module (SAM) through the American Board of Radiology (ABR).

(81) Imaging Paradigms for Spine Interventionalists

— A. Orlando Ortiz, MD, MBA

(82) Advances in Vertebral Augmentation

— Bassem A. Georgy, MD

(83) Neuroradiologist’s Role in Neck and Back Pain Management

— Blake A. Johnson, MD

Moderators: Bassem A. Georgy, MD
A. Orlando Ortiz, MD, MBA

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**Imaging Paradigms for Spine Interventionalists**

* A. Orlando Ortiz, MD, MBA

**Learning Objectives**

Upon completion of this presentation, participants will be able to:
1) Identify key anatomic findings pertinent to the safe performance of image guided spine interventions.
2) Demonstrate how optimized image preparation (protocol) can contribute towards the selection and performance of
spine interventions.

3) Integrate imaging findings with the clinical presentation in order to improve imaging analysis

PRESENTATION SUMMARY

Historically, radiologists within the various radiologic subspecialties have been performing basic interventional spine procedures predominantly for diagnostic purposes. These include spinal puncture for CSF analysis, myelography, spine biopsy and spinal angiography. Increasing experience with diagnostic spine imaging combined with the resurgence of procedures such as diskography and the development of “minimally” invasive procedures such as percutaneous nucleoplasty, vertebroplasty and kyphoplasty, and radiofrequency ablation have stimulated increased interest by radiologists in the evaluation and management of spinal disorders. Because of their core competency in the utilization of imaging guidance and their ready access to imaging technology, radiologist’s have a tremendous opportunity to contribute to the understanding and treatment of spine-related pathology. Furthermore, this learning experience can and has been enhanced by the ability to gain insights about spine pathology as a direct result of the observations that are made during spine interventions. It is paramount that both diagnostic and interventional radiologists cue each other in to not only the presence of obvious spine pathology but also to key anatomical findings and subtle potentially pathologic findings that might facilitate a better clinical outcome for a given patient. By establishing a bi-directional exchange of clinical information a strong bridge is formed between the “imagers” and the “injectionists”. While many spine interventionalists perform diagnostic imaging, it is crucial that they share their insights with respect to the need for more diagnostically relevant imaging analysis. This presentation will draw from clinical scenarios in order to demonstrate how optimized imaging preparation (protocol) and analysis can contribute towards the improvement in the selection and performance of spine procedures.

Advances in Vertebral Augmentation

Bassem M. Georgy, MD

LEARNING OBJECTIVES

Upon completion of this presentation, participants will be able to:
1) Describe different new techniques for vertebral augmentation
2) Discuss an algorithm for treatment of malignant spine metastasis
3) Discuss potential complications and how to avoid them.

PRESENTATION SUMMARY

This presentation discusses the recent advances in percutaneous cement augmentation for both benign and malignant compression fractures. The use of different new technology to further enhance control over cement deposition will be presented. Those techniques use different devices for cavity creation, height restoration or avoid cement leakage. The advantages of higher cement viscosity will be discussed. Treatment of malignant lesions will be explained in detail with an algorithm presented for treatment of different types of lesions. Finally a glimpse on the future of vertebral augmentation will be presented.

REFERENCES

Neuroradiologist’s Role in Neck and Back Pain Management

Blake A. Johnson, MD

LEARNING OBJECTIVES

Upon completion of this presentation, participants will be able to:
1) Recognize the imaging appearance and clinical findings of underlying pathology resulting in spinal origin neck and back pain.
2) Discuss the benefits of multiple diagnostic and therapeutic image-guided spine injection procedures.

PRESENTATION SUMMARY

In this session we will review the role of the neuroradiologist in neck and back pain management. The effective treatment of spinal origin neck and back pain requires precise diagnosis, which depends in turn upon accurate correlation and interpretation of history, physical findings and imaging features. In addition, the experienced proceduralist can serve as a consultant for the evaluation and treatment of back pain. Although subspecialists will typically evaluate patients and request a specific image-guided procedure, many primary care physicians and non-physician care providers benefit from the additional expertise of neuroradiologists, to provide this evaluation and determine the most beneficial spine procedure.

REFERENCES
Monday Afternoon

1:30 PM – 3:00 PM
Ballroom B

(7) (SNIS) Aneurysm Imaging and Treatment 2009

Debate: CTA versus DSA for Acute Subarachnoid Hemorrhage

DSA

— Christopher J. Moran, MD

CT Angiography

— Allan J. Fox, MD, FRCPC, FACR

Rebuttal and Discussion

(86) Aneurysm 2009 Update: Ongoing Trials and New Devices

— Cameron G. McDougall, MD

Moderator: Philip M. Meyers, MD

CT Angiography

Allan J. Fox, MD, FRCPC, FACR

LEARNING OBJECTIVES

Upon completion of this presentation, participants will be able to:
1) Distinguish CTA as a no-stroke-risk advance; and that INRs should be all around neurovascular experts for diseases, imaging, and treatment, not just for risk procedures.
2) Review CTA as fast acquisition of vascular images during seconds of contrast injection without stroke risk, and with multiple choices for display.
3) Review and discuss appropriate experts lacking experience and/or success with CTA to become educated in it.

PRESENTATION SUMMARY

Neuroimaging and neurointervention advance. INRs, innovators at the forefront of neurovascular disease, embrace logical advances. Randomized outcome trials justifying treatments are a norm in INR since ISAT. Yet except for one United States and two Canadian centers, North American INRs refused to contribute to ISAT, preferring state-of-the-

tissue landmarks, excluding possible hydrocephalus, and, finally, excluding the possibility of any other abnormalities such as arteriovenous malformation (AVM). Much of this information is obtained with noncontrast computed tomography (CT) of the head. In many hospitals, computed tomographic angiography (CTA) is nearly immediately available, acquired rapidly, associated with relatively low radiation exposure, costs less than catheter digital subtraction angiography (DSA), and has much lower risk than DSA. Sensitivity and specificity of CTA for aneurysms greater than 5 mm in size is approaching 100% in some centers, but for smaller aneurysms the sensitivity ranges from 64 to 83%. The accuracy of CTA in aneurysm detection is dependent upon multiple factors including appropriate venous access size, cardiac output, patient immobility, aneurysm size, aneurysm location, and the experience of the interpreter. Besides accurately detecting intracranial aneurysms, DSA also demonstrates two extremely important characteristics, the size of the neck of the aneurysm and the relationship of this neck to the parent vessel. It may not matter that CTA depicts most aneurysms as wide-necked if all aneurysm patients at your institution are surgically clipped. However, there are distinct benefits from endovascular treatment as compared to surgical clipping, as demonstrated in a 25% reduction in morbidity in the endovascular arm of the International Subarachnoid Aneurysm Trial (ISAT). Of course, if all patients undergo attempts at endovascular treatment, that can delay surgical clipping in unsuccessful instances. Early surgical therapy (within 48 hours of rupture) has been shown to have outcome benefit in North America due to prevention of rerupture of the aneurysm. Thus, choice of the optimum therapy is crucial, and this is best made with information from DSA; reliance on CTA lessens the number of patients identified as likely to benefit from endovascular treatment. CT angiography should be utilized as an adjunct in detection and characterization of aneurysms. Digital subtraction angiography is superior to CTA in the accuracy of diagnosis and in the characterization of aneurysms for subsequent treatment.

Digital Subtraction Angiography

Christopher J. Moran, MD

LEARNING OBJECTIVES

Upon completion of this presentation, participants will be able to:
1) Distinguish the advantages and disadvantages of CTA and DSA for acute subarachnoid hemorrhage.
2) Describe the accuracy and the factors affecting the accuracy of CTA in aneurysm detection.
3) Distinguish the imaging needs of the physician treating patients with acute subarachnoid hemorrhage.

PRESENTATION SUMMARY

There are multiple imaging needs in the evaluation of the patient with a nontraumatic subarachnoid hemorrhage (SAH). The first is identifying the hemorrhage, then localizing a possible source, characterizing the aneurysm (clot, calcification), locating the aneurysm in relation to bony and soft tissue landmarks, excluding possible hydrocephalus, and, finally, excluding the possibility of any other abnormalities such as arteriovenous malformation (AVM). Much of this information is obtained with noncontrast computed tomography (CT) of the head. In many hospitals, computed tomographic angiography (CTA) is nearly immediately available, acquired rapidly, associated with relatively low radiation exposure, costs less than catheter digital subtraction angiography (DSA), and has much lower risk than DSA. Sensitivity and specificity of CTA for aneurysms greater than 5 mm in size is approaching 100% in some centers, but for smaller aneurysms the sensitivity ranges from 64 to 83%. The accuracy of CTA in aneurysm detection is dependent upon multiple factors including appropriate venous access size, cardiac output, patient immobility, aneurysm size, aneurysm location, and the experience of the interpreter. Besides accurately detecting intracranial aneurysms, DSA also demonstrates two extremely important characteristics, the size of the neck of the aneurysm and the relationship of this neck to the parent vessel. It may not matter that CTA depicts most aneurysms as wide-necked if all aneurysm patients at your institution are surgically clipped. However, there are distinct benefits from endovascular treatment as compared to surgical clipping, as demonstrated in a 25% reduction in morbidity in the endovascular arm of the International Subarachnoid Aneurysm Trial (ISAT). Of course, if all patients undergo attempts at endovascular treatment, that can delay surgical clipping in unsuccessful instances. Early surgical therapy (within 48 hours of rupture) has been shown to have outcome benefit in North America due to prevention of rerupture of the aneurysm. Thus, choice of the optimum therapy is crucial, and this is best made with information from DSA; reliance on CTA lessens the number of patients identified as likely to benefit from endovascular treatment. CT angiography should be utilized as an adjunct in detection and characterization of aneurysms. Digital subtraction angiography is superior to CTA in the accuracy of diagnosis and in the characterization of aneurysms for subsequent treatment.

Monday Afternoon

1:30 PM – 3:00 PM
Ballroom B

Debate: CTA versus DSA for Acute Subarachnoid Hemorrhage

CT Angiography

— Allan J. Fox, MD, FRCPC, FACR

Rebuttal and Discussion

Aneurysm 2009 Update: Ongoing Trials and New Devices

— Cameron G. McDougall, MD

Moderator: Philip M. Meyers, MD

CT Angiography

Allan J. Fox, MD, FRCPC, FACR

LEARNING OBJECTIVES

Upon completion of this presentation, participants will be able to:
1) Distinguish CTA as a no-stroke-risk advance; and that INRs should be all around neurovascular experts for diseases, imaging, and treatment, not just for risk procedures.
2) Review CTA as fast acquisition of vascular images during seconds of contrast injection without stroke risk, and with multiple choices for display.
3) Review and discuss appropriate experts lacking experience and/or success with CTA to become educated in it.

PRESENTATION SUMMARY

Neuroimaging and neurointervention advance. INRs, innovators at the forefront of neurovascular disease, embrace logical advances. Randomized outcome trials justifying treatments are a norm in INR since ISAT. Yet except for one United States and two Canadian centers, North American INRs refused to contribute to ISAT, preferring state-of-the-

art aneurysm coiling treatment without concern for scientific validation. All now quote ISAT for ruptured aneurysms. Acceptance of state-of-the-art vascular imaging lags for some INRs (1). CT angiography (CTA), another x-ray imaging modality, grows for neurovascular diseases, widely replacing catheter DSA (2, 3, 4). Some INRs argue against state-of-the-art CTA especially for aneurysms (1, 5). CT angiography is done in few seconds, has no stroke risk, with imaging manipulations also available for 3D DSA [3D DSA is “C-Arm CTA” (6)]. Full catheter studies take up to an hour, with preparation and recovery time, stroke risk, and labor-intensiveness in a quasi-operating room setting. CT angiography prior to DSA of INR treatment allows calm treatment planning, and limits DSA to focussed angiography with treatment. Discrediting CTA is incongruous for a field priding itself as an advanced leader. CT angiography gives numerous contributions for hemorrhage patients (3, 4). Fictional allegory was used to ridicule CTA successes (5). Usually those who don't figure out new advances try to understand, here how to best use CTA, and to work to provide CTA as state-of-the-art care. Accurate, easy CTA display choices elude some who still try to make CTA look like selective DSA. CT angiography makes imaging and clinical management easy and accurate, including some details more difficult with catheter DSA. Denial of neuroradiology advances is historical. Early neuroradiologists performed pneumoencephalography, myelography, angiography, outlining tissue and blood vessel planes. Advances showed brain tissue, vessels, and stroke/hemorrhage with CT and MR imaging. Air studies fell in favor of CT, yet a few holdouts argued that air was better. All but a few dropped myelography, yet some still do it, continuing myelographic risk. Angiography shifted decades ago from carotid/brachial punctures to catheter, yet early holdouts declared direct puncture safer and better. Digital subtraction angiography as primary vascular imaging for acute stroke and hemorrhage is no longer done by those who best understand CTA (2, 3, 4). INRs need to be neurovascular leaders for both vascular imaging and treatment, not opposing CTA not yet mastered by some (1, 5). Is opposition to CTA from disinterest in new techniques, lack of insight into useful CTA integration, or business considerations of vascular imaging?

REFERENCES
2. Fox AJ, Symons SP, Aviv RI. CT angiography is state-of-the-art first vascular imaging for subarachnoid hemorrhage. AJNR Am J Neuroradiol 2008;29:e4-e42

Monday Afternoon
1:30 PM – 3:15 PM
Ballroom A

(8) (ASFNR) Functional Imaging in the Pediatric Population

(87) Techniques for Pediatric Functional Imaging: Special Considerations
— Timothy P. L. Roberts, PhD

(88) Interpreting fMRI, DTI, MRS and MEG in a Pediatric Population
— Jill V. Hunter, MD

(89) A Neurologist’s Perspective on Advanced Imaging in Pediatric Epilepsy
— Dennis J. Dlugos, MD

Moderator: Erin S. Schwartz, MD

Techniques for Pediatric Functional Imaging - Special Considerations

Timothy P. L. Roberts, PhD

Interpreting fMRI, DTI, MRS and MEG in a Pediatric Population

Jill V. Hunter, MD

PRESENTATION SUMMARY
Cutting edge technologies in pediatric neuroradiology. The aim of this presentation is to review state of the art neuroradiinaging in relation to its application to pediatric traumatic brain injury (TBI). Mild, moderate and severe TBI are common causes of morbidity and mortality in childhood with both short- and long-term cognitive and financial implications. As part of NIH-funded projects in collaboration with our neuropsychology colleagues we have performed longitudinal...
dinal studies in moderate to severe TBI, as well as more recently mild TBI patients, in addition to orthopedically-injured and typically developing matched pediatric controls. Imaging data including CT, conventional MR imaging and volumetric data, diffusion tensor imaging, magnetization transfer imaging, susceptibility-weighted imaging. Proton spectroscopy and functional MR imaging have been acquired and post-processed. Data resulting from analyses in these different cohorts will be provided. The use of imaging as a biomarker to better understand the underlying pathophysiology of closed head injury will be discussed in addition to future directions. The application of neuroimaging to the better understanding of mechanisms of head injury in children will be described, with implications for future interventions for improved outcomes.

**A Neurologist's Perspective on Advanced Imaging in Pediatric Epilepsy**

_Dennis J. Dlugos, MD_

Dr. Dlugos is currently an Associate Professor of Neurology and Pediatrics at The Children's Hospital of Philadelphia (CHOP), University of Pennsylvania School of Medicine. He is currently the Director of the Pediatric Regional Epilepsy Program and the Epilepsy/Clinical Neurophysiology Fellowship at CHOP, as well as Section Head for Clinical Neurophysiology in the Division of Neurology at CHOP. Dr. Dlugos obtained a Master of Science Degree in Clinical Epidemiology (MSC) from the Center for Clinical Epidemiology and Biostatistics, University of Pennsylvania School of Medicine in 2002, and his medical degree at Columbia University College of Physicians and Surgeons in 1988. He completed an internship in Pediatrics at the National Naval Medical Center in Bethesda, Maryland in 1989, and served as an Undersea Medical Officer in the United States Navy from 1989 to 1993. He then completed a residency in Pediatrics at Thomas Jefferson University and Alfred I. duPont Institute in Philadelphia, Pennsylvania, and Wilmington, Delaware. Dr. Dlugos then completed a residency in Neurology/Child Neurology and a fellowship in Epilepsy and Clinical Neurophysiology at the University of Pennsylvania Medical Center and The Children's Hospital of Philadelphia. Dr. Dlugos is board certified in Neurology with special qualifications in Child Neurology, in Pediatrics, Clinical Neurophysiology, and Clinical Neurophysiology with special qualifications in Epilepsy Monitoring. Dr. Dlugos is a coinvestigator on NIH grants involving epilepsy genetics, pharmacogenetics, and epilepsy surgery. Dr. Dlugos is course director of Brain and Behavior, part of the preclinical curriculum at the University of Pennsylvania School of Medicine curriculum. Dr. Dlugos is a member of the American Academy of Pediatrics, the American Academy of Neurology, the American Epilepsy Society, the American Clinical Neurophysiology Society, and the Child Neurology Society. Dr. Dlugos is a frequent lecturer locally and at national medical meetings on topics related to pediatric neurology, epilepsy, and electroencephalograms. He has published papers in journals such as Neurology, Pediatric Neurology, Archives of Neurology, Epilepsia, and Journal of Child Neurology.

**LEARNING OBJECTIVES**

Upon completion of this presentation, participants will be able to
1) Define the importance of clinical and neurophysiologic data in the lateralization and localization of pediatric epilepsy.
2) Identify the role of advanced imaging in the lateralization and localization of pediatric epilepsy.

**PRESENTATION SUMMARY**

This lecture will first review the strengths and limitations of clinical and neurophysiologic tools in the localization of seizure foci. These tools include history, seizure semiology, physical exam, and inter-ictal and ictal EEG. Based on this information, a hypothesis is generated regarding the location of the seizure focus (also known as ictal onset zone). Next, the role of advanced imaging techniques as a means to accept or reject the clinical hypothesis will be addressed, with an emphasis on challenging “nonlesional” cases.

**Monday Afternoon**

1:30 PM – 3:15 PM
Room 2

(9) ASNR Business Center
Programming: Government and Radiology - Part I

(90) [In] Appropriate Utilization of Imaging Self-Referral, Stark Law [in] Effectiveness...and Maryland

— Gregory L. Katzman, MD, MBA

(91) Turf Wars in Radiology: What Federal and State Governments as Well as Private Payers Are Doing to Limit Referrals

— David M. Yousem, MD, MBA

(92) Imag[ing]ing Turf Protection: Fighting Gravity 101

— Jonathan Breslau, MD

(93) Speaker and Audience Roundtable Discussion

[In]Appropriate Utilization of Imaging - Self-Referral, Stark Law [in] Effectiveness...and Maryland

Gregory L. Katzman, MD, MBA
**Paper 94 Starting at 3:30 PM, Ending at 3:38 PM**

2009 Cornelius G. Dyke Memorial Award Winner

Diagnostic Accuracy and Yield of Multidetector CT Angiography in the Evaluation of Spontaneous Intraparenchymal Cerebral Hemorrhage

Delgado Almandoz, J. E. · Schaefer, P. W. · Forero, N. P. · Falla, J. R. · Gonzalez, R. G. · Romero, J. M.

Massachusetts General Hospital

Boston, MA

**PURPOSE**

This study aims to evaluate the diagnostic accuracy and yield of multidetector CT angiography (MDCTA) for detection of vascular etiologies in adult patients presenting to the ED with spontaneous intraparenchymal cerebral hemorrhage (IPH).

**MATERIALS & METHODS**

We conducted a retrospective study of 623 consecutive adult patients presenting to the ED with spontaneous IPH that were evaluated with MDCTA within 24 hours of presenta-

*Includes 2 false-positive CTAs. †Reported p-value from univariate analysis with Pearson’s chi-square test. ‡Independent predictor in multiple-variable logistic regression analysis. The increased yield in all cases with associated IVH stemmed primarily from cases of lobar IPH with associated IVH (25%), p-value 0.05. IPH: intraparenchymal hemorrhage; CTA: CT angiogram; HTN: hypertension; IVH: intraventricular hemorrhage.
Conclusion

MDCTA is an accurate diagnostic examination in evaluation of adult patients presenting with spontaneous IPH and, given the higher diagnostic yields, should be performed in all patients with the aforementioned characteristics.

Key Words: CT angiography, intraparenchymal hemorrhage, emergency department

Paper 95 Starting at 3:38 PM, Ending at 3:46 PM

Systematic Characterization of the Spot Sign in CT Angiography Improves Its Predictive Value for Hematoma Expansion and Hospital Mortality: All Spot Signs Are Not Created Equal


Massachusetts General Hospital
Boston, MA

Purpose

The presence of active contrast extravasation on CT angiography, known as the spot sign, has been recognized as an important predictor of an increased risk of hematoma expansion and hospital mortality in patients with intraparenchymal hemorrhage (IPH). The purpose of this study is to systematically characterize the spot sign in a large patient population in order to identify features that are most predictive of hematoma expansion and hospital mortality.

Materials & Methods

We retrospectively reviewed CT angiograms (CTAs) performed in all patients who presented to our Emergency Department over an 8-year period with nontraumatic IPH and had either a follow-up noncontrast head CT within 48 hours of the CTA, and/or a known time of ictus. Three experienced neuroradiologists reviewed the CTA source images in “Spot Windows” (level 110, width 200) and determined, by consensus, the presence of spot signs according to the following criteria: (1) at least 1 site of contrast extravasation, of any size and shape, with an attenuation ≥120HU, (2) located anywhere within the IPH, and (3) discontinuous from adjacent normal or abnormal vasculature, Spot sign number, axial size, shape (round, linear or irregular), location (central or peripheral), maximum attenuation, and the total volume of extravasated contrast were recorded. Baseline and follow-up IPH volumes were determined by computerized volumetric analysis. Significant hematoma expansion was defined as an increase of either 30% from the initial IPH volume, or an absolute increase of 6 mL in the first follow-up CT.

Results

A total of 98 of 467 patients demonstrated at least 1 spot sign (21%). Spot signs were more common in patients with CTA imaging within 3 hours of ictus (55%, OR 6.9, p-value < 0.01), initial IPH volume ≥25 mL (31%, OR 4.7, p-value < 0.01), admission MABP > 120 mmHg (30%, OR 1.9, p-value < 0.01), or impaired coagulation (28%, OR 2, p-value < 0.01). The presence of any spot sign significantly increased the risk of significant hematoma expansion (60%, RR 21.8, p-value < 0.01) and hospital mortality (49%, RR 2.3, p-value < 0.01). Results of univariate and multivariate analysis for the predictive value of different spot sign characteristics for significant hematoma expansion and hospital mortality are summarized in Table 1. Multivariate analysis showed that the presence of any spot sign was an independent predictor of significant hematoma expansion (p-value < 0.01), but not of hospital mortality (p-value 0.2).

<table>
<thead>
<tr>
<th>Spot Sign Characteristic</th>
<th>Absolute Risk (%) / Relative Risk (p-value)</th>
<th>Hospital Mortality (p-value)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Volume ≥ 0.05 mL</td>
<td>90 / 2.7 (&lt;0.01) / 66 / 2.0 (&lt;0.01)</td>
<td></td>
</tr>
<tr>
<td>&gt;1 Site of Contrast Extravasation</td>
<td>76 / 1.8 (0.02) / 65 / 2.0 (&lt;0.01)‡</td>
<td></td>
</tr>
<tr>
<td>Irregular Shape</td>
<td>81 / 1.8 (0.01) / 63 / 1.6 (0.04)‡</td>
<td></td>
</tr>
<tr>
<td>Attenuation ≥ 200 HU</td>
<td>81 / 1.8 (0.01) / 62 / 1.6 (0.04)‡</td>
<td></td>
</tr>
<tr>
<td>Attenuation ≥ 70% of Ipsilateral Distal ICA</td>
<td>85 / 2.0 (0.01) / 59 / 1.4 (0.01)‡</td>
<td></td>
</tr>
<tr>
<td>Axial Size &gt; 2 mm</td>
<td>77 / 2.0 (0.01) / 58 / 1.5 (0.01)</td>
<td></td>
</tr>
</tbody>
</table>

*For patients with more than 1 spot sign, the specified shape, attenuation and axial size applies to the largest spot. †Compared to a spot sign without the specified characteristic. ‡Independent predictor in multivariate analysis.

Conclusion

Of all spot signs identified on CT angiography, those with (1) a total volume of extravasated contrast ≥0.05 mL, (2) at least 1 spot in a central location, (3) more than 1 site of contrast extravasation, (4) an irregular shape, or (5) an attenuation ≥200 HU are the most predictive of an increased risk for both significant hematoma expansion and hospital mortality. The presence of a spot sign on the admission CTA with any of these characteristics could be utilized to select patients for early hemostatic therapy or surgery.

Key Words: Spot sign, CT angiography, intraparenchymal hemorrhage

Paper 96 Starting at 3:46 PM, Ending at 3:54 PM

Dual Echo MR Arteriography/Venography at 3T and 7T

Purcell, D. D. · von Morze, C. · Xu, D. · Kelley, D. A. · Hess, C. P. · Vigneron, D. B. · Mukherjee, P.

University of California San Francisco
San Francisco, CA

Purpose

We investigate a new technique for MR angiography that enables simultaneous arteriography and venography of the brain on separate, coregistered image sets, without gadolinium chelates. The technique is based on a 3D dual gradient-echo acquisition, where the initial echo has predominantly
T1-weighted contrast for time-of-flight (TOF) MRA and the later echo is collected with longer TE for T2*-weighted imaging. In this study, we demonstrate the clinical utility of this technique in the evaluation of cerebrovascular disease.

**MATERIALS & METHODS**

Three normal adult volunteers were scanned at 3 T using both conventional 3D TOF MRA sequence and the dual-echo MRA sequence, and one volunteer and one patient with vascular pathology were scanned using the dual-echo sequence at 7 T. The dual-echo MRA acquisition parameters were nearly identical to state-of-the-art conventional TOF studies at 3 T, with an additional echo added to the sequence (matrix 512x256, FOV=22cm, TR=40ms, flip angle=20°, BW=62.5kHz (TE1=2ms, TE2=15ms). The acquisition was divided into two slabs of 16 2.0-mm thick partitions with four overlapping slices (3min 28sec per slab).

**RESULTS**

The dual-echo sequence produced intracranial arteriograms that compared favorably with conventional TOF images and provided additional venographic data in approximately the same scan time as conventional TOF. On average, 78% of the vessel contrast was maintained across all of the individual measurements. In the clinical application of the dual echo technique at 7 T, a single study permitted visualization of all pathology: images from the first echo depict the aneurysms, and images from the second echo depict the cavernous malformation and the associated DVA.

Figure: First echo TOF MRA (a) and second echo T2*-weighted image (b) in patient with mirror image MCA aneurysms (large arrows), left frontal developmental venous anomaly with deep drainage (arrowheads), and associated cavernous malformation (small arrow). Note high-quality MRA images in addition to venographic/T2* imaging, both acquired in same scan time as conventional TOF MRA.

**CONCLUSION**

Intracranial dual-echo 3D TOF MRA/T2* imaging at 3 T and 7 T provides both high-resolution arteriograms as well as second echo T2*-weighted images, which are exquisitely sensitive to blood products and small blood vessels beyond the resolution of TOF MRA. This technique could prove useful for the evaluation of hemorrhagic stroke as well as for detecting microbleeds that may presage the hemorrhagic conversion of acute ischemic stroke.

**KEY WORDS:** 7T, MR angiography

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**Impact of Contrast Media Concentration and kVp Settings on Image Quality in CT Angiography of the Intracranial Vessels**

Ramgren, B. · Siemund, R.
University Hospital Lund
Lund, SWEDEN

**PURPOSE**

Contrast media concentration and kVp setting are two important parameters with impact on the intensity of vessel enhancement in CT angiography (CTA). The purpose of this study was to quantify the effect of an increase of the contrast media concentration from 300 mgI/ml to 400 mgI/ml and the effect of a decrease of the tube voltage from 120 kVp to 90 kVp on the intracranial vessel enhancement.

**MATERIALS & METHODS**

Sixty-three patients referred for intracranial CTA were included into three groups with different protocol parameters regarding tube voltage and contrast media concentration: 1. 120 kVp, 300 mgI/ml 2. 120 kVp, 400 mgI/ml 3. 90 kVp, 400 mgI/ml. Iomeprol was used as contrast media. All examinations were performed on a MX 8000 IDT 16 slice scanner (Philips). Contrast volume 80 ml, injection rate 5 ml/s and test bolus based bolus timing. Decrease of tube voltage in group 3 was compensated by an increase of the tube current. CTDIvol of all examinations was in a range of 32.7 to 36.8 mGy. Region of interest (ROI) measurements of the intravascular Hounsfield units (HU) at the top of the internal carotid artery (ICA) were performed on both sides and mean values were calculated for each patient. The statistical evaluation of the differences between the three groups was done with the Welch two sample t-test and the distribution of the mean enhancement was illustrated by boxplot.

**RESULTS**

The mean HU values at the top of the ICA in group 1. (120 kVp, 300 mgI/ml) 372 HU, 2. (120 kVp, 400 mgI/ml) 435 HU, 3. (90 kVp, 400 mgI/ml) 577 HU. The difference between group 1 and 2 representing the effect of the contrast media concentration was statistically significant (p=0.03) and the difference between group 2 and 3 representing the effect of the tube voltage was statistically significant (p=0.0001).
CONCLUSION
Contrast media with 400 mgI/ml instead 300 mgI/ml increases intracranial vessel enhancement with 17% and the decrease of tube current from 120 kVp to 90 kVp increases intracranial vessel enhancement with 33%. The combined effect of both parameters yields an increase of the enhancement with 55%. High vessel enhancement is a prerequisite for good 3D visualization and increases the visibility subtle pathology (e.g., small aneurysms). The use of highly concentrated contrast media in combination with low tube current are easily performed measures and can be recommended for the optimization of intracranial CTA.

KEY WORDS: CT angiography, image quality, contrast concentration

Paper 98 Starting at 4:02 PM, Ending at 4:10 PM
CT Features of Angiographically Negative Subarachnoid Hemorrhage Patients and their Mid-Term Follow Up

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PURPOSE
Nontraumatic subarachnoid hemorrhage with a negative cerebral angiogram study is not an uncommon occurrence in clinical practice. In these cases, the quantity of blood and their distribution may vary considerably. The purpose of this study is to evaluate the pattern of blood distribution in plain CT study in angiographically negative patients, in correlation with their clinical grade at presentation, clinical course, outcome and mid-term follow up.

MATERIALS & METHODS
From June 1st 2005 to September 30th 2008, 219 consecutive patients who were referred to our hospital with the diagnosis of nontraumatic subarachnoid hemorrhage on plain CT were included in the study. The subarachnoid hemorrhage was evaluated by plain CT and classified depending on the blood distribution and the clinical presentation by Hunt and Hess (H&H) scale. All these patients underwent a 6-vessel cerebroangiogram. In cases where the initial digital subtraction angiogram (DSA) and 3D rotational angiography (3DRA) studies were negative, workup included a brain MR imaging with MRA and a repeat 3DRA study in 10-14 days. All these studies were assessed by a single senior neuroradiologist. The patient’s clinical course post SAH, outcome and follow up were assessed using Modified Rankin scale (MRS) by chart review and telephonic interview.

RESULTS
Of the 219 patients who underwent 3DRA for SAH, the initial 3DRA was negative in 38 patients (17%). Only one of the 38 was positive in the second angiogram (2.6%), which was a dissecting aneurysm of a duplicated right anterior inferior cerebellar artery. This was apparent only in the second angiogram. The male to female ratio was (1.25:1), with age ranging from 19 to 85 years (mean-59 years). The number of patients presenting with H&H grade (1 and 2) was 30 (79%), and with grade (3, 4 and 5) was 8 (21%). There were 19 patients (50%) with grade 4 CT pattern (diffuse subarachnoid with intraventricular and intraparenchymal hemorrhage). Eight patients (21%) needed an EVD for hydrocephalus. Five (13.1%) went on to develop angiographic vasospasm with two (5.2%) needing treatment for the same. Thirty-one patients (81.6%) had good outcome, (MRS) 0-2, six (15.8%) had bad outcome (MRS) 3-5 and one mortality 2.6%. Follow up ranged from 2 weeks to 24 months (median of 2 months).

CONCLUSION
Our CT classification is tailored to patients presenting with angiographically negative SAH. We found good correlation between the pattern of blood distribution (type 4) and the incidence of complications and final outcome. This CT classification may be helpful to start early vasospasm treatment even in patients with negative angiogram and it is helpful to monitor patients with higher chances to develop hydrocephalus. This classification is a good indicator to predict the outcome in these patients.

KEY WORDS: Subarachnoid hemorrhage, CT pattern

Paper 99 Starting at 4:10 PM, Ending at 4:18 PM
Hemodynamics Analysis of Aneurysms of the Posterior Communicating Artery

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PURPOSE
To characterize and relate the geometrical shapes of intracranial aneurysms at the posterior communicating artery (PComA) to blood flow patterns, wall shear stress (WSS), and clinical history of previous rupture.

MATERIALS & METHODS
A total of 35 patients (10 males and 25 females) with cerebral aneurysms at the PComA and imaged with 3D rotational angiography (3DRA) were selected from our database. Clinical information with regard to prior aneurysmal rupture was recorded. The lesions ranged from 1.25 to 19.2 mm in maximum length, including infundibulae to large aneurysms. Patient-specific computational fluid dynamics models were
created for each aneurysm from the 3DRA images. Visualization of the intraaneurysmal flow patterns and WSS distribution were created and the maximum WSS in the aneurysm sac was recorded. The intraaneurysmal flows were classified into four categories: I) single direction of flow rotation, II) flow impaction in the aneurysm sac with associated double vortex structure, III) flow separation inside the aneurysm with two regions of opposing directions of flow rotation, and IV) multiple (>2) vortical structures. The aneurysm shapes were classified into the following categories: A) simple conical shape (typically infundibulae), B) spherical saccular shape, C) elongated shape with a single direction of elongation, and D) irregular shape with more than one directions of elongation.

RESULTS
Flow type I accounted for 58% of all unruptured aneurysms, and 78% of aneurysms in this group were unruptured. Group II, III and IV accounted for 29%, 19% and 43% of all the ruptured aneurysms, with 75%, 100% and 75% of ruptured aneurysms in these groups, respectively. Most infundibulae (presumably at the aneurysm initiation phase) had flow type I and shape A, while most of the large aneurysms had flow type IV and shape D. Mean aneurysm size increased with increasingly complex shapes (mean sizes for shapes A, B, C and D were 2.23, 7.89, 8.31 and 12.2 mm, respectively). Three patients had cerebral nerve III palsy, and the corresponding aneurysms exhibited at least two main lobulations clearly wrapping around the nerve shaped type D. Finally, ruptured aneurysms had maximum WSS 1.72 times larger on average than unruptured aneurysms for all flow types. Aneurysms in flow type IV had the largest maximum WSS.

CONCLUSION
The anatomical subtype of PcomA aneurysms includes a wide variety of flow patterns, shapes and sizes. Flow types become more complicated with increasing size and complexity of shape. Ruptured aneurysms had larger maximum wall shear stress on average than unruptured aneurysms. These findings are consistent with previous analysis of the broader group of cerebral aneurysms and previous subtype analysis of anterior communicating aneurysms (1, 2).

REFERENCES

KEY WORDS: Cerebral aneurysm, hemodynamics, posterior communicating artery

Paper 100 Starting at 4:18 PM, Ending at 4:26 PM
Comparison of CT Angiography and Catheter Angiography in the Assessment of Clipped Intracranial Aneurysms

Bharatha, A. · Yeung, R. · Durant, D. · Fox, A. J. · Aviv, R. I. · Howard, P. · Thompson, A. L. · Symons, S. P.
Sunnybrook Health Sciences Centre, University of Toronto Toronto, ON, CANADA

PURPOSE
To examine whether CT angiography (CTA) is comparable to catheter angiography in assessing clipped intracranial aneurysms.

MATERIALS & METHODS
Retrospective review of CTA and catheter digital subtraction angiography (DSA) studies performed between January 2002 and January 2008. Patients with clipped aneurysms were identified who had undergone both CTA and DSA within 45 days of one another. The indication for clipping and the type of clip used was recorded. CT angiographies were reviewed separately by two blinded neuroradiologists, and then re-reviewed by one at a later date. Each aneurysm was classified as: complete obliteration, neck remnant, or residual aneurysm. The parent vessel also was classified as: patent, narrowed, or occluded. All DSAs were reviewed in a similar manner by a third neuroradiologist blinded to the results of CTA. All studies were reviewed in random order.

RESULTS
A total of 48 patients with 53 clipped aneurysms were identified. The average interval between CTA and DSA was 6 days. The majority of clips used were cobalt-chromium alloy; however, stainless steel and titanium clips were used in a small number of patients. On DSA, 35 aneurysms were completely obliterated, 10 had neck remnants, and 8 had residual aneurysms. The depth of residual necks ranged from 0.5 to 1.4 mm, with a mean of 1.0 mm (SD 0.4 mm). The mean maximal diameter of residual aneurysms was 6.2 mm (SD 2.9 mm). The ability of CTA to detect residual aneurysms versus complete obliterations or neck remnants was excellent (mean sensitivity 88%, specificity 100%, PPV 100%, NPV 98%). The ability of CTA to detect neck remnants versus complete obliterations was poor (mean sensitivity 20%, specificity 100%, PPV 100%, NPV 81%). CT angiography was excellent at detecting parent vessel occlusion (mean sensitivity 100%, specificity 100%, PPV 100%, NPV 100%) and was moderately good at evaluating parent vessel narrowing (mean sensitivity 94%, specificity 73%, PPV 55%, NPV 99%). There was good inter and intraobserver agreement for aneurysm and parent vessel assessment categories with kappa values ranging from 0.7 to 1.0.

CONCLUSION
Compared to DSA, CTA had a relatively high sensitivity and excellent specificity for detection of residual aneurysms. It was not as accurate as DSA in the detection of neck remnants, but most neck remnants were small and of uncertain clinical significance. CT angiography was comparable to DSA in assessing parent vessel occlusion, but while sensitive for parent vessel narrowing, had a relatively poor specificity. Overall, this study suggests that CTA is a useful modality for follow up of clipped aneurysms. However, given the poten-
tial to miss small neck remnants or residual aneurysms, we feel it may be prudent to perform initial DSA and CTA to select patients for whom CT follow up is appropriate. The efficacy of this strategy should be evaluated in future prospective studies.

**Key Words:** Angiography, aneurysm, clip

**Paper 101 Starting at 4:26 PM, Ending at 4:34 PM**

**Intracranial Cavernous Malformations: Natural History and Prognosis**

Willinsky, R. A. · Bitonti, D. L. · Willems, P. W. A. · Javadpour, M. · Tymianski, M. · TerBrugge, K. G. · Wallace, M. C.

The Toronto Western Hospital
Toronto, ON, CANADA

**Purpose**
The aim of this report is to elucidate the natural history and prognosis of intracranial cavernous malformations (CMs), based on the largest prospective patient cohort to date.

**Materials & Methods**
Data from 574 patients, referred to our group with an intracranial CM between 1989 and 2008, was entered into a database. The lesion location was classified as being deep in 191 patients (brainstem, thalamus, basal ganglia, deep cerebellar nuclei and cerebral or cerebellar peduncles) and superficial in 383 patients. Data were reviewed regarding the mode of presentation, interval event rate, interval change on MR imaging and subsequent clinical follow up.

**Results**
Deep lesions presented more frequently with hemorrhage or focal neurologic deficit (75.4%) whereas superficial ones presented more often incidentally or with headaches or seizures (77.4%) (p<0.0001). Data obtained from 416 patients, eligible for follow-up review, revealed event rates (either hemorrhagic or nonhemorrhagic) to be significantly higher in deep lesions (6.5% per year) compared to superficial lesions (1.1% per year) (p<0.0001). Clinical recovery from these events was significantly better in superficial lesions with full recovery in 85.3% of these patients compared to 20% in deep lesions (p<0.0001).

**Conclusion**
Lesion location is the most important predictor of prognosis, both with regard to event rate and subsequent recovery rate. Therefore, surgery to prevent further neurologic deterioration is not indicated in superficial lesions but may be a valid option in deep lesions, if the clinical course is unfavorable and total removal can be achieved with acceptable mortality and morbidity rates.

<table>
<thead>
<tr>
<th>Interval event rates (hemorrhagic and nonhemorrhagic combined)</th>
<th>number of patients</th>
<th>years of follow up</th>
<th>number of events</th>
<th>event rate (%)</th>
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</thead>
<tbody>
<tr>
<td>deep lesions</td>
<td>147</td>
<td>648</td>
<td>42</td>
<td>6.5</td>
</tr>
<tr>
<td>superficial lesions</td>
<td>269</td>
<td>931</td>
<td>10</td>
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</table>

**Key Words:** Vascular malformation, natural history, cavernous malformation

**Paper 102 Starting at 4:34 PM, Ending at 4:42 PM**

**4D CT Angiography in the Detection and Classification of Cranial Dural Arteriovenous Shunts**

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**Purpose**
The gold standard for intracranial vascular imaging, digital subtraction angiography (DSA), is relatively expensive, time-consuming and carries a risk of up to 1% of transient or permanent neurologic deterioration. Although noninvasive angiographic techniques have been shown to exhibit sufficient spatial resolution to answer many clinical questions pertinent to neurovascular disorders, they lack the temporal resolution necessary to demonstrate or rule out arteriovenous shunting. This precludes these techniques from being used in the diagnosis of dural arteriovenous shunt (DAVs). The purpose of this study was to assess the diagnostic value of a new type of computed tomography scanner capable of time-resolved volumetric vascular imaging (4D-CTA) in such lesions.

**Materials & Methods**
We included patients harboring a cranial DAVS, as was diagnosed with DSA. Each patient was subjected to a 4D CTA using a scanner carrying 320 parallel detectors, each 0.5 mm in width, and capable of performing up to three rotations per second (Acquilion One, Toshiba Medical Systems, Japan). Images were acquired according to the following timetable: a single rotation before the contrast reached the region of interest (mask image), 15 s of continuous rotations during the passage of contrast from the arterial to the venous phase and seven rotations at 5 s intervals for the remainder of the venous phase. Each volume was reconstructed from a full rotation and contained 640 overlapping images at 0.25 mm intervals. Subsequently, the mask image was subtracted and time-resolved maximum intensity projection series were generated at different viewing angles. The figure shows an example of an arterial and venous phase in lateral view. Two neuroradiologists were asked to review each data set inde-
pendently and determine the existence of an arteriovenous shunt and, if present, its Borden classification. Moreover, they were required to record all feeding arteries and draining veins for each shunt.

RESULTS
In this ongoing study, the first 10 recruited patients, analyzed at the time of writing this abstract, showed full concordance between DSA and 4D CTA imaging with regard to the existence of the shunt and its Borden classification. With regard to feeding vessels and draining veins, small contributaries which were detected with DSA were not always mentioned in the reviewers 4D CTA report. However, a number of these could be recognized in retrospect.

CONCLUSION
Four-dimensional CTA is a very promising new adjunct in the neuroradiologic diagnostic armamentarium. It is capable of detecting cranial DAVs and their Borden classification, enabling noninvasive determination of treatment strategy. Our first results suggest that the value of this new tool may increase as neuroradiologists grow more accustomed to its evaluation.

KEY WORDS: Cranial dural arteriovenous, shunts

PURPOSE
Digital subtraction angiography (DSA) is the current gold standard for imaging intracranial arteriovenous malformations (iAVMs) but exposes these patients to a considerable procedural risk, including thromboembolism. The tendency for AVM patients to undergo multiple DSA exams through their work up and follow up compounds the potential for complications. As such, an alternative high-quality but non-invasive imaging modality is desirable. We applied a novel, state-of-the-art, high frame rate 4D radial acquisition contrast-enhanced (4D-RACE) MR angiography (MRA) sequence at 3T to AVM patients to assess the diagnostic capabilities compared to conventional DSA. We hypothesize that this 4D-RACE MRA sequence can delineate the angioarchitecture as well as the hemodynamic behavior of iAVMs similar to DSA.

MATERIALS & METHODS
Patients with iAVMs were scanned on a 3T whole-body MR scanner (Trio, Siemens, Erlangen, Germany) within several weeks of a DSA examination. Intravenous gadolinium (0.1 mmol/kg, Magnevist, Berlex, Wayne, NJ) was injected at a rate of 4ml/sec. The 4D-RACE MRA technique included radial k-space undersampling and pseudorandom view ordering, sliding scale windowing and a sliding mask subtraction technique: field of view (FOV) of 220x220x75mm with pixel resolution of ~1mm and a temporal resolution equivalent to a 6 frames/sec. Multiplanar projection maximum-intensity-projection (MIP) CINE images were generated and stored on a workstation. The 4D-RACE MRA images were assessed independently regarding the location, nidal size, Spetzler-Martin grade, and identification of arterial feeders, drainage pattern, and any other vascular anomalies.

RESULTS
The 4D-RACE MRA correctly depicted the size, venous drainage pattern and prominent arterial feeders in all cases (Figure). Spetzler-Martin grade was determined correctly between reviewers and between the different imaging modalities in all cases except one. The nidus size was in good correlation between the reviewers, where r=0.99, p<0.000001. There was very good agreement between reviewers regarding the individual scans (κ=0.63-1) while the agreement between the DSA and 4D-RACE MRA images was also good (κ=0.61-0.85).

CONCLUSION
We have developed a 4D-RACE MRA sequence capable of imaging intracranial AVMs approximating that of DSA. Image analysis demonstrates equivalency in terms of grading AVMs using the Spetzler-Martin grading scale. This 4D-RACE MRA sequence has the potential to avoid some applications of DSA, thus saving patients from potential procedural risks.

KEY WORDS: Arteriovenous malformations, MR angiography, digital subtraction angiography
Cerebral Arteriovenous Malformations and MR Angiography with Blood Pool Contrast Agent at 3.0 T: Prospective Comparative Study of Four-Dimensional Time-Resolved MR Angiography versus High Spatial-Resolution Steady-State MR Angiography and Digital Subtraction Angiography

Civelli, V. · Scomazzoni, F. · Righi, C. · Snider, S. · Iadanza, A. · Cadioli, M. · Scotti, G. · Anzalone, N.
I.R.C.C.S. San Raffaele
Milano, ITALY

PURPOSE
To prospectively evaluate the feasibility and diagnostic value of four-dimension (4D) time-resolved MR angiography with keyhole (4D-TRAK) and high-spatial resolution 3D steady-state sequences with blood-pool contrast agent (Vasovist®, Bayer Schering Pharma) at 3.0 T, in the diagnosis and characterization of intracranial arteriovenous malformations (AVMs), compared with digital subtraction angiography (DSA).

MATERIALS & METHODS
Between April and October 2008, 15 consecutive patients (9 female, 6 male; mean age, 47.6 years) with 15 intracranial AVMs were evaluated with DSA, 4D-TRAK and high-spatial resolution 3D steady-state sequences at 3.0 T (Intera, Philips, the Netherlands). Fifty dynamic scans were obtained with a temporal resolution of 608 msec and a spatial resolution of (1.1 x 1.4 x 1.1) mm3 after power-injection of 0.2 ml/Kg of Gadofosveset, (Vasovist®, Bayer Schering Pharma); subsequently a high-spatial resolution 3D-FFE steady-state sequence (TR 25 msec; TE 3.7 msec; slices number: 100-140, slice thickness 0.5 mm; matrix 512x512; flip angle 30°; field of view 240 mm) was obtained. Time-resolved MR angiograms and 3D steady-state images then were reviewed independently by two experienced neuroradiologists and compared to DSA with regard to overall diagnostic quality, number and type of arterial feeders, nidus size, angioarchitectonic features, associated anomalies, venous drainage and assessment of Spetzler-Martin classification.

RESULTS
Image quality of both 4D contrast-enhanced MR angiography and 3D steady-state sequences was considered of diagnostic quality in all patients. Digital subtraction angiography identified 14 patent AVMs (6/14 < 1 cm; 4/14 between 1-3 cm; 3/14 between 3-6 cm; 1/14 > 6 cm). Four-dimensional MR angiograms allowed the depiction of 8/14 (56%) AVMs (1/6 < 1 cm; 8/8 > 1 cm) while 3D steady-state correctly identified 14/14 (100%) patent and 1/1 closed AVMs. In the subgroup of 8 AVMs identified with 4D-TRAK, DSA depicted 22 arterial feeders, 37 arterial peduncles and 20 draining veins. Four-dimensional MR angiograms and 3D steady-state depicted, respectively, 11 (50%) and 21 (90%) arterial feeders, 11 (30%) and 32 (80%) arterial peduncles, 15 (75%) and 20 (100%) draining veins. Both 4D-TRAK and 3D steady-state has had a 100% matching results with DSA in the assessment of nidus size, type of venous drainage and Spetzler-Martin grading. In the whole group of 14 patients with open AVMs, DSA depicted 30 arterial feeders, 47 arterial peduncles and 26 draining veins. In the same group 3D steady-state sequences allowed the depiction of 27 (90%) arterial feeders, 41 (87%) arterial peduncles and 26 (100%) draining veins, with 100% matching in defining nidus size, type of venous drainage and Spetzler-Martin grading. Moreover 3D steady-state sequences showed a significant advantage in detection of AVMs-associated anomalies (displasic or flow-related aneurysms, venous ectasias and stenosis).

CONCLUSION
Four-dimensional contrast-enhanced MR angiography with blood-pool contrast media is feasible and has a good agreement with DSA in detection of AVMs>1 cm. The use of blood-pool contrast media enables the acquisition of high-spatial resolution 3D steady-state sequences, that gives a significant advantage in depiction of small (<1 cm) AVMs and characterization of angioarchitectonics features.

KEY WORDS: Arteriovenous malformation, blood pool, time-resolved MRA

Monday Afternoon
3:30 PM – 5:00 PM
Ballroom B

(10b) Interventional: Aneurysms II
(Scientific Papers 105 – 115)

See also Parallel Sessions
(10a) Adult Brain: Vascular, Intracranial I
(10c) Adult Brain: Trauma & Other
(10d) Adult Brain: Functional Imaging I

Moderators: David F. Kallmes, MD
Ramin S. Pakbaz, MD

Paper 105 Starting at 3:30 PM, Ending at 3:38 PM
Computer-Aided Detection of Intracranial Aneurysms in MR Angiography
Brinjikji, W. · Blezek, D. J. · Yang, X. · Kallmes, D. F.
Mayo Clinic
Rochester, MN

PURPOSE
Early detection of intracranial aneurysms is important for prevention of the morbidity and mortality that result from aneurysm rupture. Current studies have demonstrated that detection rates of small intracranial aneurysms (3mm-7mm) with MR angiography (MRA) are not optimal. Sensitivities range from less than 40% for radiologists without subspecialty training to 67-69% for radiologists with subspecialty neuroradiology training. We present a computer-aided detec-
tion (CAD) algorithm designed to detect intracranial aneurysms in MRA images and improve the sensitivity of detection of small intracranial aneurysms.

MATERIALS & METHODS
We identified 232 MRA studies in patients who had undergone intracranial digital subtraction angiography (DSA) to confirm the presence of one or more aneurysms. These studies then were annotated by a trained radiologist to identify the aneurysm(s). The rater had access to reports and DSA images to increase confidence of findings. Of the 232 examinations, 130 aneurysms were present. The range of size of the aneurysms was 1mm-33mm. All three aneurysm shapes were included in this study. These cases then were applied to an algorithm designed for automated detection of intracranial aneurysms on MR time-of-flight images. The algorithm is comprised of several steps. First, a denoising filter is applied to the original MRA data set. Second, the filtered images are scaled to isotropic dimensions. Third, an automatic segmentation algorithm is used, resulting a binary mask containing segmented arterial vessels. Fourth, vessel contours and centerlines are determined. Fifth, candidate points of interest (POI) on the vessel surface are identified. Sixth, several sieving strategies are applied to the POIs to remove false positives. Finally, clustering is used to combine spatially adjacent POIs into a single detection. Detections are compared to the manually annotated aneurysms generating sensitivity and false positive rates.

RESULTS
Preliminary results have shown that our algorithm has a 90.7% sensitivity for all aneurysms with an average of 9.6 false positives per case. For small aneurysms (3-7mm), our algorithm has a 90.5% sensitivity. The algorithm is fully automated and does not require any manual intervention.

CONCLUSION
Our preliminary results show that our algorithm has high sensitivity to both small and large aneurysms. The algorithm has promise to serve as an adjunct to radiologists and improve detection rates of difficult aneurysms.

KEY WORDS: Computer-aided detection, intracranial aneurysms, MRA

Paper 106 Starting at 3:38 PM, Ending at 3:46 PM
Clinical and Angiographic Long-Term Follow Up of Completely Coiled Intracranial Aneurysms Using Endovascular Technique

Lee, S.1 · Choi, D.2 · Kim, M.1 · Willinsky, R.4 · terBrugge, K.4
1Lahey Clinic Medical Center, Burlington, MA, 2Gyeongsang National University, School of Medicine, Jinju, REPUBLIC OF KOREA, 3Pohang St Mary’s Hospital, Ulsan, REPUBLIC OF KOREA, 4Toronto Western Hospital, Toronto, ON, CANADA

PURPOSE
The anatomical evolution and clinical outcome of completely coiled intracranial aneurysms after endovascular embolization have rarely been studied separately. From our prospective database, we reviewed follow-up angiography and clinical outcome of 87 patients whose aneurysms were designated as 100% obliterated on immediate postemboliza-
RESULTS
Initial WFNS grade was one in 179 cases (44.2%), two in 87 cases (21.5%), three in 15 cases (3.7%), four in 66 cases (16.3%) and five in 58 patients (14.3%). Aneurysm location was internal carotid artery in 96 patients (23.7%), anterior cerebral artery and anterior communicating artery in 220 patients (54.3%), middle cerebral artery in 52 patients (12.8%), and vertebrobasilar system in 37 patients (9.1%). Endovascular treatment failed in three cases (0.7%). Adverse events related to the treatment were encountered in 71 patients (17.5%) including thromboembolic events in 54 patients (13.3%), intraoperative rupture in 15 patients (3.7%) and early rebleeding in two patients (0.5%). Finally morbidity and mortality to the treatment were respectively 4.0% (16/405) and 1.5% (6/405). Complications related to initial subarachnoid hemorrhage included hydrocephalus in 22 patients (5.4%) and vasospasm in 56 patients (13.8%).

CONCLUSION
Clarity-GDC study demonstrates that the endovascular treatment of ruptured intracranial aneurysms is feasible in a high percentage of cases with low morbidity and mortality.

KEY WORDS: Aneurysms, endovascular treatment, clinical outcome

Paper 108 Starting at 3:54 PM, Ending at 4:02 PM
Clarity-GDC Study: Analysis of the Immediate Anatomical Results Using Two Different Scales (Montreal and Clarity Scales)
Pierot, L. · Cognard, C. · Anxionnat, R. · Ricolfi, F. · and the Clarity study group
1Hôpital Maison-Blanche, Reims, FRANCE, 2Centre Hospitalier Universitaire de Toulouse, Toulouse, FRANCE, 3Centre Hospitalier Universitaire de Nancy, Nancy, FRANCE, 4Centre Hospitalier Universitaire de Dijon, Dijon, FRANCE

PURPOSE
Clarity-GDC study was designed to precisely analyze results of the endovascular treatment in a large, multicenter, prospective study. Analysis of the immediate anatomical results is presented using two different scales.

MATERIALS & METHODS
Four hundred five patients with ruptured aneurysms were included (228 females, 177 males; age: 18-80 years, mean: 51 +/- 13 years). Anatomical results were evaluated in 401 patients (failure of treatment: three cases: no postoperative angiogram: 1 case). Aneurysm location was internal carotid artery in 95 patients (23.7%), anterior cerebral artery and anterior communicating artery in 218 patients (54.4%), middle cerebral artery in 51 patients (12.7%), and vertebrobasilar system in 37 patients (9.1%). Aneurysm size was <= 6 mm in 228 patients (56.9%) and > 6 mm in 173 patients (43.1%). Ratio aneurysm sac size/neck size was <= 1.5 in 168 cases (41.9%) and < 1.5 in 233 cases (58.1%). Postoperative angiographies were evaluated: 1) by the neuroradiologist performing the treatment, 2) by a core lab of two independent neuroradiologists. Two scales were used: Montreal scale and the new Clarity scale. This new scale was defined as follow: A = complete occlusion of aneurysm (coils are present inside the neck and no contrast media is visible in the coil mesh), B = subtotal occlusion including B1 = coils at the level of the neck and contrast media inside the coil mesh, B2 = the neck is not completely filled with coils and no contrast media is visible inside the coil mesh, B3 = the neck is not completely filled with coils and there is some contrast media inside the coil mesh, C = aneurysm remnant.

RESULTS
According to Montreal scale, anatomical results were better if the evaluation was performed by the treating neuroradiologist (complete occlusion: 75.1%; neck remnant: 18.2%, aneurysm remnant: 6.7%) or the core lab (complete occlusion: 49.1%; neck remnant: 38.7%, aneurysm remnant: 12.2%). For the two readers of the core lab, concordance was good in both scales. In Clarity scale, evaluation of the core lab was A: 38.9%, B1: 14.5%, B2: 21.2%, B3: 13.7% and C: 11.7%. Complementary analysis included comparison of both scales for the evaluation performed by the core lab, and evaluation of factors affecting anatomical results.

CONCLUSION
The evaluation of anatomical results of the endovascular treatment of ruptured aneurysms is complex. The quality of occlusion is overestimated by the treating neuroradiologist versus an independent core lab. A precise and effective anatomical scale is mandatory; the Clarity scale can be used for anatomical evaluation with good readers’ agreement as demonstrated in our series. Mid- and long-term anatomical follow up is needed to know if Clarity scale is more appropriate than Montreal scale.

KEY WORDS: Aneurysms, endovascular treatment, anatomical result

Paper 109 Starting at 4:02 PM, Ending at 4:10 PM
Resolved Cranial Nerves Dysfunction in Complex Internal Carotid Aneurysms Using Covered Stent
Escobar, W. · Pedroza, A.
Universidad del Valle-Centro Medico Imbanaco Cali, COLOMBIA

PURPOSE
Endovascular treatment of cerebral aneurysms with detachable coils now has been proved an alternative technique to open microsurgery. The recanalization rate in wide necked, large, or giant aneurysms treated with detachable coil is too high. Additionally, such aneurysms also represent serious difficulties for the surgeon because of bony obstacles and difficulty in proximal control. We present ophthalmic and cavernous carotid aneurysms with cranial nerves dysfunction due mass effect. These symptoms resolved using endovascular deployment of a covered stent in the parent vessel to exclude the intracranial aneurysm sac from circulation in internal carotid aneurysms.

MATERIALS & METHODS
Eight internal carotid artery (ICA) aneurysms in eight patients were treated successfully by using a Jostent coronary stent graft deployed in the parent artery across the aneurysm neck. Four aneurysms were located in the cavernous and four aneurysms in the ophthalmic segments of the ICA. All patients had cranial dysfunction symptoms due to mass effect symptoms.
RESULTS
Seven aneurysms were immediately excluded from circulation after stent graft placement without contrast material filling into the aneurysm cavity. Eight were thrombosed, as shown by late control CT and MR imaging evaluations. In all patients the cranial nerves dysfunction were partially to totally resolved. We did not have complications such as vessel dissection, vessel perforation, or thromboembolism. One case had asymptomatic occlusion of the internal carotid artery. The mean mid-term follow up was 40 months.

CONCLUSION
The endovascular treatments in complex aneurysm using a reconstruction technique with covered stent are encouraging. In this small series this technique was associated to resolved cranial nerve symptoms and with thrombosed aneurysm sac using late CT and MR imaging evaluations. In the near future further research and development are needed to optimize the stent graft technology for endovascular treatment for difficult aneurysms.

KEY WORDS: Aneurysms, covered stent, cranial nerves dysfunction

Paper 110 Starting at 4:10 PM, Ending at 4:18 PM
Stent-Assisted Coiling Using the Enterprise Vascular Reconstruction Device in 26 Patients
Hurley, M. C. · Shaibani, A. · Dabus, G. · Eddleman, C. S. · Batjer, H. H. · Bendok, B. R.
Northwestern Memorial Hospital
Chicago, IL

PURPOSE
We describe a large single center experience in the use of the Enterprise VRD to perform stent-assisted aneurysm coiling.

MATERIALS & METHODS
With IRB approval we reviewed the medical records and imaging of all patients undergoing stent-assisted coiling with the Enterprise stent over an 18-month period in our institution. We recorded the indication, aneurysm location and characteristics, technique, stent type, angiographic result, complications and follow up. Aneurysm occlusion was graded by percentage (100, 95-99, 90-95, 80-90 and partial).

RESULTS
Twenty-six consecutive patients (M:F 1:12; mean age 62 years) underwent Enterprise aneurysm stenting and 23 of these were coiled. Two patients presented with SAH, 4 were referred for recoiling of previously treated aneurysms, and the remainder were incidental lesions. Seventeen aneurysms involved the intracranial ICA, 1 ACOM region, 5 basilar tip, 1 basilar trunk, 1 PCA and 1 SCA origin. Median aneurysm diameter was 7mm (range 4-31mm). Median neck diameter 6mm (range 2-10mm) and parent vessel diameter ranged 2.3-4.2mm. All elective cases were placed on Aspirin 81mg and Clopidogrel 75mg daily for at least 5 days prior to the procedure, continued Clopidogrel for 1.5-3 months and the Aspirin indefinitely. The two ruptured cases received a loading dose of Aspirin 650mg immediately preprocedure and additional Clopidogrel via an NG tube after several coils were placed in the aneurysm. All cases were performed with GA. The Enterprise stent was deployed successfully across the aneurysm necks via a Prowler Plus Select microcatheter in every case. All stents had a maximally expanded diameter of 4.5mm, whereas the length was 22mm in 12 cases, 28mm in 12 and 37mm in 2. We did not use the available 14mm stent. Six patients were staged with subsequent coiling at a later time. We were able to catheterize the aneurysm through the stent in every case using a Prowler Plus LPES, SL 10 or Echelon 10 microcatheter, using a J shaped tip predominantly. Postcoiling angiography in 23 patients showed a partial occlusion in six cases, 80-90% in seven, 90-95% in three, 95-99 in six and 100% in one. Three patients had stent placement without coiling and are awaiting follow up. Of the staged patients, one had a clear reduction in aneurysm size before subsequent coiling at 1 year. None of the remaining staged patients showed any evidence of reduced aneurysm size with stenting alone. One patient who underwent stent-coiling of a ruptured P1 segment fusiform aneurysm suffered a subsequent midbrain infarct and another patient had an asymptomatic vertebral artery dissection. There was one documented case of postprocedural “water-melon-seed” stent migration proximal to a coiled aneurysm which did not disturb the coil pack.

CONCLUSION
The Enterprise stent is highly navigable and can be deployed accurately. Ultrawide necked aneurysms may incorporate side-branches which may not be protected by the stent and require undercoiling of the aneurysm base with associated increased risk of coil compaction. Delayed stent migration due to its smooth surface, though uncommon, can be dramatic.

KEY WORDS: Aneurysm, Enterprise, stent

Paper 111 Starting at 4:18 PM, Ending at 4:26 PM
Balloon-Assisted Coiling of Intracranial Aneurysms Does Not Increase Procedural Complications Compared to Conventional Aneurysm Coiling
Perl, J. · Fease, J. · Koran, M. · Tubman, D. E.
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Minneapolis, MN

PURPOSE
Current published data on complications associated with balloon-assisted coiling (BAC) of intracranial aneurysms are limited by smaller sample sizes and have varying results. The aim of this study was to compare procedural complications associated with BAC of intracranial aneurysms to conventional coiling (CC).

MATERIALS & METHODS
All patients harboring intracranial aneurysms coiled between June 2002 and July 2008 were reviewed retrospectively and prospectively. The date range included corresponded to the use of modern high compliant balloons (Hyperglide, and Hyperform, eV3). In 643 patients, 481 were treated with BAC and 162 with CC. 143 of the aneurysms treated with BAC and 99 treated by CC were ruptured. Procedural thromboembolic complications and intraoperative perforations were analyzed, categorized with and without clinical sequela and compared by rupture status.
RESULTS

Procedural thromboembolic events with clinical sequelae occurred in 11 (2.3%) of aneurysms treated with BAC and 11 (6.8%) of aneurysms treated with CC (p = 0.03); in ruptured aneurysms: 5 (3.5%) with BAC and 11 (11.1%) with CC (p = .033) in unruptured aneurysms: 6 (1.78%) with BAC and 0 (0.0%) with CC (p = .014). Intraoperative perforations with clinical sequela occurred in 7 (1.46%) with BAC and 1 (0.6%) with CC (p = .310).

CONCLUSION

Aneurysms coiled with BAC had fewer procedural thromboembolic events with clinical sequela compared to CC in ruptured aneurysms, but slightly more in unruptured aneurysms. There was no statistically significant difference in the occurrence of intraoperative perforations between the techniques.

KEY WORDS: Balloon, coil, aneurysm

Paper 112 Starting at 4:26 PM, Ending at 4:34 PM
Hydrocoils versus Bare Platinum Coils, Occlusion Rates and Outcomes: A Single Center Study

O’ Hare, A. · Pearly -Ti, J. · Brennan, P. · Thornton, J.
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Dublin, IRELAND

PURPOSE

Hydrocoils are an expansile hybrid coil used which have a potential increase in occlusion rate over bare platinum coils. However the angiographic efficacy on follow up and complication rate is not well established.

MATERIALS & METHODS

We performed a single center retrospective review of 220 patients over a 4-year period. The indication, initial occlusion rate, complication rate with follow-up occlusion rate was evaluated. A modified Raymond and Roy score and percentage occlusion was used to assess occlusion. Degree of hydrocoil packing was according to coil length. Results were compared to published series using bare platinum coils alone.

RESULTS

Two hundred twenty patients were followed over an average of 10 months. On average the hydrocoils occupied an average 49% of total coil length. Sixty-six percent (146) of patients had an acute subarachnoid hemorrhage. Twenty percent (44) had progression to occlusion on follow-up angiography, 33 (15%) had significant regrowth, of which nine required recoiling with the remainder having a persistent stable remnant or small regrowth. There was a nine percent procedural complication rate and less than one percent mortality.

CONCLUSION

In comparison to endovascular coiling using bare platinum coils the use of hydrocoils allows similar complication rate while offering an increased rate of progression to occlusion and significant regrowth relative to bare platinum coils.

KEY WORDS: Coiling, hydrocoil

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Paper 113 Starting at 4:34 PM, Ending at 4:42 PM
Intravenous Aspirin in the Treatment of Thromboembolic Complications During Intracranial Aneurysm Coil Embolization

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PURPOSE

Thromboembolism is a recognized, common and severe complication of intracranial aneurysm coil embolization with significant impact on patient outcome. Experience with intravenous Aspirin in the treatment of thromboembolism during endovascular coil embolization is limited.

MATERIALS & METHODS

We retrospectively reviewed 37 cases in which intravenous Aspirin was administered in our institution during a 15-month period. Between October 2007 and December 2007, in order to treat such complications five patients were administered an intravenous bolus of 250mg and 32 patients a bolus of 500mg of intravenous Aspirin.

RESULTS

Emphasis in our review was placed on angiographic improvement and posttreatment clinical outcome with particular weight on any hemorrhagic complications following Aspirin administration.

CONCLUSION

In this small retrospective series, intravenous Aspirin was found to be safe and effective when used as a rescue agent for thromboembolic complications encountered during coiling of intracranial aneurysms.

KEY WORDS: Intravenous aspirin, aneurysm coiling, thromboembolic complications

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Paper 114 Starting at 4:42 PM, Ending at 4:50 PM
Can Common Carotid Artery Ligation Induce Microaneurysm Formation at the Rabbit Basilar Terminus?

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Rochester, MN

PURPOSE

Intracranial aneurysms have been reported to be induced in rats, mice and primates. Recently, a study showed nascent aneurysm formation at the basilar terminus (BT) of rabbits after unilateral or bilateral common carotid artery (CCA) ligation. We routinely create elastase-induced aneurysm in rabbits in which the unilateral CCA was permanently ligated. After the rabbits were euthanized and the aneurysms for the original project were removed, the basilar artery and its bifurcation were harvested for histologic study of aneurysm formation at the BT.
**MATERIALS & METHODS**

Elastase-induced aneurysms were created using vessel ligation and elastase incubation in the right CCA in 30 New Zealand White rabbits. The basilar artery and its bifurcation were harvested at 8 weeks (n=5), 13 weeks (n=3), 14 weeks (n=2), 16 weeks (n=4), 17 weeks (n=4), 30 weeks (n=6) and 33 weeks (n=6). All specimens were embedded in paraffin and sectioned at 5μm in a coronal orientation, to show the basilar bifurcation and its branches. All the sections were stained with hematoxylin and eosin (H&E) staining. After the sections were evaluated and the photomicrographs were taken, the sections were destained and restained with Verhoeff-Van Gieson (VVG) staining for elastin.

**RESULTS**

The internal elastic lamina (IEL) was intact and continuous at the BT in all 30 (30/30) rabbits, as was the medial layer in all cases. No bulge-like, local dilation, to suggest microaneurysm or nascent aneurysm formation, was observed at the BT in any subject. There were small (0.08 ± 0.02 mm in diameter) concave structures along the P1 segments in five (16.7%) of 30 rabbits (Figure 1a). On adjacent tissue slices each of these five structures were shown to be branch vessels (Figure 1b). Further, each of these concave structures had intact IEL.

**CONCLUSION**

Unilateral RCCA ligation does not induce microaneurysm formation at the BT in rabbits.

**Acknowledgement:** This study was partly supported by NIH grant NS42646.

**KEY WORDS:** Aneurysm, basilar terminus, rabbit

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**MATERIALS & METHODS**

Thirty elastase-induced rabbit aneurysms embolized with platinum coils were analyzed retrospectively. Three groups were classified according to different extent of coil packing: Group 1, aneurysm lumen was incompletely occluded with platinum coils no matter loose or dense packing; Group 2, aneurysm lumen was completely occluded with platinum coils but coil packing was loose (several coil loops were shown within aneurysm from angiography); Group 3, aneurysm lumen was completely occluded with platinum coils and coil packing was dense (no coil loop was shown within aneurysm and the coils appeared as uniform mass from angiography). Digital subtraction angiography (DSA) was performed after embolization and before sacrifice. Aneurysms were harvested at least 2 weeks after coil embolization. H&E-stained slides of embolized aneurysms were analyzed. Follow-up angiographic results (progressive occlusion, stable, recanalization and coil compaction) were evaluated. Histologic features were evaluated according to the extent of thrombus organization (incomplete or complete thrombus organization) and tissue coverage of the aneurysm orifice. Comparison between angiographic features was performed using Fisher’s Exact test.

**RESULTS**

All the 10 incompletely occluded aneurysms in group 1 showed coil compaction and aneurysm recanalization (Figure 1 A-C). In group 2, eight aneurysms showed coil compaction and aneurysm recanalization, two aneurysms remained completely occluded, but showed coil compaction (Figure 2 A-C). All the 10 aneurysms in group 3 remained completely occluded without coil compaction (Figure 3 A-C). Histological slices indicated unorganized thrombus within aneurysms in group 1 and 2, and some empty space without thrombus at all in the aneurysm cavity near neck in group 1. The aneurysms in group 3 showed completely thrombus organization within aneurysm cavity and connective tissue across the aneurysm neck. Recanalization rates in group 1 and 2 were significantly higher than that of Group 3 (p<.05).
**Monday Afternoon**

3:30 PM – 5:00 PM

Ballroom A

(10c) Adult Brain: Trauma & Other

(Scientific Papers 116 – 126)

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**Paper 116 Starting at 3:30 PM, Ending at 3:38 PM**

What the Future May Bring: Diffusion Tensor Imaging Evidence of Acute Prefrontal Axonal Injury Predicts Long-Term Executive Function Impairment following Mild Traumatic Brain Injury

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**PURPOSE**

Although mild traumatic brain injury (mTBI) is a major cause of morbidity and disability, only a subset of mTBI patients sustain permanent impairment. Diffusion tensor imaging (DTI) can detect brain abnormalities after mTBI, but it is not clear whether these abnormalities predict future cognitive dysfunction. We sought to determine whether frontal lobe DTI abnormalities in acute mTBI predict future executive function impairment.

**MATERIALS & METHODS**

The study had IRB approval and written consent. Diffusion tensor imaging was performed on 20 mTBI patients within 2 weeks of injury and 20 matched controls. Fractional anisotropy (FA) and mean diffusivity (MD) images (3.0 T; 25 directions; b=1000) were compared using whole brain voxelwise analysis at a false discovery rate <0.01. The continuous performance task (CPT) and the executive maze task (EMT) were used to quantify patients’ executive function at 3 months following injury. Spearman’s rank correlation analyses evaluated associations between baseline diffusion measures and executive function 3 months after injury, while accounting for potential confounders in multivariable analyses.

**RESULTS**

At baseline, five frontal white matter clusters of lower FA, including the dorsolateral prefrontal cortex (DLPFC), were present in patients (p<0.005), with several clusters also demonstrating higher MD (p<0.005), indicative of prefrontal axonal injury. Nine of the original 20 patients returned for follow-up testing at 3 months. Significant correlations were observed between patients’ DLPFC FA and 3-month test scores (p<0.05) independent of age, gender, education, stress, anxiety and depression; lower baseline DLPFC FA was associated with poorer performance on both the CPT and EMT.

**CONCLUSION**

Dorsolateral prefrontal cortex FA in acute mTBI predicts impaired executive function 3 months after injury. Correlation of acute DTI measurements with an important mTBI outcome suggests that DTI is an indicator of significant brain injury and may prove clinically useful in assigning patients at risk for poor cognitive outcome to intensive and/or novel therapeutic interventions.

**KEY WORDS:** Mild traumatic brain injury, diffusion tensor imaging, executive function

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**Paper 117 Starting at 3:38 PM, Ending at 3:46 PM**

Prospective Longitudinal 3 T Diffusion Tensor Imaging Study of Mild Traumatic Brain Injury

Ng, J.¹ · Wahl, M.¹ · Lee, H.¹ · Veeraraghavan, S.¹ · Xu, D.¹ · Zhao, S.¹ · Kornak, J.¹ · Meeker, M.¹ · Ghajar, J.² · Manley, G. T.¹ · Mukherjee, P.¹

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**PURPOSE**

Diffuse axonal injury (DAI) of white matter is thought to be the key mechanism of the cognitive impairment caused by traumatic brain injury (TBI). Diffusion tensor imaging (DTI) recently has been used to detect serial microstructural white matter changes in moderate or severe TBI (1,2). Since it is not yet known whether DTI has sufficient sensitivity to detect such changes in mild TBI, we applied highly reproducible quantitative DTI tractography methods (3) to measure microstructural white matter integrity longitudinally during the first year after mild head injury.

**MATERIALS & METHODS**

Thirty-one patients with mild TBI (GCS 13-15) and 19 control subjects matched for age, gender, and educational level were enrolled. Each TBI patient was scanned at least 2 weeks, at 1 month, and at 1 year following head injury using a 3T GE Signa EXCITE scanner with 8-channel phased array head coil. Diffusion tensor imaging was performed...
using a multislice single-shot echo-planar sequence with interleaved 1.8-mm axial sections with no gap, in-plane resolution of 1.8 x 1.8 mm, and 55 diffusion-encoding directions at b = 1000 s/mm². Scan data were analyzed using DTI Studio (http://www.mristudio.org). Quantitative three-dimensional fiber tracking was used to measure the average fractional anisotropy (FA) over whole fiber tracts bilaterally, including the cingulum bundle (CB), arcuate fasciculus (AF), inferior fronto-occipital fasciculus (IFO), uncinate fasciculus (UF), corticospinal tract (CST), and the genu and splenium of the corpus callosum (CC) according to protocols described by Wakana et al.3 Group comparisons were made using the nonparametric Wilcoxon signed-rank test, with group differences considered significant at p<0.05.

RESULTS
Compared to controls, patients with mild TBI demonstrated reduced FA values (p < .05) within the IFO, UF, CB, and the genu of the corpus callosum. The greatest differences between patients and controls were observed in the UF, seen across all time points. No statistically significant differences were observed within the AF or the CST at any time point. Fractional anisotropy values trended lower between 1 month and 1 year in all tracts except the AF, although the statistical power of this study was not adequate to establish that these longitudinal changes were statistically significant.

CONCLUSION
In adult mild TBI patients, quantitative DTI tractography detected reduced FA compared to matched controls within the UF, IFO, CB and callosal genu and splenium. Almost all of these tracts have prefrontal connectivity, and also are those most commonly affected in chronic symptomatic mild TBI (4,5). Reduced FA in the UF was apparent as early as 2 weeks after mild head injury. The longitudinal trends towards decreasing FA during the first year after injury will need to be confirmed by a larger-scale investigation of mild TBI.

REFERENCES

Acknowledgment: This study was funded by a collaborative grant from the James S. McDonnell Foundation to the Cognitive and Neurobiological Research Consortium in Traumatic Brain Injury (CNRC-TBI).

KEY WORDS: Diffusion tensor imaging, TBI, white matter,

Paper 118 Starting at 3:46 PM, Ending at 3:54 PM
Is Head CT Necessary for Patients Taking Warfarin or Clopidogrel Who Suffer Head Trauma and Present with a Glasgow Coma Score of 15?

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PURPOSE
Several papers have suggested that the yield of head CT is low for patients who suffered head trauma with a presenting Glasgow Coma Score (GCS) of 15 and that such CTs may not be necessary even in patients who are anticoagulated. Fewer studies have examined the relationship between antiplatelet therapy and minor head trauma. Several anecdotal cases at our trauma center suggested that not performing such CTs would be an unwise clinical management policy. We undertook this study to (1) determine the frequency of intracranial hemorrhage in this patient population and its impact on clinical management, (2) identify predictors of positive imaging findings and (3) assess potential differences between anticoagulation and antiplatelet therapy.

MATERIALS & METHODS
We conducted a retrospective review of the trauma registry at our institution, a Level II trauma center. All head trauma patients registered between the years 2004 and 2006 who were taking warfarin or clopidogrel and had a presenting GCS of 15 were included in the study. The inclusion criteria for the trauma registry are: an ICD9-CM diagnostic injury code between 800 and 959.9, excluding 905-909 (late effects of injuries), 910-924.9 (superficial injuries) and 930-939 (foreign bodies). Intracranial hemorrhage (epidural, subdural or parenchymal hematomas, subarachnoid hemorrhage, cerebral contusion) on head CT was considered a positive result. Relevant clinical data were assessed by chart review. Forward and backward logistic regression was used to identify predictors of positive imaging findings.

RESULTS
One hundred forty-one patients (male n=67, female n=74), mean age 65 years (range 36-101 years) were included in the study. Eighty-five patients were anticoagulated with warfarin, 20 patients had a combined therapy (warfarin and aspirin n=17, warfarin and clopidogrel n=2, warfarin, clopidogrel and aspirin n=1) and 36 patients were on only antiplatelet therapy (clopidogrel n=15, clopidogrel and aspirin n=21). Forty-two (29.8%) patients were diagnosed with intracranial hemorrhage. Thirty-seven (88.1%) of these 42 patients underwent reversal and/or discontinuation of clopidogrel and/or warfarin. Five underwent surgical treatment of intracranial hemorrhage. The frequency of a positive CT finding with regards to anticoagulation, antiplatelet or combined therapy was 23/85 (27%), 4/20 (20%), 15/36 (41%) (p = .164), respectively. Loss of consciousness (Wald 7.422, p = .006), and motor vehicle accident as a mechanism of injury (Wald 4.200, p = .006) predicted a positive CT result. Fracture other than a nasal fracture predicted a negative CT result (Wald 8.622, p = .003). Age, gender, external evidence of injury above the shoulders, and type of medication (warfarin, aspirin or clopidogrel) did not reach statistical significance as predictors.
CONCLUSION
Despite a presenting GCS of 15, patients on anticoagulation or antplatelet therapy suffering head trauma have a high risk of intracranial hemorrhage. Head CT should be strongly considered in such patients, especially after a motor vehicle accident or reported loss of consciousness.

KEY WORDS: Head injury, anticoagulated, antiplatelet

Paper 119 Starting at 3:54 PM, Ending at 4:02 PM
Evaluation of Deep Gray Structures Lesions May Predict Neurologic Outcome in Severe Traumatic Brain Injury

Clarençon, F.1 · Galanaud, D.1 · Bardinet, E.1 · Yelnik, J.1 · Martinerie, J.1 · Tollard, E.2 · Lehéricy, S.1 · Puybasset, L.1 · Chiras, J.1 · Dormont, D.1
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PURPOSE
To evaluate the correlation between basal ganglia (BGs) lesions and neurologic outcome by evaluation of the location and extent of basal ganglia lesions using a 3D deformable atlas (1) (registered on T2 fast spin-echo (FSE)-weighted images.

MATERIALS & METHODS
Fifty-eight patients (44 males and 14 females, 15-77 years old; m = 38.5) with severe traumatic brain injury (TBI) were included prospectively from May 2001 to July 2007. They all underwent an MRI protocol including T2 FSE-weighted images (3mm thickness) on which 3D deformable atlas was registered. The quality of the registration was evaluated by checking the concordance of the boundaries of selected cerebral structures. Lesions of BGs were evaluated using a semi-quantitative classification from 0 (no lesion) to 5 (total involvement). A kappa test was performed to evaluate the interobserver reliability of the evaluation of BGs lesions. A multivariate analysis (Support Vector Machine: SVM) was performed to separate, on the basis of the evaluation of BGs lesions, the patients with a good neurologic outcome (no/minor neurologic deficit) from the patients with a poor one (death, vegetative or minimally conscious state) evaluated at 6 months.

RESULTS
Seventy-four percent of the patients had perfect or very good registration of 3D atlas on T2 FSE-weighted images. Registration was uninterpretable in only 9%. Poor registration was more frequent for caudate nuclei (CNs); especially in patients with ventricular dilatation. The kappa index for the interobserver reliability was 0.71. Lesions of BGs were seen in 79% of cases. Ninety-one percent (10/11) of patients without BGs lesions had a good outcome. One hundred percent (13/13) of patients with bilateral lesions of BGs had a poor outcome. The multivariate analysis showed a heavy weight of thalamic lesions for poor neurologic outcome. The discriminative function correctly classified for 82% of patients with poor prognosis.

CONCLUSION
This preliminary study shows that the assessment of BGs lesions, using the registration of a 3D deformable atlas on T2 FSE-WI, may predict poor neurologic outcome at 6 months in severe TBI, with a 82% positive predictive value.

REFERENCES

KEY WORDS: Basal ganglia, traumatic brain injury, MRI

Paper 120 Starting at 4:02 PM, Ending at 4:10 PM
Multidetector CT angiography (MD CTA) is being increasingly utilized in the initial evaluation of patients presenting to the Emergency Department with acute head and cervical spine trauma to assess for vascular injury. This study aims to determine the diagnostic yield of MD CTA in this clinical setting.

MATERIALS & METHODS
We conducted a retrospective study of 1,353 consecutive patients that presented to the Emergency Department with acute head and/or cervical spine trauma and were evaluated with MD CTA of the head and/or neck over a period of 9 years. Noncontrast CTs and CT angiograms were reviewed for the presence of (1) cervical spine and/or skull fractures, and (2) vascular injury. A positive MD CTA was defined as a study in which injury to at least one vascular structure (including traumatic dissections, transections, pseudoaneurysms, and/or dural venous sinus thromboses) was present. Medical records were reviewed for mechanism of injury.

RESULTS
Multidetector CTA demonstrated evidence of vascular injury in 225 patients (16.6%). The most common vascular injuries were acute dissections and traumatic dural venous sinus thromboses. Results for the frequency of vascular injury according to mechanism of injury and fracture location are summarized in Tables 1 and 2, respectively. Table 3 depicts the frequency of associated cerebral ischemic injury for the most commonly injured vascular structures. Multiple variable logistic regression analysis demonstrated that the presence of (1) a cervical spine and/or skull fracture (25%, RR 6.1, p-value <0.0001), as well as (2) a high-risk mechanism of injury (23.7%, RR 2.1, p-value <0.0001), were independent, statistically significant predictors of an increased risk of vascular injury detected by MD CTA.

CONCLUSION
Multidetector CTA is an important diagnostic tool in the evaluation of patients presenting to the Emergency Department with acute head and/or cervical spine trauma, and should be performed in all patients with (1) fractures of the cervical spine and/or skull reaching a vascular structure, as well as (2) high-risk mechanisms of injury. Patients with evidence of vascular injury at MDCTA would benefit from an MR imaging examination to assess for associated cerebral ischemic injury.
Suboccipital craniotomy is a commonly used surgical approach for Chiari I decompression. Postoperative MR scans of these patients are obtained when Chiari symptoms recur or complications arise. This study was undertaken to describe the often unrecognized and sometimes life-threatening complication of postdecompression intracranial hypotension.

**Materials & Methods**

Following Institutional Review Board approval, patients who had undergone suboccipital craniotomy between 2003 and 2008 at the University of Utah were identified from the surgical record. Sixteen of these patients developed symptoms requiring reoperation. A retrospective review of postoperative imaging studies identified eight patients with MR imaging findings of intracranial hypotension.

**Results**

Sagittal T1-weighted imaging was available for all eight patients. Midbrain slumping with decreased pontine-midbrain angle and effacement of the preponite cistern was identified in all eight cases. Decreased suprasellar subarachnoid space with “draping” of the optic chiasm over the dorsum sellae was found in seven of eight. Serial exams demonstrated interval pituitary enlargement in six of eight cases with developing intracranial hypotension. However, only one patient had a pituitary gland which measured >10 mm in height. Medial herniation of the hippocampus into the tentorial incisura on sagittal imaging was seen in five of eight. A decrease in ventricular angle (<120°) was seen in four of eight patients on coronal imaging. Dural enhancement and other classic findings of ICH were uncommon.

**Conclusion**

A retrospective review of the MR imaging findings in a series of eight patients with clinical complications following suboccipital craniotomy demonstrates the variable presence of what are often subtle imaging findings of intracranial hypotension. This is a common complication that can be life threatening and therefore must be recognized acutely. Evaluation of a single postoperative scan is inadequate. Comparison of serial examinations often is necessary for identification of these subtle changes.

**Key Words:** Intracranial hypotension, craniotomy, Chiari

**Paper 122 Starting at 4:18 PM, Ending at 4:26 PM**

**Impact of MR Imaging on Electrophysiology of the Motorcortex: A Transcranial Magnetic Stimulation Study at 1.5 T and 7 T**

Schlamann, M. U.1 · Yoon, M.1 · Maderwald, S.1,2 · Pietrzyk, T.1 · Bitz, A.3 · Gerwig, M.1 · Ladd, M. E.3 · Ladd, S.1 · Forsting, M.1 · Kastrup, O.1

1University Hospital Essen, Essen, GERMANY, 2Erwin L. Hahn Institute for Magnetic Resonance Imaging, Essen, GERMANY

**Purpose**

Increasing spread of high-field and ultra-high field MR scanners encouraged a new discussion on security aspects of MR examinations. Relatively few studies are published on possible effects of MR examinations. Some authors found a slight disturbance of short-term memory after a stay in a static magnet field. Older studies report elongation of auditory evoked potentials. This finding could not be confirmed in...
later MR examinations at 1.5 T and 7 T by means of transcranial magnetic stimulation (TMS).

**MATERIALS & METHODS**
Transcranial magnetic stimulation was performed in 12 male, right-handed volunteers. At first the individual motor threshold (MT) was specified. After that the silent period (SP) was measured. Subsequently the volunteers were examined in the MR scanner (Siemens Avanto, 1.5 T) for 63 minutes using standard gradient- and spin-echo sequences. The MR examination was followed immediately by another TMS session. Fifty minutes later the TMS session was repeated. All TMS sessions were performed outside the scanner room. Four weeks later the same setting was repeated at a 7 T whole body scanner (Siemens 7 T). Control settings included lying in the 1.5 T scanner for 63 minutes without scanning (control condition 1) and lying in a separate room for 63 minutes(control condition 2). Transcranial magnetic stimulation was performed three times in the same way. For statistical analysis a Wilcoxon rank test was performed.

**RESULTS**
Silent period was elongated in all 12 subjects. The elongation averaged 35.9% at 1.5 T and 32.7% at 7 T (p=0.002). Ten minutes after examination the silent period tended to be normal again. Motor threshold was increased in 10 subjects between 1% and 23%, left constant in one subject and slightly decreased in one subject (p=0.006). At 7 T motor threshold was increased in eight subjects between 5% and 28%, left constant in three subjects and slightly decreased in one subject (p=0.01). The control conditions revealed no significant results.

**CONCLUSION**
MR examinations lead to a transient highly significant increase of SP and MT. This effect does not seem to depend on the strength of the static magnetic field. Possible causes will be discussed.

**KEY WORDS:** MRI, 7 T, transcranial magnetic stimulation
change in the Evan’s ratio or F/O Horn ratio predicted change in ventricle volume were 0.550 and 0.639 respectively. The strongest association was seen when the Evan’s ratio and F/O Horn ratio were used together to predict volume/interval change.

**CONCLUSION**
The F/O Horn ratio was shown to correlate well with ventricle volume regardless of age and can be used to predict interval volume change on successive CT scans.

**Key Words:** Hydrocephalus, ventricle volume

**Paper 124 Starting at 4:34 PM, Ending at 4:42 PM**

**MR Imaging Signs in Secondary Intracranial Hypertension**

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**Purpose**
To determine the sensitivity and specificity of cranial MR imaging and phase contrast MR venography (pcMRV) in patients with secondary intracranial hypertension (SIH).

**Materials & Methods**
Thirty-six patients with SIH were investigated using a standardized MR protocol including a coronal STIR sequence of the orbit and pituitary and a pcMRV. Patients suffered from SIH due to the following diseases: meningeval disease (n=10), venous sinus thrombosis (n=8), intracranial tumor (n=8, 5 with compression of adjacent venous sinuses, 3 with mass effect), congenital hydrocephalus (n = 5, 3 with insufficiency of ventriculo-peritoneal shunt systems), others (n=7). In three patients there were multiple potential causes of SIH. Patients without IH served as controls (n = 159). We determined descriptive signs such as elongation and edema of the optic nerves, protrusion of the optic disk and flattening of the posterior sclera. We measured luminal width of the ophthalmic veins, height of the pituitary and width of the optic nerve sheath (ONS) at four positions. On maximum intensity projections (MIP) and primary slices of pcMRV we recorded venous sinus narrowings and flow gaps and used a simple new scoring system to define cranial venous outflow obstruction.

**Results**
Elongation of the optic nerve, optic nerve edema and optic disk protrusion were specific for IH with a sensitivity of 6%, 14% and 33%. A flattened posterior sclera was observed in 23 patients (64%), but specificity was only 78%. Widening of the superior ophthalmic vein occurred in 11 patients (31%), a reduction of the pituitary height was seen in 23 patients (64%) and widening of the ONS was noticed in 33 patients (92%). For these measurements, the range between the 3rd and 97th percentile of the control group defined normal results. Cranial venous outflow obstruction was present in 90% of patients (excluding the ones having venous sinus thrombosis or venous sinus compression by a tumor), but in none of the controls. Cerebrospinal fluid pressure correlated well with the number of positive MR imaging and MRV signs (r = 0.6, p = 0.005). Combining MR imaging and MRV, at least two signs of IH were present in each patient but in none of the controls.

**Conclusion**
The combination of cranial and orbital MR imaging and MRV is sensitive and specific in the diagnosis of intracranial hypertension, even in patients who do not present with hydrocephalus or with an intracranial mass lesion. A standardized imaging and scoring system is useful to separate normals from patients with SIH. A theory explaining phenomena of venous sinus alterations in SIH is proposed.

**Key Words:** Intracranial hypertension, MRI

**Paper 125 Starting at 4:42 PM, Ending at 4:50 PM**

**Spatial Distribution of MR Imaging Findings in Hypoxic-Ischemic Encephalopathy**

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**Purpose**
To determine whether the distribution of MR imaging findings in cerebral gray and white matter in patients with hypoxic-ischemic encephalopathy (HIE) correlates with severity of the insult and clinical outcome.

**Materials & Methods**
In 56 patients with HIE we retrospectively analyzed the spatial distribution of MR imaging findings typical for hypoxia in cerebral gray and white matter. Distribution patterns were correlated with clinical parameters describing severity of the insult and outcome at the end of the initial hospital stay.

**Results**
Fifty-four patients had a distribution of MR imaging findings that could be assigned to one of three patterns. These patients either showed affection of cerebral cortex (group I) or signal changes in cortex and basal ganglia (group II) or cortical, basal ganglia, thalamic and brainstem affection (group III). The spatial extension of lesions correlated closely with the duration of hypoxia and clinical outcome. Patients who experienced short hypoxic intervals had the best clinical outcome and presented with a cortical distribution of lesions. Group III patients had the longest duration of hypoxic events. Almost all patients in this group died early after the insult. White matter lesions were observed only in prolonged cases of rather mild hypoxemia.

**Conclusion**
The results confirm a strong correlation between spatial extension of MR imaging findings and clinical outcome. This helps to establish MR imaging criteria with predictive value for the prognosis of patients with HIE. Furthermore, the results show that white matter damage occurs in cases of prolonged mild hypoxemia as opposed to gray matter damage seen after cerebral anoxia.

**Key Words:** Hypoxic-ischemic encephalopathy, spatial distribution, clinical outcome
Effect of Tube Voltage on Image Quality at 64-Section Multidetector Intraarterial 3D CT Angiography: Evaluation with a Vascular Phantom with Superimposed Bone Skull Structure

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PURPOSE
In an attempt to mitigate the hazards of radiation exposure, various technology- and patient-based strategies have been evaluated to optimize the tube voltage and tube current settings. To our knowledge, however, there have been no studies on the evaluation of the ability of 3D CT angiograms with MDCT to delineate cerebral vascular lesions at various kilovoltage settings. Thus, the purpose of our study was to investigate image quality on 3D CT angiograms of the brain at various kilovoltage settings by evaluating the depiction of simulated intracranial aneurysms and aneurysmal blebs using an anthropomorphic vascular phantom with superimposed bone skull structures.

MATERIALS & METHODS
An anthropomorphic vascular phantom with superimposed bone skull structures was designed to simulate the various intracranial aneurysms with aneurysmal bleb. We obtained the CT angiography by using a 64-detector row CT scanner for various effective tube currents with four tube voltages of 80 kVp, 100 kVp, 120 kVp, and 135 kVp. A simulated aneurysm enhancement and image noise were quantified; signal-to-noise ratio (SNR) and contrast-to-noise ratio (CNR) were calculated. The depiction of the simulated aneurysms and blebs on 3D CT angiograms obtained with the volume rendering technique were assessed subjectively by two radiologists in consensus. Effective dose was calculated on the basis of weighted CT dose index. Results of both protocols were compared by using the Student t test.

RESULTS
At identical doses levels (weighted CT dose index), the mean SNR and CNR at 100 kVp were significantly higher than those at 80 kVp, 120kVp, and 135 kVp. A simulated aneurysm enhancement and image noise were quantified; signal-to-noise ratio (SNR) and contrast-to-noise ratio (CNR) were calculated. The depiction of the simulated aneurysms and blebs on 3D CT angiograms obtained with the volume rendering technique were assessed subjectively by two radiologists in consensus. Effective dose was calculated on the basis of weighted CT dose index. Results of both protocols were compared by using the Student t test.

CONCLUSION
Our phantom study suggests that an excessively high or low kilovoltage settings result in the degradation in diagnostic image quality of cerebral CT angiography, and it may be feasible to use 100 kVp for 3D CT angiograms.

KEY WORDS: CTA, aneurysm, phantom

Monday Afternoon
3:30 PM – 5:00 PM
Room 1

(10d) Adult Brain: Functional Imaging I
(Scientific Papers 127 – 137)

Resting State Functional Connectivity MR Imaging for Presurgical Planning

Shimony, J. S. · Zhang, D. · Johnston, J. M. · Fox, M. D. · Roy, A. · Leuthardt, E. C.
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PURPOSE
Evoked fMRI is routinely used for presurgical planning in patients with brain tumors. Evoked fMRI methods are difficult or impossible to perform in certain patients, such as patients under sedation, young children, patients with mental status changes or those that cannot follow instructions, and patients with aphasia or hemiparesis. Resting state functional connectivity MR imaging (fcMRI) has emerged as an alternative method for localization of brain networks that requires no active patient participation and can be done under sedation (1). The purpose of this study was to explore the use of fcMRI for presurgical planning.

MATERIALS & METHODS
Eight patients with brain tumors or metastasis were scanned on a 3T Trio MR scanner (Siemens, Erlangen, Germany) as part of their presurgical evaluation. Anatomical MR scan was done using MPRAGE and T2 fast spin-echo. Evoked fMRI for localization of the motor and language systems was performed as per routine protocols. Resting state fcMRI (TE=25ms, 90° flip, 4 x 4 x 4 mm voxel size) was performed as described in (1). Postprocessing was performed to align each set of scans into standardized Talairach coordinate system using cross modal affine transformations. Functional
connectivity within the motor system was determined by selecting a seed within the motor cortex contralateral to the tumor. Functional connectivity within the language system was determined by selection of a seed region in the left BA44/45 (Broca’s) region. Details of the fMRI processing, including signal filtration is described in (1).

RESULTS
Robust and consistent delineation of sensorimotor cortex and the language system was obtained using the resting state BOLD data. Resting state functional mapping in patients showed localization to sensorimotor areas consistent with traditional fMRI and with cortical stimulation mapping when available, and in all cases performed as well or better than task-based fMRI. Other brain networks, such as the visual, auditory, attention, and default networks were identified easily in selected patients. Obtaining these results using traditional task-based methods would require a prohibitive amount of time.

CONCLUSION
Resting state fMRI can provide useful information for presurgical planning and can be performed in many patients that cannot benefit from traditional fMRI. This method has the potential to improve patient care and outcomes.

REFERENCES
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KEY WORDS: Functional MRI, brain neoplasm

Paper 128 Starting at 3:38 PM, Ending at 3:46 PM
Use of Computed Lateralization Model to Aid Language Lateralization in Presurgical fMRI: Preliminary Results

Lockwood, D. · Ahmed, M. · Emch, T. · Jones, S. E. · Phillips, M. · Mahmoud, S. Y. · Masood, P. · Moon, D. · Ruggieri, P. · Smith, A. · Stultz, T. · Tievsky, A. Cleveland Clinic Foundation Cleveland, OH

PURPOSE
Preoperative localization of language function is critical in minimizing morbidity from epilepsy and brain tumor surgery. Despite the potential of fMRI to noninvasively localize language, significant challenges remain in generating consistent and reliable results. The purpose of our study is to test the effect of a new computed lateralization model (CLM) on fMRI interpretation. The CLM provides an objective, reproducible way to quantify language lateralization that highly correlates with Wada testing (1). It generates a sheet of informative data including an overall numerical lateralization index, visual representation of laterality, probability of Wada correlation, and an examination noise score. We report preliminary results of the effect of using the CLM data sheet on interpretation of presurgical fMRI.

MATERIALS & METHODS
Twenty-two preoperative fMRIs performed at 3T were reviewed retrospectively twice by each radiologist within a busy hospital practice. Computed lateralization models were generated for each exam using methods described previous-

ly (1). Each radiologist reviewed each exam without and with the aid of the CLM, all in a separated randomized order. Radiologists rated exam quality, noise, and language lateralization for all paradigms, in addition to an overall subjective lateralization score including a confidence measure. Overall lateralization was rated on a numerical scale: -2 = completely right, -1 = predominantly right, 0 = bilateral, 1 = predominantly left, 2 = completely left. Overall confidence was rated from zero (no confidence) to three (very confident).

RESULTS
Preliminary results comparing radiologist generated lateralization scores with CLM scores reveal high correlation between the two values (R² = 0.79), whose correlation coefficient improved with concurrent use of CLM scores. These improvements became more evident with the increased subjective confidence of lateralization. Further, there was increased sensitivity of lateralization with increased confidence, again improved with concurrent use of CLM data. Complete results from review by all ten members of the our neuroradiology division will be presented.

CONCLUSION
The addition of an objective, quantitative lateralization index during clinical readout of conventional presurgical fMRI interpretation improves subjective lateralization and increases uniformity of interpretation.

REFERENCES

KEY WORDS: fMRI, language lateralization

Paper 129 Starting at 3:46 PM, Ending at 3:54 PM
Comparison of Conventional and Stereoscopic Diffusion Tensor Imaging Visualization Techniques

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PURPOSE
To compare several visualization methods for displaying diffusion tensor imaging (DTI) data for clinical use.

MATERIALS & METHODS
Diffusion tensor imaging data have been displayed as a grayscale functional anisotropy map (GSFM) or as a coded

Day
orientation map (CCOM). A stereoscopic visualization tool has been developed at our institution which displays the principal eigenvector as a headless arrow, and can be viewed with either a regular or a stereoscopic LCD monitor. In this tool, the principal eigenvector at each voxel, Vmax, is depicted as a headless arrow, while a color scale is used to encode the fractional anisotropy (FA) index. A survey of clinical utility, using a paired comparison questionnaire format with forced and graded choices, was performed by eight board-certified neuroradiologists. Five representative DTI studies, in patients with intracranial neoplasms, were selected and comparing the following: a) GSFM, b) CCOM, c) Vmax maps using regular nonstereoscopic display (VM), and d) Vmax maps with stereoscopic display (VMS).

RESULTS
Six of eight neuroradiologists favored Vmax maps over traditional methods of display (GSFM and CCOM), one preferred the traditional method and one had no preference. When comparing stereoscopic display (VMS) vs. the nonstereoscopic (VM) modes, four of eight favored VMS, two favored VM, and two had no preference. The main reason given for the preference of the stereoscopic DTI visualization tool (VMS, VM) to the conventional DTI visualization methods (CCOM and GSFM) was better delineation of white matter tract and improved three-dimensional anatomy effect. In one case, the Vmax maps with stereoscopic display (VMS) were beneficial in determining that a lesion was displacing rather than invading adjacent fiber tracts.

CONCLUSION
Diffusion tensor imaging data displayed by our Vmax based display methodology seem to be preferred over traditional display methods. Further study will be necessary to assess clinical utility.

KEY WORDS: Diffusion tensor imaging, stereoscopic, neoplasms

Paper 130 Starting at 3:54 PM, Ending at 4:02 PM
Spatial Distribution of Abnormal 18-F-FDG Accumulation Within High-Grade Primary Brain Tumors
Paldino, M. J. · Wong, T. Z. · Reardon, D. A. · Friedman, H. S. · Barboriak, D. P.
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PURPOSE
To determine whether the depth or locations of areas of high FDG accumulation within regions of tumor-related enhancement in patients with high-grade primary brain tumors is useful for predicting the direction of subsequent tumor spread.

MATERIALS & METHODS
Institutional Review Board approval and informed consent were obtained for this HIPAA compliant study. Sixteen patients with Grade III or IV astrocytoma were treated with resection followed by intracavitary radiation therapy with I-131 labeled antitenascin monoclonal antibody. Patients then underwent serial 18-F FDG-PET and 1.5T MR imaging including contrast-enhanced 3D SPGR imaging. For each patient, all subsequent MR imaging studies were aligned to that patient’s initial MR imaging using a rigid-body normalized mutual information algorithm. FDG-PET image volumes then were aligned to the MR imaging obtained at the same time point (defined as performed within 48 hours of the MR exam). Contrast-enhancing volumes of interest (VOI) were defined at each time point using a semiautomated k-means clustering technique. FDG activity within each voxel of the VOI was calculated from the coregistered FDG-PET scan as an activity ratio (AR) relative to FDG activity in contralateral normal-appearing white matter (NAWM). Regions of high absolute FDG accumulation were isolated using a threshold of AR greater than 1.5. VOIs also were segmented into quintiles of AR. For each VOI, volumes of interval tumor growth were isolated by subtraction of that patient’s most recent prior VOI. The distance between regions of highest FDG accumulation (defined by AR > 1.5 or highest quintile AR) and future tumor growth was compared to the average distance of the entire enhancing VOI to future growth using the Wilcoxon rank sum test. The depth from the tumor margin of regions defined by each quintile of AR also was calculated. The relationship of the AR to distance from the enhancing tumor margin was evaluated using a generalized mixed linear model.

RESULTS
Thirty-five paired, registered PET and MR exams were available. Tumor regions with highest AR (either AR greater than 1.5 or AR in the highest quintile for that VOI) were not significantly closer to regions of future growth than the average enhancing pixel (p = 0.93; p = 0.35 respectively). Activity ratio was inversely related to depth from the tumor margin (p < 0.0001). Pixels in the highest quintile of AR were significantly further from the tumor margin than pixels in any other quintile (60th to 80th percentile: p < 0.05; 40th to 60th percentile: p < 0.01; 20th to 40th percentile: p < 0.0009; less than 20th percentile: p < 0.0001).
CONCLUSION
The depth and location of regions of high FDG accumulation in patients with high-grade primary brain tumors was not helpful for predicting the direction of tumor spread. These regions tend to be located deep within the volume of enhancing tumor. No significant relationship was detected between the locations of these regions and future tumor growth.

KEY WORDS: FDG PET, brain tumor

Paper 131 Starting at 4:02 PM, Ending at 4:10 PM
Added Value of Perfusion MR and MR Spectroscopy for Differentiating Between Tumors and Nontumorous Conditions of the Brain

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PURPOSE
Although conventional MR imaging (MRI) is the modality of choice for differential diagnosis of intracranial mass lesions, sometimes it is very difficult to differentiate nontumorous brain lesions from tumors by conventional MRI alone. Advanced MRI technique such as perfusion-weighted image (PWI) and proton MR spectroscopy (MRS) may provide complementary information for the diagnosis of brain lesions without invasive procedure. There are several reports about the usefulness of PWI or MRS for differentiation between tumors and nontumorous conditions, but it is not clear whether PWI or MRS really has additional value to the conventional MRI. The purpose of this study is to investigate if PWI and MRS have added value to the conventional MRI for differentiating between tumors and nontumorous conditions of the brain.

MATERIALS & METHODS
Sixty-three patients with brain tumors (n=36) and nontumorous lesions (n=27) who underwent conventional MRI, PWI and MRS were evaluated. The maximum relative cerebral blood volume (rCBV) normalized to the contralateral corresponding region, Cho (choline) /Cr (creatine) ratio and Cho (choline) /NAA (N-acetyl aspartate) ratio were measured in the mass lesion. Two experienced neuroradiologists, who were blinded to the clinical information, separately evaluated the conventional MR images of each patient and the diagnosis was made with five scales (1: definite nontumor, 2: probable nontumor, 3: possible tumor, 4: probable tumor, 5: definite tumor). If there was discordant case, the diagnosis was made by consensus. We defined cutoff value for rCBV, Cho/Cr and Cho/NAA using receiver operator characteristic (ROC) curve. Using the cutoff value of each parameter, the same scoring system was applied again to the combination of conventional MRI and PWI, and conventional MRI and PWI/MRS, respectively. We assessed the area under the ROC curve (AUC) of conventional imaging criteria alone, combined conventional MRI and PWI, and combined conventional MRI and PWI/MRS data to test whether there is additional diagnostic value of PWI and MRS.

RESULT
Among the AUC of MRS parameters, Cho/Cr ratio is the higher value. The ROC curve showed that rCBV >1.14 (sensitivity 75.9%, specificity 67.7%) and Cho/Cr > 1.96 (sensitivity 72.2%, specificity 67.7%) was optimal for predicting tumor. Conventional MRI combined with PWI/MRS had highest discriminatory capabilities in differentiating tumors from non-tumorous conditions than conventional MRI alone (AUC 0.942 vs 0.841, p value < 0.05) and the sensitivity and specificity was higher (97.2%, 77.8% vs 86.1%, 66.7%). Combined conventional MRI and PWI had higher AUC value (0.907) compared to conventional MRI alone but the difference did not reach to the significant level (p=0.08).

CONCLUSION
The combination of conventional MRI with PWI and MRS revealed superior diagnostic performance compared to conventional MRI alone or combination of conventional MRI and PWI for differentiating between the brain tumors and nontumorous conditions. Our result may advocate the usage of PWI and MRS for differentiating between tumors and nontumorous conditions in the brain.

KEY WORDS: Functional MRI

Paper 132 Starting at 4:10 PM, Ending at 4:18 PM
Pilot Study of Diffusion Tensor Imaging in Fibromyalgia: Evaluation of the Pain Pathway and Limbic System

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PURPOSE
Fibromyalgia (FM) is a chronic, painful rheumatologic syndrome commonly associated with complaints of poor short-term memory and other cognitive impairments. Routine brain MR imaging in FM is usually unremarkable, and a prior diffusion tensor imaging (DTI) study did not describe CNS abnormalities, although there was no detailed study of pain pathways reported in that study. Since a recent report described significant peripheral myelin injury in FM we looked for CNS myelin abnormalities in FM pain and limbic system pathways, compared to age-matched, healthy control patients, using DTI.

MATERIALS & METHODS
Five FM patients with cognitive impairment and five age-matched healthy controls had MR imaging on a 1.5 T scanner. Diffusion tensor imaging was obtained using 2 x 2 x 4 mm voxel size, two b values of 500 and 1200 s/mm² for 12 directions. Collective regions of interest (ROI) were defined in the pain pathway and limbic pathway. The pain pathway included: ventroposterior lateral nucleus and anterior nucleus of thalamus, posterior insular cortex, anterior cingulate gyrus, and periaqueductal gray. The limbic system pathway included: hippocampus, parahippocampal gyrus, fornix, anterior thalamic nucleus and cingulum. Mean ADC and FA values in the right posterior insular cortex in FM patients were significantly lower compared to the control subjects (p = 0.02). There was a trend toward lower mean FA values for the left ventroposterior lateral thalamic nucleus, left anterior cingulate gyrus and left amygdala. There was no significant difference in mean ADC values.

RESULTS
The mean FA values in the right posterior insular cortex in FM patients were significantly lower compared to the control subjects (p = 0.02). There was a trend toward lower mean FA values for the left ventroposterior lateral thalamic nucleus, left anterior cingulate gyrus and left amygdala. There was no significant difference in mean ADC values.
between the FM patients and normal controls.

**CONCLUSION**

This pilot study supports the feasibility of using DTI to study the pain and limbic pathways in FM. An ongoing analysis of a larger group of FM patients and controls is in progress.

**KEY WORDS:** Fibromyalgia, DTI

**Paper 133 Starting at 4:18 PM, Ending at 4:26 PM**

**Limbic Metabolic Changes in Young Unaffected Biological Relatives of Schizophrenia Patients Detected with 1H MRS at 3 T**

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**PURPOSE**

Schizophrenia is a heritable neurodevelopmental disorder characterized by brain volume deficits(1) and reduced N-acetyl-aspartate (NAA)(2). Biological relatives of schizophrenia patients are at higher risk to develop schizophrenia and similar, but less severe, neuroanatomical, electrophysiological, neurocognitive and behavioral deficits. The purpose of this research is to determine 1H MRS markers of disease vulnerability in the hippocampus and anterior cingulate cortex (ACC) that might be useful in the early identification of schizophrenia.

**MATERIALS & METHODS**

A total of 35 normal relatives of schizophrenia patients (19.43 years old ± 2.8, 62.8% men) and 24 healthy controls (20.27 years old ± 2.9, 58.3% men) were evaluated with MR imaging and MR spectroscopy (MRS) of the left hippocampus at 3 T (Magnetom Tim Trio; Siemens, Erlangen, Germany) with the 8 channel head coil. MR spectroscopy of the ACC was obtained in 24 relatives (19.65 years old ± 2.6, 62.5% men) and 20 controls (20.66 years old ± 2.9, 60% men). The MR imaging protocol included: 1) Coronal T1 3DMPRAGE: TR/TE/TI=2530/3.34/1100, 1 NEX, flip angle =10°, FOV=260 mm, 1.5mm thick, voxel size=1.4x1x1.5, 2) Coronal T2 TSE: TR/TE= 5340/14, FOV=260 mm, 3mm thick, voxel size=1.4x1x3, 3) Water-suppressed single voxel MRS with PRESS volume selection centered at the left hippocampus with TR/TE=3000/30, 128 acquisitions, VOI size = 4.5 cc, 4) Water-suppressed single voxel MRS with PRESS volume selection localized in the midline including the bilateral ACC with TR/TE=3000/30, 64 acquisitions, VOI size = 8 cc. Sequences 3) and 4) were repeated without water suppression. Raw spectroscopy data files were postprocessed with LCModel software. The unsuppressed water signal was used for eddy current correction and as quantification standard. Signals from NAA, creatine, choline, myo-inositol and glutamate plus glutamine were quantified. Fit values with Cramer Rao lower bounds of 20% or higher were excluded from the analysis. Metabolite ratios were used to account for partial volume effects.

**RESULTS**

There was no significant age or sex difference between biological relatives of schizophrenia patients and controls. Compared to controls, relatives of schizophrenics had reduced NAA/choline in the left hippocampus (4.61 vs. 5.07, F(1,58)=4.99, p=0.029) and the bilateral ACC (5.75 vs 6.39, F(1,43)=5.077, p=0.030). No other significant metabolic differences between the groups were demonstrated.

**CONCLUSION**

Young, nonpsychotic relatives of schizophrenia probands, who are within age range at risk for developing the disorder, show brain chemical abnormalities in the bilateral ACC and left hippocampus. Reduced NAA and/or increased choline suggest impaired neuronal integrity and increased membrane turnover respectively. N-acetyl-aspartate loss has been replicated in the frontal lobes and hippocampus of schizophrenia patients (2). These findings add to the expanding knowledge on premorbid markers that may assist in the early identification of schizophrenia for primary and secondary prevention of the disorder.

**REFERENCES**


**KEY WORDS:** Spectroscopy, schizophrenia

**Paper 134 Starting at 4:26 PM, Ending at 4:34 PM**

**Effect of Prescan Patient-Radiologist Encounter on Functional MR Image Quality**

Mahmoud, S. Y. · Ahmed, M. · Emch, T. · Jones, S. E. · Lockwood, D. · Masood, P. · Moon, D. · Phillips, M. D. · Ruggieri, P. · Smith, A. · Stultz, T. · Tievsky, A.
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**PURPOSE**

Due to low signal-to-noise ration(SNR), a non-negligible fraction of clinical fMRI examinations inadequately assess language localization or lateralization, usually secondary to patient movement and suboptimal participation. We hypothesize a dedicated radiologist prescan interview reduces the fraction of nondiagnostic scans. Added significance are new CPT codes for fMRI: previously a single code (70554) was used for fMRI; now two codes (70555 and 96020) can be used, the former providing for image acquisition, and the latter providing for professional involvement of neurofunctional testing selection and administration (1).

**MATERIALS & METHODS**

A single noise score for each acquisition was produced from time series data, based on a weighted sum of 22 factors. Included were variations and task-correlation of head displacement and rotation, background signal intensity and gradients, outliers, and fractional activation overlaying brain periphery and calvarium. Noise scores were quartiled as 0-5 = excellent, 5-10 = adequate, 10-15 = marginal, and > 15 = unacceptable. This measure was tested on 149 fMRI patients: 98 without physician prescan interview and 51 with physician prescan interview using a programmed flip-folder of images and text to reinforce the importance of minimizing...
motion and task cooperation. Radiologist’s interview time ranged from 5-15 minutes, except for one investigator with an extended interview of 20 minutes. A Siemens Trio was used with motor and language paradigms including rhyming, word-generation, and listening. Noise scores between the two groups were compared on both sequence and mean-exam basis, using Mann-Whitney test.

RESULTS
Seven hundred thirty-seven sequences were acquired, of which 269 used a prescan interview. Of these, 69 interviews were extended. The mean noise-score was significantly reduced from 7.8 (without) to 6.3 (with intervention), p=0.0012. The extended subgroup was reduced to 5.4, p=0.0022. Prescan intervention reduced percentage of unacceptable sequences from 15% to 10%. Intensive intervention reduced the percentage from 15% to 5%. Below are example images from the patient-presentation, graphically illustrating the importance of reduced movement (left pair) and active participation (right pair).

CONCLUSION
We demonstrate a modest but significant reduction in fMRI noise score by the prescan physician-patient encounter, with longer encounter times leading to improved scan quality. Number of inadequate sequences can be reduced by one to two thirds, depending on the degree of encounter. These results support the newly added billable costs of the intervention of professionals prior to fMRI scans.

REFERENCES

KEY WORDS: fMRI, functional localization, scan quality

Paper 135 Starting at 4:34 PM, Ending at 4:42 PM
Correlations Between Axonal Counts and Diffusion Tensor Imaging Measures in a Mouse Model of Experimental Autoimmune Encephalomyelitis

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PURPOSE
Multiple sclerosis (MS) is an inflammatory disease of the central nervous system resulting in accumulation of areas of demyelination and axonal loss. The animal model of the disease, experimental autoimmune encephalomyelitis (EAE) has been used extensively to elucidate disease pathogenesis and test novel treatments. There have been reports of correlations between diffusion tensor imaging (DTI) measures and histopathologic data pertaining to axonal loss and demyelination in a rat model of EAE and very small numbers of EAE mice. The purpose of our study was to assess relationships between cord DTI measures and histopathology in a population of EAE mice at different stages of the disease.

MATERIALS & METHODS
A total of 22 C57BL/6 mice were induced with EAE at 6-8 weeks of age. Mice were sacrificed at 7, 12, 30 days, 7 and 11-12 months post-immunization and the spinal column fixed overnight. The fixed cervical spinal column/cord was imaged using an 11.7 T Spectrometer and a Micro 2.5 gradient system (Bruker Biospin, Billerica, MA, USA). A 15 mm birdcage coil was used as the radio frequency signal transmitter and receiver. Images were acquired using 3D multiple spin-echo sequence, echo train length (ETL) of 6, repetition time (TR) of 900 ms, two signal averages and echo times (TE) of 36/50/64/78/92/106 ms. Imaging resolution was 0.1 mm x 0.1 mm x 0.1 mm. Eight diffusion-weighted images were acquired: 2 images of minimum b-value (50s/mm2) and 6 with maximum b-value (1500s/mm2); δ=5 ms, Δ=12 ms. Diffusion sensitizing gradients were applied along six directions.

After imaging, the spinal cord was embedded in paraffin. One micron sections were cut at the C5 level and stained for axonal counting. The axons in the medial dorsal column at C5 were toluidine blue-stained and quantified. Imaging analysis involved manually defining regions of interest within the dorsal columns at the C5 level corresponding to the areas included in the axonal count. Apparent diffusion coefficients (ADC), axial diffusivity (λ₁), radial diffusivity (λ₂), and fractional anisotropy (FA) values were determined for each region of interest. All imaging postprocessing was performed using our fiber tracking software (DTIstudio). Correlations were examined between DTI parameters and axonal counts.

RESULTS
Axonal counts within the dorsal column at the C5 level ranged from 1127 to 11506 (mean=3930 ± 574.7). Significant correlation was present between axonal counts and λ₂ (r=0.60, p=0.004). There was also a significant correlation between FA and axonal counts within the dorsal column in this EAE model (r=0.54, p=0.009). A trend towards a negative correlation between λ₁ and axonal counts also was observed (r=-0.40, p=0.06). There was no significant correlation between ADC values and axonal counts.

CONCLUSION
Our study supports prior findings of significant correlations between λ₂ and FA values and axonal counts; findings appear to pertain to a wide range of axonal loads. Contrary to prior reports, a trend for significant correlation also was observed between axonal counts and λ₁ in this model with minimal demyelination, indicating that λ₁ differences are not purely an effect of myelin loss.

KEY WORDS: Experimental autoimmune encephalomyelitis, diffusion tensor imaging
Paper 136 Starting at 4:42 PM, Ending at 4:50 PM
Highly Accelerated SENSE-MRSI at 3 T Using a 32-Channel Head Coil

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Baltimore, MD

PURPOSE
Proton magnetic resonance spectroscopic imaging (MRSI) is a powerful tool for investigating brain metabolism in vivo. However, when using conventional 2D or 3D phase-encoding techniques, scan times are prohibitively long for high-resolution acquisitions with extended spatial coverage. The purpose of this study was therefore to investigate the feasibility of highly accelerated sensitivity-encoded (SENSE) multislice of the human brain at 3 T using a newly developed 32-channel head coil.

MATERIALS & METHODS
Multislice MRSI was performed at 3T using a prototype 32-channel head coil, and compared to a standard 8-channel coil (Invivo, Gainesville, FL) in a normal human volunteer. RF pulses were transmitted using the body coil. Three 15 mm thick slices were recorded with TR/TE 2500/140 ms, outer volume and dual band water and lipid suppression, FOV 230 x 180 mm, matrix 33x27, nominal voxel size 0.84 cm3. Using a SENSE acceleration factor of 6 (3 L-R, 2 A-P), total scan time was 4 min 38 sec.

RESULTS
Using the 32-channel head coil, good quality, artifact-free metabolic images were produced (Figure). In contrast, at this high SENSE factor (6), the 8-channel data contains appreciable artifacts, particularly due to insufficient lipid unfolding. Over all voxels analyzed, the NAA signal-to-noise ratio was 34% higher with the 32-channel coil compared to the 8-channel coil.

CONCLUSION
Rapid, multislice MRSI with high SENSE factor acceleration is feasible, and shows improved SNR and reduced artifacts with a 32-channel compared to an 8-channel coil. Accuracy of SENSE reconstruction (particularly lipid unfolding) is improved with the larger number of coils, which also have improved (less degenerate) sensitivity pro-

files. SENSE encoding allows high-resolution MRSI with extended spatial coverage to be performed within a clinically acceptable scan time of less than 5 minutes.

KEY WORDS: Spectroscopic imaging, brain, SENSE

Paper 137 Starting at 4:50 PM, Ending at 4:58 PM
Functional MR Imaging Evaluation at 3 T of the Visual Cortical Response in Asymmetric Glaucoma

Nguyen, T. H. · Stievenart, J. L. · Yoshida, M. · Abanou, A.
1C.H.N.O. des XV-XX, Paris, FRANCE, 2Jikei University and School of Medicine, Tokyo, JAPAN

PURPOSE
Comparative exploration in 3 T functional MR imaging (fMRI) of cortical response according to visual field defect in asymmetric glaucoma.

MATERIALS & METHODS
We evaluated 10 patients addressed for asymmetric glaucoma (6 male and 4 female, aged from 55 to 73 years). Unilateral visual loss was observed in central field in six patients, in central and peripheral field in three patients. The contra lateral eye presented a normal visual field or a mild peripheral visual field defect. A comparative fMRI evaluation was completed in five volunteers with no ophthalmologic involvement. Anatomical evaluation preceded fMRI, which alternated still and flickering black and white checkerboards with spatial and temporal frequencies dedicated to the magnocellular and the parvocellular visual pathways. Anatomical realignment and statistical evaluation were completed using Brain Voyager©, fitting the raw functional data to the hemodynamic response function (HRF) and to ICA analysis.

RESULTS
Anatomical MR imaging demonstrated normal or small diameters of the nervus opticus respectively according to the evolution of glaucoma. A signal abnormality may be associated, mainly concerning the canalar and cisternal portions of the nerve. Functional MR imaging elicited different cortical responses: 1) in optic atrophy, a lower response in V1 was associated to recruitment of secondary visual areas, with an inversed temporal evolution; 2) in extended visual field defect with preserved central vision, an enhanced response in V1 and V5; 3) in mild visual field defects, a visual cortical response comparable to that of the normal eye.

CONCLUSION
These preliminary results suggested a cortical adaptation to the evolution of visual field defect in glaucoma, with a V1 reinforcement compensating the peripheral visual defect. Recruitment of the secondary visual areas may supply the central field loss to complete the perception and the analysis of the visual stimuli. Functional MR imaging of the visual cortical response should be included in the routine follow up of visual field loss in glaucoma.

KEY WORDS: Vision, glaucoma, fMRI
Imaging Selection Criteria for Spinal Fusion

Davashish Nag, FRCR

LEARNING OBJECTIVES
Upon completion of this presentation, participants will be able to:
1) Review imaging selection criteria for spinal fusion.
2) Analyze correlation of imaging with clinical outcomes.

PRESENTATION SUMMARY
Long before the advent of anesthesia, immobilization of the spine formed an integral part of management of back pain. With time, and the ability of imaging to demonstrate aberrations of spine anatomy, came the extension of the old philosophy, that restoring the spine to its normal position would surely lead to clinical benefits. Over the years a multitude of surgical techniques have been developed, all specifically designed to provide stability, with a view to reducing pain and disability. Radiologic imaging forms a key element of patient selection for fusion procedures. As always, there is continued debate about the overall success of these procedures, particularly when measured against the outcomes in control groups of the population where less invasive or other forms of interventions have been tried. During this talk, the correlation between successful outcomes after spinal fusion and preoperative imaging selection criteria will be fully explored. Particular emphasis will be placed on the role of plain films, dynamic imaging, diskography, CT and MR imaging in the evaluation of individual disease processes. The analysis will focus on published series with a commentary on the pathophysiologic basis of apparent discrepancies in results.

REFERENCES

Imaging of Spinal Implants

Alyssa T. Watanabe, MD

LEARNING OBJECTIVES
Upon completion of this presentation, participants will be able to:
1) Review surgical options in treating axial low back pain.
2) Identify imaging appearance and potential complications of spinal implants.
3) Describe cutting edge techniques in imaging a patient with hardware.

PRESENTATION SUMMARY
Since the 1960s, there has been increased recognition of internal disk derangement (IDD) as a source of axial back pain. The increased diagnosis of IDD has led to a significant change in the way that low back pain is managed. This lecture will review the different surgical approaches used for spinal fusion. Anterior fusion has become technically more successful with the use of fixation hardware, interbody cages, and bone morphogenic protein. The goals of the anterior fusion include restoration of disk height and foramina, restoration of lordosis or alignment, increased stability, and limiting motion to permit fusion. Posterior fusion adds compression which promotes anterior fusion. Normal imaging findings and potential complications such as subsidence, pseudoarthrosis, heterotopic bone formation, hardware failure, and cerebrospinal fluid (CSF) leak will be addressed. Today, numerous other devices have been developed for treating back pain, including artificial disks, nuclear replacement, and interspinous process devices. Interspinous process
devices are approved for use in spinal stenosis and sometimes may be inserted in association with a mini-laminotomy. Examples of bio-absorbable implants and dynamic stabilization devices also will be presented. Even facet replacement is being investigated. New surgical approaches, such as XLIF and hybrid fusion/disc replacement surgery will be illustrated. The XLIF is a minimally invasive approach to anterior spinal fusion which involves endoscopic surgery and no removal of the anterior or posterior longitudinal ligaments. However, it can be performed at L1-5 levels only. Technical aspects of how to reduce imaging artifacts on CT and MR imaging from hardware will be discussed. The cobalt-chrome used in artificial disks is most problematic for CT and MR imaging. The STIR sequence is significantly superior to T2 fat suppression in metal artifact reduction since there is less dependence on field homogeneity. Gradient-echo imaging has more magnetic susceptibility than T2 FSE due to lack of 180 degree refocusing pulse. Therefore, T2 FSE is useful in imaging cervical ADR patients. Although 3T MR imaging produces greater susceptibility artifacts than lower field strength magnets, the degree of distortion is offset by wider bandwidth, higher gradient strengths, and higher matrix inherent in the ultra-high field systems. Clinical examples comparing 1.5 and 3 T imaging will be presented. Metal artifact reduction sequences (MARS) may diminish hardware artifacts somewhat, but at the sacrifice of imaging resolution. Also, the longer echo train lengths with MARS results in longer imaging acquisition times. For CT, higher kVp and smoothing algorithms reduce metal artifact, but increasing mAs does not. The key to metal artifact reduction in CT is thin collimation and isotropic imaging, which can be obtained using current 16 slice and above CT scanners.

REFERENCES

**Intervention in Post Operative Back**

*Gregory J. Lawler, MD*

**Learning Objectives**
Upon completion of this presentation, participants will be able to:
1) Review various image-guided techniques for diagnosis and therapy in the post-operative spine.
2) Discuss the indications, risks, and benefits of each technique.
3) Review materials and technical aspects of each interventional procedure.

**Presentation Summary**
Various image-guided interventional techniques in the post-operative spine will be discussed. Emphasis will be placed on indications for each technique as well as technical aspects of performing each procedure. Clinical cases and management of each case will be discussed. Procedures discussed will include: provocative discography, epidural blood patch, epidural lysis of adhesions, vertebroplasty after failed kyphoplasty, lumbar drain placement, drainage of post-operative fluid collections, disk aspiration, bone biopsy, and myelography to evaluate for CSF leak.

**Monday Afternoon**

5:00 PM – 6:30 PM
**Hall A**

(13) (SNIS) Intracranial Atherosclerotic Disease (ICAD) Imaging and Treatment Audience Response Plus (AR+)*
Self-Assessment Module (SAM)**

*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 and SAM session programming

**Programming is currently under review for qualification as a Self Assessment Module (SAM) through the American Board of Radiology (ABR).**

(142) Rationale for the SAMMPRIS Trial
— Colin P. Derdeyn, MD

(143) Imaging of ICAD
— Harry J. Cloft, MD, PhD

(144) Follow-up Imaging after Stenting (MRA/CTA/TCD/MR Phase Contrast/Angio)
— Aquilla S. Turk, DO

**Moderator:** Gary M. Nesbit, MD
Rationale for the SAMMPRIS Trial

Colin P. Derdeyn, MD

LEARNING OBJECTIVES
Upon completion of this presentation, participants will be able to:
1) Summarize the existing data supporting angioplasty and stenting for intracranial atherosclerotic stenosis.
2) Explain the rationale for the randomized trial of medical therapy versus angioplasty and stenting.

PRESENTATION SUMMARY
The Stenting versus Aggressive Medical Management for the Prevention of Recurrent Ischemic Stroke (SAMMPRIS) Trial is an NIH-funded randomized multicenter trial designed to test the hypothesis that angioplasty and stenting together with guideline-based risk factor management of serum cholesterol and hypertension is superior to medical management alone. This is a critically important study for the field of NeuroIntervention and will have a profound impact on our practice. This trial opened to enrollment in November, 2008. The purpose of this talk is to review the background and rationale for the trial. This will include the current knowledge regarding natural history and medical treatment, as well as the subgroup analyses from trials of medical management that have identified subgroups at particularly high risk for future stroke. The current level of evidence for endovascular intervention will also be reviewed. The design and current status of this important and ongoing trial will be summarized.

Imaging of ICAD

Harry J. Cloft, MD, PhD

LEARNING OBJECTIVES
Upon completion of this presentation, participants will be able to:
1) Understand the imaging modalities used to evaluate intracranial stenosis.
2) Review DSA is the gold-standard, but CTA is sometimes more accurate in assessing intracranial stenosis.
3) Discuss MRA and TCD which can be misleading in the diagnosis of intracranial stenosis.

PRESENTATION SUMMARY
Diagnosis of Intracranial Stenosis. In the case of intracranial atherosclerosis, four imaging modalities might be considered. These modalities are digital subtraction angiography (DSA), computed tomographic angiography (CTA), magnetic resonance angiography (MRA), and transcranial Doppler (TCD). Digital subtraction angiography traditionally has been the gold standard for imaging intracranial pathology. It offers superb spatial resolution and contrast resolution. But DSA for patients with TIA/stroke is an invasive procedure that carries a small but real risk of permanent neurologic deficit of 0.7%. Digital subtraction angiography gives physiologic information about flow contribution from the injected artery. This physiologic effect is sometimes a disadvantage, as slow-flow vessels distal to a stenosis may be poorly filled with contrast material and thus poorly visualized. Multiple arteries often need to be injected to show collateral blood flow. For posterior circulation stenosis, both vertebral arteries generally need to be evaluated. CT angiography can be better than catheter angiography when flow is severely limited distal to the stenosis. CT angiography can give excellent anatomical visualization of intracranial atherosclerosis. The use of CT angiography does not avoid the use of contrast material or ionizing radiation, but these offer trivial risks in most patients relative to the potential risks associated with symptomatic intracranial atherosclerosis. Spatial resolution occasionally may limit our ability to distinguish very severe stenosis from occlusion compared to DSA. Calcium also might occasionally cause overestimation of a stenosis, as was described for CTA of the cervical carotid artery. It is a firmly established fact that MRA tends to overestimate degree of stenosis. MR angiography has poor spatial resolution relative to what is now available for CTA and DSA, so we cannot reasonably expect to reliably image stenotic vessels with a lumen of less than one millimeter. 3D TOF MRA is susceptible to artifacts secondary to turbulent flow, and some degree of turbulent flow generally is present with stenotic intracranial atherosclerosis. Even normal arteries can be misrepresented on MRA, because curves in normal arteries can cause turbulence that creates an artificial stenosis. These artificial stenoses account for the poor positive predictive value of MRA for intracranial atherosclerosis. No contrast or ionizing radiation is needed for an MRA, but how much harm really comes to patients from the use of iodinated contrast material or ionizing radiation? Transcranial Doppler has a high negative predictive value (83%), but a low positive predictive value (55%), so it is often inaccurate and should not be relied upon in cases of suspected intracranial stenosis.

Follow-up Imaging after Stenting (MRA/CTA/TCD/MR Phase Contrast/Angio)

Aquila S. Turk, DO

LEARNING OBJECTIVES
Upon completion of this presentation, participants will be able to:
1) Identify the role of non-invasive imaging in the follow up of intracranial stenting.
2) Review the strengths and benefits of the various imaging modalities in follow up of intracranial stenting.

PRESENTATION SUMMARY
Endovascular stenting for the treatment of intracranial atherosclerosis is a rapidly growing modality in the field of neurointerventional surgery. While reports of the initial clinical benefits seem positive and the SAMMPRIS trial is ongoing, the incidence of restenosis associated with the stent is not trivial. The United States multicenter registry results, reported by Fiorella, et al., found restenosis rates of approximately 35%, but fortunately the majority of those patients were asymptomatic. The ability to noninvasively follow patients with intracranial stents seems to offer a safe and convenient way to follow these patients, especially in the absence of recurrent clinical symptoms. Magnetic resonance imaging/angiography (MRI/A), computed tomography/angiography
(CT/A), transcranial Doppler (TCD) and conventional catheter angiography comprise the primary tools utilized to evaluate the cerebral vasculature. This lecture will highlight the advantages and pitfalls associated with each of these imaging modalities that are used to follow intracranial stents.

**MR Spectroscopy in Pediatric Brain Tumors**

*Stevan Bluml, PhD*

**LEARNING OBJECTIVES**

Upon completion of this presentation, participants will be able to:

1. Identify metabolic features of the most common pediatric brain tumors.
2. Specify the importance of consistency and quality control.

**PRESENTATION SUMMARY**

Childhood brain tumors are the second most frequent malignancy of childhood, exceeded only by leukemia, and the most common form of solid tumor. Brain tumors are the leading cause of death from cancer in pediatric oncology. In this presentation the metabolic pattern of the most common pediatric brain tumors will be presented. The emphasis will be on spectroscopy acquisition methods that are widely available (proton spectroscopy and “push-button” applications) at clinical field strength. It will be discussed where and how MR spectroscopy (MRS) can improve accuracy of initial diagnoses. Whereas most brain tumors in adults are gliomas (~75% malignant anaplastic astrocytoma and glioblastoma), a significant portion of pediatric brain tumors originate from different cell types with significantly different metabolism such as medulloblastoma (primitive neuroectodermal tumor), pilocytic astrocytomas, ependymomas, germ cell tumors and others. It also will be discussed whether MRS might be useful for initial risk assessment and to what extent MRS can be used for therapeutic monitoring of tumors. Also, the limitations and pitfalls of MRS in clinical practice and the importance of quality control will be pointed out.

**GABA, Glutamate and More**

*Dikoma C. Shungu, PhD*

**LEARNING OBJECTIVES**

Upon completion of this presentation, participants will be able to:

1. Identify a number of biological roles of GABA, glutamate and glutathione.
2. Discuss the challenges associated with reliable brain detection of TABA, glutamate and glutathione using proton MRS.
3. Indicate existing “spectral editing” methods for making reliable brain measurements of GABA, glutamate and glutathione using proton MRS.

**PRESENTATION SUMMARY**

There is a great deal of interest in measuring brain levels of γ-aminobutyric acid (GABA), glutamate (Glu) and glutathione (GSH), respectively, the major inhibitory and excitatory amino acid neurotransmitters and antioxidant in the central nervous system (CNS), due to their potential involvement in the pathophysiology of a variety of neuropsychiatric (schizophrenia), neurologic (epilepsy) and neurodegenerative (Parkinson disease, aging) disorders (1-3). Currently, proton magnetic resonance spectroscopy (1H MRS) is the only noninvasive technique that offers the possibility to measure these critically important neurometabolites in the living brain (4,5). However, in practice, GABA, Glu and GSH detection by 1H MRS presents formidable challenges due to (a) their relatively low brain concentration, (b) the overlap of their resonances by much stronger signals, and (c) the contamination of the detected signals by those from mobile macromolecule, which can decrease spectral purity and complicate quantitation and interpretation. This presentation will describe sophisticated approaches that have been implemented to overcome these impediments to reliable brain GABA, Glu and GSH measurements, including use of “spectral editing” to eliminate spectral overlap and phased-array head coils to increase detection sensitivity. At the conclusion of the presentation, the participants should be familiar with a number of the biological roles of GABA, glutamate and glutathione, as well as with the challenges and solutions for making their reliable in vivo brain measurements using 1H MRS.

**REFERENCES**

MR Spectroscopy at Very High Magnetic Fields

Ivan Tkac, PhD

Dr Tkac attended graduate school and received his PhD from Comenius University, Bratislava, Slovakia. His previous academic appointments were: Slovak Academy of Sciences (High-resolution NMR spectroscopy) and the University Hospital Bratislava (In vivo NMR spectroscopy). Dr Tkac’s current appointment is: Center for Resonance Research, University of Minnesota. His main fields of interest are: Development of methods for high-field MRS, MRS of human brain at very high fields, and MRS of transgenic mouse models.

LEARNING OBJECTIVES
1) Describe what we gain at high field.
2) Identify potentials and challenges of high field MRS.

PRESENTATION SUMMARY
In vivo magnetic resonance spectroscopy (MRS) is a unique method providing quantitative biochemical information about the selected volume of interest inside the body noninvasively. The strength of magnetic field has a significant impact on achievable biochemical information due to increased sensitivity and chemical shift dispersion at high magnetic fields. The aim of this presentation is to provide an overview of potentials and challenges of human brain MRS at very high magnetic fields. First, the basic methodology of high-field MRS (1), allowing reliable quantification of more than 15 brain metabolites, will be described. Second, with selected examples of high-field MRS, the strength of using neurochemical profiles for a better understanding of the function of the brain under normal (2) and pathologic conditions (3) will be demonstrated. Finally, potentials of finding new metabolic markers for diagnosis and the monitoring of treatment will be reviewed.

REFERENCES
Tuesday Morning

7:45 AM - 8:45 AM
Hall A

(16) Maintenance of Certification (MOC) - Adult Brain and Pediatric Spine
Audience Response Plus (AR+)*
*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.

(149) Adult Brain

— Steven G. Imbesi, MD

(150) Pediatric Spine

— Kevin R. Moore, MD

Moderator: Steven G. Imbesi, MD

Adult Brain

Steven G. Imbesi, MD

**Learning Objectives**
Upon completion of this presentation, participants will be able to:
1) Interpret numerous adult brain pathologies.
2) Formulate an appropriate limited differential diagnosis for the imaging findings.
3) Cite adult brain cases to help prepare for the Neuroradiology Maintenance of Certification (MOC) exam.

**Presentation Summary**
Unknown adult brain CT, MR imaging, and angiogram cases will be presented 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. 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 practicing neuroradiologists.

Pediatric Spine

Kevin R. Moore, MD

**Learning Objectives**
Upon completion of this presentation, participants will be able to:
1) Illustrate common and uncommon pediatric spine diagnoses.
2) Discuss important age specific pediatric spinal disorders.
3) Review for the MOC recertification examination.

**Presentation Summary**
The presenter will provide unknown cases demonstrating important common and uncommon pediatric spinal disorders, with an emphasis on practical discussion of entities that may be seen both in primarily adult practices as well as pediatric practices. Review questions will be tailored to MOC recertification examination preparation.
Dr. Wolfe became interested in visual perception during the course of a summer job at Bell Labs in New Jersey during high school. He graduated with an AB in Psychology (summa cum laude) from Princeton in 1977 and a PhD from MIT in 1981. Dr. Wolfe remained at MIT until 1991 publishing on binocular rivalry, visual aftereffects, and accommodation. In the late 1980s, the focus of the lab shifted to visual attention and visual search. In 1991, Dr. Wolfe moved to Brigham and Women's Hospital where he is on the steering committee of the Center for Advance Medical Imaging and Harvard Medical School where he is Professor of Ophthalmology. Dr. Wolfe is Past-President of the Eastern Psychological Association, He won the Baker Memorial Prize for teaching at MIT in 1989. He is a fellow of the American Association for the Advancement of Science, the American Psychological Association (Div. 3 and 6), the American Psychological Society, and a member of the Society for Experimental Psychologists. He lives in Newton, Mass. with his wife, Julie Sandell (Professor of Neuroanatomy at Boston University School of Medicine), three sons, two cats, two snakes, and occasional mice.

Advanced Concepts and Techniques for Medical Volume Data Visualization

Kwan-Liu Ma, PhD

Dr. Kwan-Liu Ma is a professor of computer science at the University of California Davis. He leads the VIDI (Visualization and Interface Design Innovation) research group, and directs the DOE SciDAC Institute for Ultra-Scale Visualization. His research spans the fields of visualization, high-performance computing, and user interface design. Professor Ma received his PhD in computer science from the University of Utah in 1993. During 1993-1999, he was with ICASE/NASA LaRC as a research scientist. In 1999, he joined the University of California Davis. In the following year, Professor Ma received the Presidential Early Career Award for Scientists and Engineers (PECASE). Professor Ma is presently leading a team of 20 researchers working on projects in large data visualization, information visualization, visual interface design, artistically inspired illustrations, and volume visualization. He actively serves the research community by playing leading roles in the SC06, SC07, and SC08 Workshop on Ultra-Scale Visualization, 2007 Asia-Pacific Symposium on Visualization, 2008 Pacific Visualization Symposium, and 2008 Eurographics Symposium on Parallel Graphics and Visualization. He is a paper chair of the IEEE Visualization Conference in 2008 and 2009. Professor Ma also serves on the editorial boards of the IEEE Computer Graphics and Applications and the IEEE Transactions on Visualization and Graphics.

LEARNING OBJECTIVES:
Upon completion of this presentation, participants will be able to:
1) Describe advanced visualization technologies.

PRESENTATION SUMMARY
In this talk, I will introduce a few advanced concepts and techniques for data visualization that we have developed recently relevant to medical volume data analysis. The visualization of complex 3D images remains a challenge, a fact that is magnified by the difficulty to classify or segment volume data, the increased size of the data, and the growing use of multimodal data. I will begin with an overview of our large data visualization research. Next, I will present a new interactive classification technique that enables isolation and enhancement of volumetric features in image data according to their size, and then also present an interactive view-dependent feedback design making easier classifying features of interest that are occluded by materials of similar values. Finally, I will discuss collaborative image analysis and diagnosis through novel interactive visualization interface designs.
Moving Toward Solutions to Image Overload
Evan K. Fram, MD

LEARNING OBJECTIVES
Upon completion of this presentation, participants will be able to:
1) Discuss the image overload problem in medical imaging.
2) Describe aspects of visual perception and cognition relevant to image interpretation and image overload.
3) Review some early progress that has been made in moving toward solutions to the image overload problem and the potential for further progress.

PRESENTATION SUMMARY
Too many images and too few eyes. The image overload problem is one of the biggest challenges facing medical imaging today and the result of three factors: 1) An explosion in the number of images/exam, the result of technical advances in scanner technology and new clinical applications. 2) Continued growth in the number of exams/year as medical imaging continues to prove its value, new applications are developed, and the overall demand for medical care grows. 3) A shortage of radiologists. While advances in technology enabled the explosion in medical images, they have not lead to solutions to the resulting image overload. Advanced visualization techniques such as 3D are very useful, but so far in only a minority of exams. And despite decades of work on computer-aided diagnosis (CAD), it has had no impact in neuroradiology and only limited impact in radiology. Today, and for the foreseeable future, the most powerful medical image analysis system that exists is the neuroradiologist. But because of his human form, even the neuroradiologist is subject to the biological limits of human perception and cognition. In fact, modern PACS systems are capable of displaying huge numbers of images at rates that vastly exceed a human’s ability to assimilate and interpret the data. Therefore, the core issue in the image overload problem is biological, human perception and cognition. The challenge to developing biologically-based solutions to the image overload problem is that this endeavor does not fall into a single field, but at the intersection of fields - radiology, visual perception, cognition, imaging informatics, and computer gaming. Through collaboration with experts in these various fields there is the potential to move toward solutions to image overload by: 1) Designing new ways of interacting with images that leverage the strengths and overcome the weaknesses of human perception and cognition. 2) Developing training tools that enhance perception and cognition. The goals of this talk are to: 1) Outline the nature of the image overload problem. 2) Describe features of visual perception and cognition relevant to what we do as neuroradiologists and to the image overload problem. 3) Review some progress that has been made with respect to the image overload problem and discuss the potential for future progress.

Tuesday Morning
10:45 AM – 12:30 PM
Hall A

(18a) Adult Brain: Neoplasms I
(Scientific Papers 154 – 166)

See also Parallel Sessions
(18b) Interventional: New Devices & Techniques
(18c) Adult Brain: Vascular, Extracranial & Vascular, Intracranial II
(18d) Pediatric: Functional Imaging
(18e) Excerpta Extraordinaire: Interventional & Spine

Moderators: Marco Essig, MD, PhD
Edmond A. Knopp, MD

Paper 154 Starting at 10:45 AM, Ending at 10:53 AM
Terminology and Reporting System for Assessing Primary Glial Brain Tumors: Defining Imaging Biomarkers to Predict Clinical Outcomes

Flanders, A. E. 1 · Rubin, D. L. 2 · Dodd, L. 3 · Gorniak, R. J. 1 · Friedman, D. P. 1 · Freymann, J. 3 · Madhaven, S. 3
1 Thomas Jefferson University Hospital, Philadelphia, PA, 2 Stanford University, Palo Alto, CA, 3 National Cancer Institute, Bethesda, MD

PURPOSE
Current methods for assessing brain tumors and predicting clinical course based on radiologic imaging, such as MacDonald or RECIST criteria, do not exploit the diverse features currently visible on MR imaging. Our goal was to define comprehensive image features that may better characterize brain tumors and predict treatment response earlier than current assessment methods.

MATERIALS & METHODS
We studied current measures and criteria for assessing brain tumors on imaging. We expanded on the prior work to create a comprehensive set of image assessments for reporting and a controlled subjective terminology for describing brain tumors, including lesion location, morphology of substance, margin, and vicinity of lesion, and remote alterations. Our reporting system comprises 30 unique MR imaging features of brain tumors, organized into five categories. Each feature is recorded using controlled terminologies, enabling interoperability with other terminological standards, such as RadLex. This featureset was incorporated into a custom PACS research workflow engine such that exams could be graded directly on the clinical PACS system. Three neuroradiologists independently used the reporting system to evalu-
ate the features of 33 primary glial neoplasms. Collaborative training of the three neuroradiologists took place at the initi-
ation of the study and after review of the first 15 cases. Interobserver variation across all features was assessed with the Fleiss kappa statistic. The percentage agreement amongst raters for each feature individually also was calculated.

RESULTS
For the cases in which this reporting system was evaluated, overall interobserver agreement among all three readers was high (kappa = 0.68, p<0.001). Percentage agreement was also high for most features individually; 22 of 30 features (73%) had agreement greater than 50%, and 12 features (40%) had 80% agreement or better. No features had 20% or worse agreement. Single boolean features yielded the highest level of agreement while descriptors that required integration of multiple subjective features over multiple images (e.g. proportional estimates) performed poorer. Agreement was initially lower where definition of descriptors remained ambiguous. Agreement showed notable improvement after intervening training session suggesting that familiarity with the features improved reporting consistency.

CONCLUSION
Our terminology and reporting system for assessing brain tumors captures a broad spectrum of rich and detailed imaging features. While these are comprehensive and detailed descriptors, they could be quickly applied by neuroradiologists, as there was relatively low interobserver variation for most of the features. This suggests that a standardized lexicon can be applied successfully in describing imaging features of specific neurologic disease processes. Moreover, consistent use of a standardized vocabulary adds value to clinical imaging as a valid biomarker for grading and treatment response. Future work will be to correlate these features with clinical outcomes and molecular events.

KEY WORDS: Ontology, treatment response

Paper 155 Starting at 10:53 AM, Ending at 11:01 AM
Impact of High-Grade Gliomas on the Motor Hand Area: Functional MR Imaging, Dynamic Susceptibility Contrast MR Imaging and Clinical Evaluation

van Laak, D. · Wolff, S. · Moeller, B. · Warneke, N. · Jansen, O. · Ulmer, S.
University Hospital of Schleswig-Holstein Kiel, GERMANY

PURPOSE
The cause of loss of motor function in brain tumor patients is not known, but is thought to be caused by pressure of the lesion or the adjacent edema on the primary motor cortex. Decrease in cerebral perfusion and diminished activated voxels in functional MR imaging (fMRI) also have been described in a small series of patients. In this study we tried to assess influences of brain tumors on the adjacent brain.

MATERIALS & METHODS
Eleven patients with high-grade glioma (WHO grade III and IV) close to the motor cortex were included in this study after signed informed consent was achieved. Patients underwent clinical testing for fine motor skills (Purdue Pegboard, Picking Up Test) and were examined using the Frontal Lobe Score. Functional MR imaging (fMRI) was performed with a simple motor hand task using a block design, while patient’s motor tasks were recorded during the scanning using a pneumatic device. SPM 2 was used for data analyzes. Within the scope of preoperative imaging dynamic susceptibility contrast (DSC) MR imaging also was performed in eight patients. These data were analyzed using the NordicNeuroLab software (NordicNeuroLab, Bergen, Norway).

RESULTS
Clinical impairment did not correlate with the volume of fMRI activation (ratio affected vs nonaffected hemisphere). Handedness did not influence this either. The distance of the lesion to the primary motor hand area was independent of the volume of activated voxels and clinical impairment. Perfusion values (rCBV, rCBF and MTT) in the motor hand area were not influenced by the proximity of the lesion. However we found a significant correlation between DSC MR imaging and fMRI: the interhemispheric ratio of rCBF correlated significantly (p=0.046, cross correlation) with that ratio of interhemispheric voxel activation in fMRI.

CONCLUSION
Our preliminary data suggest that the distance of a high-grade tumor to the primary motor hand area does not influence clinical impairment; however, more data are needed especially with lesions being very close to the primary motor hand area. Activated voxels in fMRI rather represent cortical perfusion in general than a reflection of clinical impairment. This is an important finding as a ratio of activated voxels in fMRI is thought to be consistent with hemispherical dominance or handedness, but as demonstrated by our data this is nontransferable to a ratio of voxel activation in fMRI in brain tumor patients as it does not reflect clinical impairment.

KEY WORDS: DSC MR imaging, fMRI, motor hand area

Paper 156 Starting at 11:01 AM, Ending at 11:09 AM
Measuring Tumor Variability - Maximum Standard Deviations of Fractional Anisotropy and Apparent Diffusion Coefficient: Predicting Glioma Grade

White, M. L. · Zhang, Y. · Yu, F. · Kazmi, S. A. · Helvey, J. T. · Omojola, M. F. · Poage, D. P. · Hanh, F. J.
1University of Nebraska Medical Center Omaha, NE, 2University of Nebraska, Omaha, NE

PURPOSE
High grade gliomas are histologically more heterogeneous than low grade ones even without considering macroscopic tumoral cystic change, necrosis, and hemorrhage. This study is to determine if malignant gliomas have more variation of fractional anisotropy (FA) and apparent diffusion coefficient (ADC) by diffusion-tensor MR imaging. There has been very limited analysis of the dispersion of MR imaging metrics in gliomas. Maximum standard deviations (SDs) of tumor FA and ADC were compared respectively, among different tumor grades.

MATERIALS & METHODS
We retrospectively reviewed the pretreatment 3T MR (GE HDX, 8 channel head coil) images, including DTIs, of 26 patients with brain gliomas. Seven WHO grade II, 4 grade
III, and 15 grade IV gliomas were proved histologically. Fractional anisotropy and ADC measurements were made at an ADW 4.0 GE workstation by placing regions of interest (ROIs) over the pathology on the FA and ADC maps, respectively. Regions of interest were positioned carefully within the solid part of the tumors with effort to avoid any volume averaging from cystic changes/necrosis and peripheral tissue. The selected maximum SDs of FA and ADC were compared respectively, based on the different tumor grades, II, III and IV. Statistical significance was determined with Kruskal-Wallis Test and Wilcoxon Two-Sample Test.

RESULTS
The maximum SDs of tumor FA were 0.0159 - 0.0411 (mean = 0.0290) in grade II, 0.0492 - 0.1160 (mean = 0.0718) in grade III, and 0.0510 - 0.1430 (mean = 0.0852) in grade IV (Figure 1). The maximum SDs of tumor ADC were 5.61 - 11.60 (mean = 7.78) in grade II, 14.70 - 18.70 (mean = 16.00) in grade III, and 9.18 - 30.60 (mean = 20.83) in grade IV (Figure 2). There are significant differences in maximum SDs of tumor FA and tumor ADC between grade II and grade III or grade IV (p < 0.001), but not between grade III and grade IV.

CONCLUSION
The maximum SDs of tumor FA and ADC may reflect the histopathologic heterogeneity to some extent and could be useful in differentiating between low grade and high grade gliomas. Further study with more cases is needed to confirm the clinical application of maximum SD measurements for grading gliomas.

KEY WORDS: Glioma, fractional anisotropy, apparent diffusion coefficient
fied (R = -0.67, p < 0.02) for the average tumor ADC. Thus diffusion measurements patients with GBM spanning the SVZ and cortex had lower group survival.

**CONCLUSION**

This study supports the utility of physiologic MRI measurements in conjunction with anatomical MR imaging to predict survival. While the limited study size warns against overinterpretation, these preliminary findings warrant further investigation into the role of diffusion and perfusion imaging as tools for the noninvasive prediction of GBM outcome measures.

**KEY WORDS:** Glioblastoma multiforme, diffusion, perfusion

**Paper 158 Starting at 11:17 AM, Ending at 11:25 AM**

**Role of New Diffusion Restriction in Predicting Tumor Progression in Patients with Glioblastoma**

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**PURPOSE**

To determine whether diffusion restriction can be used to predict the development of enhancing tumor in patients with glioblastoma multiforme (GBM).

**MATERIALS & METHODS**

We retrospectively examined 122 GBM patients who underwent diffusion-weighted imaging (DWI) (high and low b-value images at 1000 and 0 mm²/s, respectively). Apparent diffusion coefficient (ADC) maps were calculated. Total 16 patients (13.1%) were identified as having low ADC lesions that lacked corresponding enhancement, ischemia, hemorrhage or postoperative change. Apparent diffusion coefficient measurements were made using region-of-interest (ROI) analysis. Cases were followed to determine if congruent enhancing lesions developed at the site of low ADC lesion. A chart review was performed to classify the patients as having progressive disease, partial response, stable disease or complete response. The means of the ADC values obtained before and after the development of restricted diffusion were compared using a Wilcoxon signed-rank test. A Kaplan-Meier time-to-enhancement curve with a 95% confidence interval was constructed. A log-rank test was used to compare the enhancement-free probability for patients receiving vs. not receiving Avastin (bevacizumab).

**RESULTS**

All 16 patients with isolated low ADC lesions had clinical evidence of progressive disease. Patients with baseline studies (9/16) showed a 26% decrease in ADC values, from 111 to 76 x10⁻³ mm²/sec (p=0.0078). Thirteen patients developed a new congruent enhancing lesion at the site of low ADC lesion (mean time 4.1 months, range 1.2-9.4 months). These low ADC lesions had a >80% chance of developing enhancement between 3-5 months. Of the other three patients, two have not developed new enhancing lesions after 0.8 and 3.9 months of follow up, while the last patient showed resolution of the low ADC lesion 4.2 months after beginning chemoradiation therapy. Patients receiving Avastin had a slightly longer enhancement-free survival than those not receiving Avastin; this trended toward but did not reach statistical significance (p=0.06). Five of the eight patients that had completed radiation therapy had MR perfusion and/or FDG PET/CT results consistent with tumor. In fifteen patients, the low ADC lesion extended along major white matter tracts away from the enhancing tumor.

**CONCLUSION**

In a subset of patients with GBM, low ADC lesions may predict the development of enhancing tumor. Finding early imaging biomarkers prior to enhancing disease may be very useful in guiding clinical treatment decisions.

**KEY WORDS:** Glioblastoma, diffusion, enhancement

**Paper 159 Starting at 11:25 AM, Ending at 11:33 AM**

**Comparison of High-Resolution Magic Angle Spinning, MR Spectroscopy and MIB-1 Labeling of Nonenhancing Astrocytoma**

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**PURPOSE**

Neoplastic lesions that do not enhance on MR images (MRI) are often heterogeneous with respect to proliferative activity and yet appear uniform on MR imaging. Proliferation is the key difference between low grade (AS2) and anaplastic (AS3) astrocytomas. A previous in vivo MR spectroscopy (MRS) study showed that choline-compounds may reflect proliferative activity within gliomas; however, the specific choline-compound associated with proliferation was not determined. We present results from ex vivo MRS and MIB-1 proliferation studies of nonenhancing astrocytoma that clarify the associations observed in vivo.

**MATERIALS & METHODS**

All patients were consented under IRB standards. Fourteen patients (7 AS2 and 7 AS3) with nonenhancing lesions underwent surgical resection and two sister biopsies were collected from several intratumoral regions. In all, 26 tumor regions were biopsied (14 AS2 and 12 AS3). The metabolic profile of one sample was determined with high-resolution magic-angle spinning (HRMAS) MRS and the proliferative activity was assessed using MIB-1 immunolabeling of the sister sample.
RESULTS
The figure displays HRMAS spectra from AS2 and AS3 respectively. The MIB-1 labeling index in AS3 (2.35±0.90) was higher (p=0.0002, two-tailed t-test) than that of AS2 (1.01±0.70). Consistent with in vivo MRS findings, total choline [phosphocholine (PC)+glycerophosphocholine (GPC)+free choline(Cho)] was higher in AS3 versus AS2 (p=0.003). The difference was primarily driven by PC (p=0.005) with smaller contributions from GPC (p=0.034) and Cho (p=0.035). There was a trend toward higher creatine+phosphocreatine (Cre) levels in AS3 versus AS2 (p=0.027), and no difference in myoinositol (MyoI). We found positive correlations between MIB-1 and total choline (p=0.004) and PC (p=0.004).

CONCLUSION
These results suggest that the elevated total choline observed in vivo is due primarily to elevations in PC and reflects the proliferative activity within astrocytomas. The fact that Cre and MyoI were not higher in AS2 suggests that the differences observed in vivo may be more associated with the presence of contrast enhancement than with proliferation or tumor grade. Experiments with contrast-enhancing tumors will be performed to verify this assertion. These results are useful for improving the biological interpretation of MRS data from nonenhancing tumors.

REFERENCES

Acknowledgment: This study was supported by NIH CA116041, UCSF BTRC Tissue Bank, Jan Wooten.

KEY WORDS: Proliferation, astrocytoma, HRMAS

Paper 160 Starting at 11:33 AM, Ending at 11:41 AM
Differentiating Low- and High-Grade Nonenhancing Cerebral Gliomas: A Comparative Study of MR Perfusion and Diffusion Tensor Imaging

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PURPOSE
Of all nonenhancing supratentorial gliomas, 14-45% are graded as malignant (WHO grade 3 and 4), but they are not uncommonly misdiagnosed as low-grade (WHO grade 1 and 2) because of their lack of enhancement. The purpose of this study was to establish the value of MR perfusion-weighted imaging (PWI) and diffusion tensor imaging (DTI) in differentiating between low- and high-grade nonenhancing supratentorial gliomas.

MATERIALS & METHODS
Thirty-nine patients with pathology-confirmed nonenhancing supratentorial gliomas, whose examinations included dynamic susceptibility contrast (DSC)-GRE-PWI and DTI data, were included in the study. There were 21 patients with low-grade and 18 with high-grade tumors. The relative cerebral blood volume (rCBV), mean and maximal fractional anisotropy (FA), and mean trace apparent diffusion coefficients (trace ADC) within the tumors were calculated and compared using Mann-Whitney U test.

RESULTS
The maximal FA and mean FA in the high-grade group (0.386±0.133 and 0.189±0.04, respectively) were significantly higher (P=0.000) than in the low-grade group (0.180±0.033 and 0.124±0.011, respectively). The maximal rCBV in the high-grade group was 2.168±1.417 and mean trace ADC was 1.274±0.239, which compares to an rCBV of 1.884±1.470 and a mean trace ADC of 1.358±0.531 in the low-grade group. However, there was no significant difference between the two groups with regard to either maximal rCBV or mean trace ADC (P>0.05). Classify discrimination analysis was performed showing that a maximal FA threshold of 0.244 could differentiate between high-grade and low-grade nonenhancing supratentorial gliomas with a sensitivity of 90% and specificity of 90%. A mean FA threshold of 0.141 showed a sensitivity as well as specificity of 90%. In contrast, the maximal rCBV, had sensitivity of 61.5% and specificity of 50% with threshold of 1.320. The common published maximal rCBV threshold of 1.75 showed a sensitivity of 46.2% and specificity of 58.3%. In the mean trace ADC, the sensitivity and specificity was only 60% and 40%, respectively with a threshold of 1.239.

CONCLUSION
Perfusion-weighted imaging alone, with the common threshold of rCBV ratio of 1.75, was not sufficient to grade the nonenhancing supratentorial gliomas. The maximal and average FA may be better surrogate markers than mean trace ADC and rCBV.

REFERENCES

KEY WORDS: Glioma, diffusion tensor imaging, perfusion
Optimal Diffusion Indices in Grading Nonenhancing Cerebral Gliomas and Neuronal-Glial Tumors

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PURPOSE
Malignant, nonenhancing supratentorial gliomas (G) and neuronal-glial (NG) tumors sometimes are misdiagnosed as low-grade tumors. Earlier studies have indicated that up to 45% of the nonenhancing supratentorial gliomas are malignant. Diffusion tensor imaging (DTI) can supply multiple diffusion indices of which minimal apparent diffusion coefficient (ADC) and ratio fractional anisotropy (FA) have been reported to differentiate between low- and high-grade gliomas. The aim of this study was to evaluate the diffusion indices from DTI with regard to their ability to distinguish between low- and high-grade tumors.

MATERIALS & METHODS
Twenty-five patients with pathologically confirmed nonenhancing supratentorial gliomas and neuronal-glial tumors were included. Fourteen patients had a low grade (WHO grade 1 and 2) and 11 with high grade (WHO grade 3 and 4). Besides a region of interest (ROI) which covered the entire tumor, additional smaller ROIs, 20 - 30 voxels each, were placed inside the tumor to measure the maximal FA and minimal ADC. The same size ROIs were placed on the contralateral side for reference. The mean, maximal and mean maximal FA as well as mean, minimal and mean minimal ADC values were measured. The ratios for all FA and ADC values also were calculated (diffusion index value in the lesion side/ the contralateral side). The difference between the low- and high-grade groups for each diffusion index was analyzed by Mann-Whitney U test, and receiver operating characteristic (ROC) analyses was performed for optimal grading threshold.

RESULTS
There was a significant difference between low and high grade in nonenhancing supratentorial gliomas and neuronal-glial tumors for all FA values as well as FA ratios (p values varied between 0.000 and 0.008), but not for any of the ADC indices. The mean maximal and maximal FA values showed better separation between low and high grade. Furthermore, a ROC analysis showed that a mean maximal FA value of 0.238 separated between low and high grade with a sensitivity of 90.9% and a specificity of 100%. The similarly calculated threshold for the maximal FA value was 0.243 which resulted in a sensitivity of 90.9% and a specificity of 93%.

CONCLUSION
This study shows a significant difference for all measured and calculated FA indices when comparing low and high grade in nonenhancing supratentorial gliomas and neuronal-glial tumors. The mean maximal FA and maximal FA values may be better valuable diagnostic tools for grading of nonenhancing supratentorial gliomas and neuronal-glial tumors.

KEY WORDS: Glioma, neuronal-glial tumor, diffusion tensor imaging

Determining Early Responses of Locally Applied Radiotherapy in a Brain Tumor Model Using Dynamic Susceptibility Contrast MR Imaging

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PURPOSE
Dynamic susceptibility contrast (DSC) MR imaging commonly is used preoperatively for differential diagnosis of brain tumors, but also has been used to distinguish recurrent disease from radionecrosis. First attempts have been made to analyze the influence of radiation therapy on brain tumors and metastasis, but studies on early changes caused by irradiation are missing. The purpose of this study was to assess early perfusion changes caused by brachytherapy in a malignant brain tumor model.

MATERIALS & METHODS
A C6-glioma model was used in 14 Wistar rats. 10-6 glioma cells were stereoatctically injected into the basal ganglia of the rats inducing a rapid aggressive tumor growth. Sixteen days after injection of the cells an MR imaging was performed using a 3 T scanner and a dedicated solenoid coil (Philips, Best, The Netherlands) including T1- and T2-weighted sequences to define tumor size prior to therapy. Seven rats were irradiated using HDR afterloading remote machine (VariSource iX, Varian Medical Systems, Charlottesville, Inc., VA, USA) for 5 days (2 Gy per fraction) followed by another MR imaging including a DSC MR imaging using a T2*-weighted EPI PRESTO sequence (TR/TE = 30/14 ms, matrix 64 x 64, FOV 90 mm; slice thickness of 1.5mm). Ratios of rCBV and rCBF were created using the NordicIce Software (NordicNeuroLab, Bergen, Norway).

RESULTS
Compared to the control animals, tumor size was not reduced in the irradiated group. Relative cerebral blood volume was significantly reduced (t = 1.95; p = 0.038, one-tailed t-test). A trend for this effect was also found for rCBF (t= 1.73, p = 0.055, one-tailed t-test).

CONCLUSION
Our results demonstrate that early changes in tumor perfusion occur already after 5 days of radiation therapy and can be monitored using DSC MR imaging. The choosen tumor model resembles the human glioblastoma multiforme demonstrating neovascularization and vascular sprouting. Stereotactic radiation led to a significant reduction in cerebral perfusion values, whereas tumor size was not yet reduced. Dynamic susceptibility contrast MR imaging is a powerful tool in assessing early response to treatment, distinguishing residual tumor after therapy, and possible treatment failure and therapy-related complications, such as radiation necrosis.

KEY WORDS: DSC-MRI, brain tumor, radiotherapy
Patterns of Tumor Progression on Serial MR Imaging of Patients with Recurrent Glioblastoma Undergoing Antiangiogenic Therapy

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PURPOSE
Bevacizumab, a monoclonal antibody against vascular endothelial growth factor (VEGF), is an antiangiogenic agent that has demonstrated synergy in combination with traditional cytotoxic agents for metastatic colon, lung, and breast cancers. More recently, it has been used for patients with glioblastoma multiforme (GBM), where higher levels of VEGF expression correlate with poorer prognosis. The purpose of this study was to evaluate patterns of tumor progression in patients with recurrent glioblastoma undergoing antiangiogenic therapy.

MATERIALS & METHODS
We retrospectively reviewed 19 patients with recurrent GBM who have been enrolled in a phase II clinical trial comparing bevacizumab alone or in combination with irinotecan. The baseline and follow-up MR images (every 6 weeks) were evaluated for the degree of initial response, the pattern of disease progression, and the presence of treatment complications (e.g., intracranial hemorrhage).

RESULTS
Allowing for variation in severity of disease on the baseline MRI, the initial response was positive in 16 of 19 patients (84%), as measured by decreased enhancement, edema, and mass effect. The remaining three patients showed disease progression on the initial follow-up MRI. Of the 16 responders, 10 patients showed disease progression at 2-13 months, and six patients discontinued therapy for other reasons. Of the 13 total patients who progressed during therapy, five revealed an atypical pattern of weakly enhancing FLAIR hyperintense satellite nodules, separate or distant from the original disease site (Figure).

CONCLUSION
Recurrent GBM has an especially poor prognosis, with response to traditional chemotherapy in less than 20% and 6-month progression-free survival in less than 30%. Our retrospective review confirms a high response rate to bevacizumab followed by eventual radiographic progression in most of the patients. Some of the patients progressed with an atypical pattern of weakly enhancing FLAIR hyperintense satellite nodules, possibly reflecting a shift in tumor biology to a more migratory phenotype. Further study is needed to determine whether such progression should be considered a failure of bevacizumab therapy or whether therapy should continue with appropriate modification of concurrent chemotherapy.

KEY WORDS: Glioblastoma, bevacizumab, Avastin
Neurologically Associated Intravascular Lymphomatosis: Imaging Spectrum

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PURPOSE

Intravascular lymphomatosis (IVL), also known as intravascular large B-cell lymphoma, is a rare systemic disease with a nonspecific clinical presentation and high mortality rate. In the central nervous system, IVL classically presents with stroke-like symptoms or cognitive disturbance (1). This study describes the imaging spectrum in 22 pathologically proved cases of IVL and describes new imaging findings that should suggest the diagnosis. Increased understanding of the imaging spectrum should improve early diagnosis and enable early treatment which has been shown to decrease mortality.

MATERIALS & METHODS

The clinical records and imaging studies of 22 patients with biopsy- or autopsy-proved IVL were reviewed retrospectively.

RESULTS

Ten male and 12 female subjects ranged in age from 40 to 79 years. The most common presenting symptoms were progressive dementia and cerebrovascular events. Seventeen cases involved the brain; seven involved the spinal cord. Two subjects demonstrated both brain and spine involvement. Lesions were located from the cortex and cerebral white matter to the conus medullaris and cauda equina. Twenty-one patients had MR scans. All 17 brain cases showed nonspecific multifocal hyperintense white matter signal on T2WI/FLAIR. Eight demonstrated a distinct "tigroid" or "striped" area of lesser hyperintensity within a confluent area of surrounding T2 hyperintensity. Contrast-enhanced scans were obtained in all cases. Thirteen of the 17 brain cases showed multifocal linear enhancing foci. In six cases, the linear enhancement extended perpendicular from the lateral ventricles into the periventricular deep white matter. Diffusion imaging was performed in four cases. Three showed multifocal patchy diffusion restriction. Two demonstrated linear diffusion restriction that spared the cortex. Mass effect was minimal to absent in all cases. Seven patients had spinal cord involvement. Five had dedicated spine MR imaging; one additional case demonstrated cerebrospinal fluid flow imaging and/or cerebrospinal fluid flow imaging. One patient had only lumbar myelography that demonstrated conus enlargement and nodular thickening of the cauda equina. The conus medullaris was the most commonly involved site (5/7 patients). Of those with dedicated spinal imaging, spinal cord T2 hyperintensity was noted in all cases. Enhancement was seen in 5/6. Cauda equina enhancement and/or nerve root thickening was present in 4/6.

CONCLUSION

Nonspecific clinical presentation of IVL contributes to its high mortality. Therefore early recognition of the imaging findings is important in leading to a prompt diagnosis. Intravascular lymphomatosis should be considered in any middle-aged or elderly patient with multifocal T2 hyperintense lesions in deep white matter demonstrating linear contrast enhancement. Lesions demonstrating little to no mass effect relative to the size of mass, a “tigroid” or striped pattern of hyperintensity on T2 sequences, linear enhancement perpendicular to the lateral ventricles, and linear diffusion restriction should also raise suspicion for IVL. Spine imaging findings in IVL are nonspecific and include spinal cord T2 hyperintensity, conus involvement, and nerve root enhancement and thickening.

REFERENCES


KEY WORDS: Intravascular lymphomatosis, angiocentric lymphoma, intravascular large B-cell lymphoma

Presurgical Prediction of Adhesion Between Meningioma and Brain: Development of “Brain Surface Motion Imaging”

Taoka, T. · Akashi, T. · Miyasaka, T. · Nakagawa, H. · Sakamoto, M. · Myochin, K. · Takayama, K. · Kichikawa, K.

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PURPOSE

We developed novel imaging technique (“Brain surface motion imaging”) that is subtraction of pulse gated 3D fast spin-echo sequence of “blight cerebrospinal fluid (CSF)” and “black CSF” phases, which enables assessment of the dynamics of brain surface motion. We hypothesized that location with adhesion has no discrepancy in pulsatile motion between tumor and brain. In order to obtain information of discrepancy in pulsatile motion, we made subtraction between systolic and diastolic phases of heavily T2 weighted image using pulse gated 3D fast spin echo sequence. The purpose of this study is to evaluate the feasibility of this imaging method for providing presurgical information about adhesion between meningioma and brain surface.

MATERIALS & METHODS

Subject of the current study was 14 cases (34 - 75 years old, 12 female and 2 male) with surgically resected meningioma, in which “brain surface motion imaging” was obtained presurgically. Imaging consisted of a pulse-gated cine phase contrast prescan and two sets of pulse-gated 3D fast spin-echo scan by syngo SPACE technique (Siemens AG, Erlangen, Germany). Images of systolic phase and diastolic phase were obtained, and subtraction was made with offset of 100 signal unit. Thus, white areas on the subtracted image mean the region in which brain is replaced by CSF with pulsatile movement, and black areas are the reverse. We analyzed the presence of high and/or low signal band like texture surrounding meningioma which we hypothesized as an
indicator of “no adhesion”, and judged degree of adhesion as “total”, “partial” and “no”. We studied surgical record and obtained the degree and location of adhesion. For the cases with “partial” adhesion, agreements in location of adhesion also were evaluated.

**RESULTS**

On presurgical “brain surface motion imaging”, seven cases were judged as total adhesion, five cases were judged as partial adhesion, and two cases were judged as no adhesion. These presurgical predictions about adhesion and surgical finding agreed in 12 cases (85.7%). Location of the adhesion agreed in all three cases with partial adhesion. Disagreements were seen in two cases, and both of them were judged as total adhesion on “brain surface motion image”, while, no adhesion was found at surgery.

**CONCLUSION**

Adhesion between brain and extraaxial tumor such as meningioma is one of major cause for difficulty in surgical resection. Presurgical prediction of adhesion between brain and meningioma will bring great advantage for surgical planning. In the current study, prediction for brain/meningioma adhesion by “brain surface motion imaging” agreed with surgical findings in 85.7% of the cases. This imaging method may be feasible to provide presurgical information about brain/meningioma adhesion.

**KEY WORDS:** Tumor adhesion, brain motion, meningioma

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**Tuesday Morning**

**10:45 AM – 12:30 PM**

**Ballroom B**

(18b) Interventional: New Devices & Techniques

(Scientific Papers 167 – 179)

See also Parallel Sessions

(18a) Adult Brain: Neoplasms I

(18c) Adult Brain: Vascular; Extracranial & Vascular, Intracranial II

(18d) Pediatric: Vascular, Extracranial & Vascular, Intracranial II

(18e) Excerpta Extraordinaire: Interventional & Spine

Moderators: Michael Marks, MD

Robert W. Tarr, MD

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**Paper 167 Starting at 10:45 AM, Ending at 10:53 AM**

**Preliminary Experiences with the SILK Stent**

Gal, G. · Nepper-Rasmussen, J.

Odense University Hospital

Odense, DENMARK

**PURPOSE**


**MATERIALS & METHODS**

Between March and December 2008, 15 intracranial aneurysms in 15 patients were treated with a recently developed stent that has such a tight mesh that it can cause thrombosis of the aneurysm sac without placing any additional embolic agent in it. Six patients were treated in Odense, one in Copenhagen, Denmark, three in Tromsø, one in Oslo, Norway, two in Riga, Latvia, one each in Tartu and Tallinn, Estonia. All but one of the aneurysms were large or giant, with extremely wide or partially/fully fusiform neck. All but one of the patients had progressing mass effect. The aneurysms were evaluated carefully with either rotational angiogram with 3D-reconstruction or CTA, with accurate measurements of the sac and the neck, to decide the suitable size of the stent, as it is individually manufactured for the time being. The patients were premedicated adequately with Clopidogrel and ASA. They were treated under general anaesthesia and full Heparinization. Following a rotational angiogram with 3D-reconstruction, the most optimal working projections were chosen - in most cases using a by-plane, “state of the art equipment”. The neck then was crossed with the delivery catheter, a Vasco-21 (BALT Extrusion) over an 0.14” guide wire. This procedure was sometimes technically challenging and time-consuming, especially in true fusiform aneurysms. After withdrawal of the guide wire, the stent was loaded in the microcatheter, navigated to the desired position, and deployed, by pushing the delivery wire until the whole stent left the microcatheter. In the majority of cases, the stent was not detached after this, and some gentle pushing of the delivery catheter was necessary to achieve that.

**RESULTS**

All but one of the stents were delivered and deployed at the desired location. In one case, the parent artery was so tortuous that the stent got stuck in the delivery catheter, due to the high friction. In two cases, we did not have access to stents with optimal lengths, and the ones we used became shorter than expected following the deployment, which caused technical difficulties during the treatment, with no clinical consequences. The immediate control angiograms after the detachment showed good alignment of the stents to the vessel walls and considerably reduced flow in the sacs. The patients were left on Clopidogrel in 2 and ASA in 3 months. Three-month follow-up angiograms - in five cases so far - show total or nearly total occlusion of the sac. The mass-effect has initially progressed, and then successively diminished by the time in those cases with long enough follow-up interval.
CONCLUSION
This new device is a promising tool in the treatment of this group of cerebral aneurysms that caused major difficulties both for the surgeons and the interventional neuroradiologists. Further evaluation of the results concerning the mass-effect is necessary to define its role in the management of these, otherwise difficult-to-treat aneurysms.

KEY WORDS: Stent, aneurysm, fusiform

Paper 168 Starting at 10:53 AM, Ending at 11:01 AM
Withdrawn

Paper 169 Starting at 11:01 AM, Ending at 11:09 AM
Treatment of Wide-Necked Intracranial Aneurysms Using the Enterprise Stent: Mid-Term Clinical and Angiographic Results

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University of Massachusetts Medical School
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 nitinol 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 2008, 39 wide-necked and fusiform/dissecting intracranial aneurysms in 37 patients were treated endovascularly using the Enterprise stent. The aneurysms were in the following locations: ophthalmic/paranophthalmic (six aneurysms, 15%), posterior communicating artery (eight, 21%), basilar apex (four, 10%), vertebral artery/posterior inferior cerebellar artery (three, 8%), internal carotid artery (nine, 23%), superior hypophyseal artery (four, 10%), anterior communicating artery (three, 8%), and middle cerebral artery (two, 5%). Six (15%) were treated acutely following subarachnoid hemorrhage, six (15%) were recurrent aneurysms following primary embolization with coils, two (5%) were recurrent aneurysms after surgical clipping, and 31 (80%) were treated as de novo aneurysms. The mean aneurysm neck size was 5.5 mm (SD 2 mm, range 2.5-10 mm), and the mean dome-to-neck ratio was 1.5. All patients were given loading doses of aspirin and clopidogrel and maintained on these medications in situ management during kyphoplasty procedures. Using an innovative PEEK wafer stack, structural kyphoplasty permits directional control for vertical reduction of the vertebral body while still providing fracture stabilization and pain relief. The purpose of this retrospective review is to determine the safety and efficacy of the StaXx® FX structural kyphoplasty system in the treatment of vertebral compression fractures (VCF).

MATERIALS & METHODS
Using fluoroscopic guidance, the vertebral body was accessed through a peri-pedicular approach. PEEK StaXx® FX wafers were inserted via instrumentation in 1 mm increments. A small amount of cement then was inserted anterior to the stack for stabilization. Surgical data, pain relief and initial outcome information were analyzed retrospectively on an initial series of structural kyphoplasty cases at a single center. Determination of the subsequent fracture rate was assessed via patient interviews over a 14-month period.

RESULTS
Twenty-six osteoporotic VCFs (T11-L4) in 25 patients were percutaneously treated for fracture repair. A mean of 2.0 cc of cement was injected anteriorly to the wafer stack. Average follow up was 8 months. Postoperative VAS pain score was decreased significantly (p<0.001) from 9 to initial 1.6 and 1.5 at follow up. No neurologic complications as a result
of the device or the procedure have been reported. No cement extravasation was noted. No postoperative subsequent fractures have been report in this series of patients.

**CONCLUSION**

Controlled vertebral augmentation, not possible with balloon kyphoplasty, is now possible with the StaXx® FX structural kyphoplasty system. Structural kyphoplasty appears to be a safe and effective procedure that relieves pain, and uses less cement volume than vertebroplasty and balloon kyphoplasty. No procedure-related complications have occurred. Refracture rates appear to be as low as if not lower than traditional VCF fracture fixation methods, and no adjacent level fractures have occurred.

**KEY WORDS:** Structural kyphoplasty, pain

**Paper 171 Starting at 11:17 AM, Ending at 11:25 AM**

**Resolution Limits of Multislice Computed Tomography:**

C-Arm Flat Panel CT, Flat Panel CT, and MicroCT

Ionescu, M.¹ · Metcalfe, R.¹ · Cody, D.² · Alvarado, M.³ · Hipp, J.¹ · Benndorf, G.²

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**PURPOSE**

Noninvasive multislice CT, playing an increasing role in cardiac imaging, could also have significant potential for imaging of intracranial stents. The purpose of our study was to evaluate the quality and spatial resolution in stent visualization provided by a currently available state of the art 64 slice CT (Multislice CT) scanner in comparison with a clinical high-resolution imaging modality (C-arm CT) and two preclinical imaging modalities: Flat Panel CT (FP CT) and ultra-high-resolution MicroCT.

**Material & Methods**

A 2.3 x 23 mm Cypher stent (Cordis Neurovascular) was deployed in a straight polytetrafluoroethylene (PTFE) tube (WL Gore & Associates, Inc., Newark). MS CT was acquired using VCT (GE Healthcare, Milwaukee, WI), C-arm CT using Artis dBA (DynaCT, Siemens, Medical Solutions, Germany), FP CT using a preclinical research CT scanner (GE Global Research Center Nyskayuna, NY), and MicroCT (GE) using eXplore Locus SP (GE Healthcare, USA).

**RESULTS**

Due to blooming effects and partial volume averaging, the volume rendering generated from MS CT showed artificially increased strut dimensions with no clear distinction between the regular struts and connector struts. The shape of the reconstructed stent surface differed remarkably from the actual stent shape. C-arm CT and FP CT derived volume renderings were superior to MS CT, but also exhibited significantly exaggerated strut dimensions compared to MicroCT. Basic geometric features of struts and connectors were visible, while finer details, as identified by MicroCT, were inconsistently visualized.

**CONCLUSION**

The spatial resolution of 64 slice CT scanners is significantly inferior to C-arm CT and FP CT. All of these modalities are currently insufficient to accurately visualize structural details of small metallic stents as are elucidated by MicroCT. Substantial increase in the spatial resolution of current and future clinical imaging modalities, especially MS CT, is necessary for reliable and accurate assessment of stent deployment and patency.

**KEY WORDS:** Imaging, stent, computed tomography

**Paper 172 Starting at 11:25 AM, Ending at 11:33 AM**

**Intraarterial Chemotherapy (Chemosurgery) in Children With Advanced Intraocular Retinoblastoma: A New Treatment Paradigm**

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**PURPOSE**

To describe the safety and efficacy of a new therapeutic approach that consists of intraarterial (IA) infusion of chemotherapy in the ophthalmic artery (OA) in children with advanced intraocular retinoblastoma.
Materials & Methods
Forty-two patients (1 month to 10 years, median 22 months) with retinoblastoma were enrolled into this IRB-approved protocol. In four patients, both eyes were treated simultaneously for a total of 46 eyes treated. In 42 eyes, tumors were large with vitreous seeds (Reese-Elsworth grade V) and the only therapeutic alternative was enucleation. Four eyes had small tumor close to the macula, and usual treatments (laser or plaque) would have resulted in vision loss. Catheterization of the OA was performed via the femoral approach using 4F guide catheter and microcatheter system, under general anesthesia and systemic anticoagulation. Chemotherapy consisted in Melphalan (2.4 -7.5 mg), Topotecan (0.3-1.5 mg) or Carboplatin (30-50mg), infused through the microcatheter over 30-45 minutes. The procedure was repeated every 3 weeks for a total of two to six sessions per patient. Detailed ophthalmologic evaluations, physical exams and blood tests were performed every 3 weeks, prior to each procedure. Follow-up ophthalmologic evaluations were performed every 3 to 6 weeks.

Results
Catheterizations of the OA were successful in 129/133 cases. Nonocular complications included: bronchospasm when catheterizing the OA in eight patients, severe leucopenia in one patient, transient femoral artery occlusion in one patient, transient (2-6 weeks) skin erythema in the frontal territory of the OA in three patients, and transient loss of eyelashes in one patient. Ocular toxicity included delayed avascular retinopathy in three patients, resulting in blindness. Treatment is completed for 41 eyes and is ongoing in five. Three eyes could not be treated. Of the 38 eyes in whom treatment was achieved: 17 eyes are cured with preserved vision, five have stable tumor with preserved vision, and nine are cured with no preserved vision (3 avascular retinopathy, 6 persistent retinal detachment or vitreous hemorrhages). Seven eyes were enucleated.

Conclusion
Chemosurgery has changed the treatment of retinoblastoma in our institution. With minimal complications, we can now save with preserved vision more than 50% of eyes that, before chemosurgery, would have been enucleated. Although this initial success is encouraging, three issues remain: 1) long-term follow up; 2) improving our chemosurgery protocols; 3) challenging ophthalmologic follow up due to anatomical distortion caused by the large tumor size and the rapid treatment-induced shrinkage.

Key Words: Intraarterial chemotherapy, retinoblastoma

Preoperative Glue Embolization of Selected Venous Malformations Using a Decompressing “Venting” Needle: A Novel Technique

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Purpose
Introduce a novel approach to preoperative embolization of selected low flow venous malformations (VM) using an acrylic glue agent and a decompressing “venting” needle.

Materials & Methods
Retrospective review of procedural reports, peri-procedural imaging, and clinical records in patients with known VM treated with the above embolization technique at Vancouver General Hospital.

Results
Three patients were embolized preoperatively between July 2007 and April 2008 using a “venting” needle technique for VM undergoing surgical excision. All patients were female, with two patients have intraorbital lesions, and a third having a VM in her left lateral neck. Average age of the patients was 27.7 years (16, 48, and 19 years of age, respectively), with preprocedural imaging consisting of dual-phase CT examinations in order to demonstrate dynamic contrast filling of the lesions. In the case of the orbital lesions, Valsalva delayed venous phase imaging was performed in order to reveal potential distensibility. All cases were done with general anesthetic and endotracheal intubation, with intralesional phlebography via direct percutaneous puncture. In the orbital cases, phlebography was done intraoperatively with C-arm fluoroscopy after surgical exposure of the lesions, while the neck VM case was done in a biplane neuroangiography suite immediately before surgical resection. A 24-gauge angiocatheter cannulae were used for dual access to the orbital VMs, with one serving as the injection cannula, and the other as the decompressing “venting” cannula. The neck VM was injected via a 22 gauge butterfly needle, with a 22 gauge angiocatheter accessed anteriorly within the lesion as the “venting” cannula. All phlebograms demonstrated “through and through” contrast flow on digital subtraction angiography (DSA), with contrast exiting through the “venting” cannula. Acrylic glue embolic (Histoacryl, opacified with Lipiodol) then was injected in a similar manner under DSA control, with complete embolization of all lesions, and no evidence of embolic extending into nontarget draining veins. All lesions subsequently were resected completely, without significant blood loss.

Conclusion
Preoperative embolization of selected VM using acrylic glue may be aided by a decompressing “venting” needle, allowing control of intralesional pressure, and minimizing nontarget embolization. Such a technique allows for improved lesion resection with less complex surgery, while minimizing potential for blood loss.

Key Words: Embolization, venous malformation, orbit
C-Arm CT Measurement of Cerebral Blood Volume in Ischemic Stroke: An Experimental Study in Canines

Niemann, D. D. · Strother, C. M. · Bley, T. T. · Pulfer, K. · Royalty, K. · Zellerhoff, M. · Deuerling-Zheng, Y. · Bender, F. T. · Consigny, D. · Yasuda, R. · Bakke, S. · Turski, P. · Rowley, H.

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PURPOSE
Cerebral blood volume (CBV) is key in distinguishing penumbra from ischemic core. Our purpose was to compare CBV measurements acquired with standard perfusion CT (PCT) with ones obtained with C-arm CT in a canine stroke model.

MATERIALS & METHODS
Under an institutional approved protocol 10 canines underwent embolization such that emboli were delivered predominantly into the MCA. Four hours after embolization each animal underwent MR imaging on a 1.5 T system (Signa HDx, GE HealthCare Waukesha, WI.). Immediately after MR imaging animals underwent standard perfusion CT (PCT) imaging using a 64 slice scanner (V GE HealthCare Mw, WI.). Immediately following, 2 C-arm CT CBV maps were acquired (two injection protocols) using a flat-detector angiographic system (AXIOM Artis dBA Siemens AG, Forchheim, Germany). Perfusion CT measurements were processed using commercially available software. C-arm CT measurements were processed using prototype software. A region of interest (ROI) was placed manually on the PCT and C-arm CT CBV maps to match as closely as possible the center of any abnormality on the diffusion-weighted images. A symmetrical ROI was prescribed in the opposite hemisphere. Absolute mean CBV values in these two ROIs were calculated and compared. Also, 10 PCT CBV maps and 10 C-arm CT CBV maps from a previous study of normal animals (N = 20 normal) were combined with the maps from the PCT and C-arm CT CBV studies of the 10 animals with ischemic stroke (N = 30 ischemic stroke). The combined CBV maps (N = 50) were randomly mixed and presented to three experienced observers. Observers were asked to grade each CBV map as being either normal or abnormal and, if abnormal, to designate the side of the abnormality.

RESULTS
Diffusion-weighted MR imaging revealed the presence of an ischemic stroke in nine of the 10 animals. The three expert observers correctly identified an area of reduced CBV in 70-75% of the PCT studies and in 83-87% of the C-arm CT examinations. False positives (CBV abnormality identified in location where there was no diffusion-weighted imaging abnormality) were found in 1.7% of the PCT and 3.3% of the C-arm CT studies. False negatives (no abnormality identified in location where there was a diffusion-weighted imaging abnormality) were found in 25% of the PCT and 12.2% of the C-arm CT studies. In all studies there was a significant difference between the CBV values in the ROIs in normal and abnormal tissue (p < 0.005). There were no significant differences in the values recorded by PCT and C-arm CT in either normal or abnormal ROIs (p > 0.05). Using a threshold of 56% of the normal side as a level indicating infarct, PCT studies were abnormal in three of nine cases; the C-arm CT in six of nine, and nine of nine (1).

CONCLUSION
CBV values obtained with C-arm CT were comparable to ones acquired with standard PCT in this canine stroke model.

REFERENCES

KEY WORDS: Ischemic stroke, cerebral blood volume, C-arm CT

Time-Resolved Digital Subtraction Angiography with Color Coding

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'University of Wisconsin, Madison, WI, 2Siemens AG Healthcare Sector, Forchheim, GERMANY, 3Siemens Medical Solutions, Hoffman Estates, IL

PURPOSE
The use of color is known to improve visual tasks that involve search and recognition. It was our purpose to assess the value of using a combined temporal and intensity coded algorithm to color code DSA acquisitions from a variety of complex central nervous system vascular lesions.

MATERIALS & METHODS
Conventional digital subtraction angiography (DSA) acquisitions were obtained from a database of studies of subjects with ischemic stroke, arteriovenous malformations and fistula, stenosis, aneurysms, dissections, tumors and vasospasm. Acquisitions were performed using an AXIOM Artis dBA (Siemens AG, Germany) and retrospectively color coded using prototype software. Time-contrast concentration curves were obtained for each individual pixel from the DSA acquisitions. The temporal and intensity color-coded algorithm allows extraction of parameters related to bolus timing and concentration. The time to peak contrast concentration (TTP) is then color coded while the color brightness was determined by the peak pixel intensity. Images were then displayed as a color map composite of the acquisition. Three expert and three naïve readers were shown color coded and standard DSA images and were asked to provide an opinion as to: a) their diagnosis and their confidence in the diagnosis, b) usefulness in treatment planning and c) evaluation of the success of treatment.

RESULTS
Color-coded images enhanced the ease of evaluating treatment success in more than 40% of cases (p < 0.0001). It also had a statistically significant impact on treatment planning making planning easier in more than 20% of cases (p = 0.0069). In more than 20% of the examples color coding made diagnosis and treatment planning easier for all readers (p < 0.0001). Color coding also increased the confidence of
diagnosis compared with use of DSA alone (p = 0.056). The impact of this was greater for the naïve readers than for the expert observers.

**CONCLUSION**
At no additional cost in x-ray dose or contrast medium color coding of DSA acquisitions enhanced the conspicuity of findings on DSA images. It was particularly useful in situations where there was complex flow patterns and in evaluation of pre and posttreatment acquisitions. Its full potential remains to be defined.

**KEY WORDS:** Postprocessing, angiography

**Paper 176 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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Kamakura, JAPAN

**PURPOSE**
Because there may be large amounts of thrombi in chronic total occlusions (CTOs) of the cervical arteries, an expected risk associated with endovascular recanalization is high. The aim of this 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 May 2007, (2) with recurrent TIAs, (3) modified Rankin scale of ≤ 2, (4) with angiographic total occlusion of the cervical vertebral or carotid arteries, (5) with estimated occlusion length of 150 mm or shorter in the affected arteries and (6) who underwent stenting for CTOs of the cervical arteries under flow reversal by proximal flow control technique. Procedural success, complications, 1-year angiographic and clinical outcomes were investigated.

**RESULTS**
During the study period, seven patients underwent stenting for cervical CTOs; carotid arteries in five cases and vertebral arteries in two cases. The median real occlusion length was approximately 26 mm (range from 10 mm to 38 mm). In all seven cases, CTOs were penetrated successfully with hard-type guidewires and dilated sufficiently with stents. No complications occurred during the peri-procedural period, no TIAs have recurred for 1 year after stenting, and no restenosis occurred at 1-year 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:** CTOs, stenting, flow reversal

**Paper 177 Starting at 12:05 PM, Ending at 12:13 PM**

**Endovascular Treatment of Idiopathic Intracranial Hypertension: Experience with 35 Patients**

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**PURPOSE**
To present our experience with endovascular stenting of dural venous sinuses in the treatment of idiopathic intracranial hypertension (IIH).

**MATERIALS & METHODS**
A retrospective analysis was conducted of 35 consecutive patients who underwent endovascular venous stenting for IIH between October 2001 and November 2008. The direct intracranial venous manometry measurements pre and post-treatment were analyzed. Data collection also included the patient demographics, techniques used, stents deployed and complications.

**RESULTS**
The 35 consecutive patients included 33 female and 2 male patients. The age range was 9-63 with a mean age of 33.6 years. A total of 46 stents were deployed in 41 endovascular procedure sessions. Twenty-five stenting procedures were carried out on the right transverse or sigmoid sinuses and 16 on the left system. Thirty patients had a single treatment session, with a single stent used in 27 cases, 2 stents in 2 patients and 3 stents in 1 patient. Five patients had repeat stenting procedures, with 4 patients having only unilateral transverse or sigmoid sinus stenting and 1 patient undergoing bilateral stenting. Four patients underwent 2 separate stenting procedures. Three of this group had a single stent placed at each procedure and 1 patient had 2 stents deployed at the first procedure and a single stent at the second session. One patient had 3 separate stenting procedures with a single stent deployed at each session. Forty-six stents were deployed in total with 24 balloon-expandable and 22 self-expanding stents used. The range of prestensting pressure gradients across the stenoses was 0-41mmHg with a mean of 17.95mmHg. Poststenting the gradient was reduced to 1-3mmHg in 40 procedures. Following 1 stenting, a significant gradient of 14mmHg persisted. This treatment was considered incomplete and following further stenting the gradient was obliterated. Thirty patients (85.7%) were treated suc-
cessfully with a single stent with reduction of intracranial venous pressures, obliteration of the venous pressure gradient across a stenosis and long-term resolution of symptoms. Four patients (11.4%) required repeat stenting to achieve these outcomes. One patient (2.9%) had temporary improvement in symptoms and manometry results after 3 separate unilateral stent deployments. Further evaluation confirmed a contralateral venous stenosis as the cause of recurrent symptoms and contralateral venous stenting is planned. There was 1 severe complication with a subdural haematoma following stenting.

CONCLUSION
Endovascular treatment of idiopathic intracranial hypertension with dural venous sinus stenting is a safe and effective management. Careful patient selection and thorough intracranial venous pressure measurements are essential. Excellent angiographic results with obliteration of pressure gradients and symptomatic cure are achievable.

KEY WORDS: Idiopathic intracranial hypertension, endovascular, stent

Paper 178 Starting at 12:13 PM, Ending at 12:21 PM
Percutaneous Injection of Liquid Embolic Material: An Adjunct to the Preoperative Treatment of Hypervascular Lesions of the Head and Neck

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PURPOSE
Embolization of hypervascular tumors with particulate material is well documented in the literature. However, few reports have described the embolization of head and neck lesions using percutaneous techniques. We report our preliminary experience in the percutaneous embolization of hypervascular head and neck tumors and vascular malformations using liquid embolic agents such as Onyx (ethylene-vinyl alcohol copolymer, eV3, Irvine, CA) or n-BCA (n-butyl cyanoacrylate, Cordis Neurovascular, Miami Lakes, FL). We describe the technical aspects of the procedure and its efficacy in reducing intraoperative blood loss.

MATERIALS & METHODS
We retrospectively studied 18 patients (8 females and 10 males, mean age: 35 years, range 12 - 60 years), from January 2003 - December 2008, with 19 hypervascular tumors or malformations of the head and neck that underwent diagnostic angiography and subsequent embolization utilizing percutaneous injection of Onyx or n-BCA. Percutaneous injection of liquid embolic agents was performed under ultrasound and/or fluoroscopic guidance and utilized in tumor compartments incompletely devascularized with endovascular particulate material. Ten paragangliomas, four juvenile angiofibromas (JNA), four arteriovenous malformations of the face, and a venous malformation of face required percutaneous treatment. Fourteen tumors underwent surgery within 24 - 48 hours postembolization. Documented blood loss was obtained from operative reports from twelve patients.

RESULTS
Homogenous intratumoral penetration with progressive blood flow stasis was achieved during each injection. There were a mean of two needles (20 gauge x 3.5 inch spinal needles placed percutaneously into the tumors (range 1 - 4). The mean intraoperative blood loss was 390 cc (range 40 cc - 1700 cc). In resected tumors, intraoperative blood loss was less than 100 cc in six patients (50%). Following percutaneous injection of liquid embolic material, complete angiographic devascularization was achieved in 10 of 14 tumors. There were no local complications or neurologic deficits from the percutaneous access or embolization of these hypervascular lesions.

CONCLUSION
Percutaneous techniques for the embolization of hypervascular lesions of the head and neck with liquid embolic agents is technically feasible and safe. Reduced intraoperative blood loss from endovascular techniques alone may allow safer and complete surgical resection. However, further large series studies and follow-up data are required for critical assessment of this new treatment modality.

KEY WORDS: Onyx, percutaneous, embolization

Paper 179 Starting at 12:21 PM, Ending at 12:29 PM
Transnasal Percutaneous Biopsies Under Multidetector Tomography

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PURPOSE
Various tumors can affect the skull base and nasopharynx area. Their histological diagnosis and treatment is quite complex, requiring major surgical interventions in many instances exposing 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 histological 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 transnasal percutaneous and nasopharynx biopsies, in order to obtain a histological diagnosis. In the case of hypervascular lesions, percutaneous embolization can be performed using the same access pathway.

MATERIALS & METHODS
Between the years 2005 and 2008, 12 transnasal percutaneous image-guided biopsies were performed, at our center, in different regions of the nasopharynx and skull base including the anterior cranial fossa, parasellar region and clivus. To reach the lesions we used the transnasal approach route (Figure). Nine procedures were performed under tomography guidance alone in the tomography suite using the tandem technique. Two biopsies were obtained under CT guidance and then embolization in angiography suite. 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 14, 16 or 18G biop-
sy needle with automatic firing was placed to obtain the core biopsy. In hypervascular lesions percutaneous embolization with PVA was performed.

RESULTS
Tissue samples were obtained in 12 lesions and a diagnosis was possible in 10 cases. Histological diagnosis included: chordoma, chondrosarcoma, carcinoma, metastasis, juvenile nasoangiofibroma, pituitary adenoma, lymphoma and schwannoma. Three hypervascular lesions were encountered and percutaneously embolized at the time of the biopsy.

CONCLUSION
Transnasal percutaneous and nasopharynx biopsies are possible to perform. It is a safe procedure, and allows histological diagnosis to plan for appropriate surgical, radiation or chemotherapy treatment and it is a new development in neuroradiology.

KEY WORDS: Percutaneous biopsies, transnasal, multidetector tomography

Tuesday Morning
10:45 AM – 12:30 PM
Ballroom A

(18c) Adult Brain: Vascular, Extracranial & Vascular, Intracranial II
(Scientific Papers 180 – 192)

See also Parallel Sessions
(18a) Adult Brain: Neoplasms I
(18b) Interventional: New Devices & Techniques
(18d) Pediatric: Functional Imaging
(18e) Excerpta Extraordinaire: Interventional & Spine

Moderators: Allan J. Fox, MD, FRCPC, FACP
Bruce A. Wasserman, MD

Paper 180 Starting at 10:45 AM, Ending at 10:53 AM
CT Angiographic Evaluation of Carotid Plaque in Symptomatic vs Asymptomatic Side for Patients with Hemispheric TIA/Stroke

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PURPOSE
Indications for carotid revascularization currently are based on stenosis grade alone. We investigated carotid plaque morphologic features in addition to stenosis in the setting of symptomatic hemispheric TIA/stroke to identify factors that may predict plaque activity.

MATERIALS & METHODS
A retrospective review was performed from a prospectively maintained CT angiogram database from June 2004 to August 2007. Patients who presented with hemispheric ischemic symptoms and had a CT angiogram which included imaging of both carotids within 24 hours were included. CT angiography was performed using a multidetector scanner (Siemens, Erlangen, Germany) with raw data reconstructed to 1mm overlapping axial sections and reformats for the carotids performed in the sagittal oblique plane. The scans were interpreted by two experienced readers blinded to clinical information, studying morphologic features such as plaque length and width, density, shape, surface, presence and degree of calcification as well as intraluminal thrombus in addition to stenosis. An intraluminal thrombus was defined as a pedunculated filling defect projecting into the lumen of the vessel.

RESULTS
There were 988 patients who had evaluation of the carotids, of which 673 patients (408 male patients and 265 female patients, ages 18-91 years; Mean age = 65.8 ±15.2) were identified with interpretable scans and who also had a hemispheric event. Three hundred forty-nine patients had right hemispheric symptoms and 324 patients left hemispheric symptoms. The ipsilateral carotids served as cases (n=673) and the contralateral side as controls (n=673). Analysis was conducted using STATA statistical software. Univariable logistic regression showed that carotid occlusions (p =0.01; OR=5.27), high grade stenosis (70-99%) (p=0.06; OR=1.8) and presence of intraluminal thrombus (p=0.01; OR =4.33) were highly predictive of symptomatic side. In addition some features were seen to be more commonly associated with the non-symptomatic side such as smooth plaque surface (p=0.01; OR=0.73) and extensive calcification (p=0.03; OR=0.72). There was no correlation between plaque hypodensity (p=0.7; OR=1.06) or ulcerated plaque (p=0.74; OR=0.955) in predicting symptomatic side. In a multivariable logistic regression model, accounting for age, gender and degree of stenosis, presence of intraluminal thrombus was still found to be significantly associated with the symptomatic side (p=0.048; OR=3.1) and presence of extensive calcification with the nonsymptomatic carotid (p=0.047; OR=0.69). This also demonstrated a graded increase in odds ratios as degree of stenosis increased towards occlusion.
CONCLUSION
In our study we noted that in addition to higher stenosis grades, presence of intraluminal thrombus is highly predictive of symptomatic side in atherosclerotic carotid disease. The presence of a smooth appearing plaque and extensive calcification seems to afford a protective effect. We did not find evidence to show that hypodense plaque, suggesting a higher lipid component, or plaque ulceration were useful in predicting symptomatic carotid disease. This information may be useful in radiologic risk stratification in carotid disease in addition to the current evidence available based on stenosis criteria alone.

KEY WORDS: Carotid disease, plaque

Paper 181 Starting at 10:53 AM, Ending at 11:01 AM
Noninvasive Determination of Spatial Distribution and Temporal Gradient of Wall Shear Stress at Common Carotid Artery
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PURPOSE
Wall shear stress (WSS) has been proved to play a critical role in formation and development of atherosclerotic plaques. Our objective was to quantify local WSS in vivo in normal subjects, and to analyze spatial distribution patterns and determine the temporal gradient of WSS using high-resolution MR imaging velocity data combined with postprocessing techniques.

MATERIALS & METHODS
Seventy-eight common carotid arteries (CCAs) of 42 healthy volunteers were studied using 3.0 T Siemens MR scanner and a custom-made surface coil. The measurement position was selected to be at CCA 2 cm below the bifurcation. Flow velocity was measured using a retrospectively gated cine PC sequence with 0.47×0.47mm in-plane resolution. Three-dimensional paraboloid model method was applied to fit the velocity data and local WSS values for 24 points on the vessel wall were calculated.

RESULTS
Mean/range WSS was 0.783±0.209 (-0.541 -3.464) N/m² for CCAs. The 95% confidence interval for mean WSS value in CCA was (0.736-0.830) N/m². Different WSS spatial distribution patterns were classified into three types according to the location of low WSS values during a cardiac cycle. Maximum temporal gradient of WSS were 14.12±5.46 (5.87-33.23) N/m² s⁻¹. Skewed velocity profiles were displayed in most CCAs. Negative WSS values were found in the location where obvious skewed velocity profiles were demonstrated.

Fig. 1a Type I. Local WSS distributions were approximately same for all cardiac phases.
Fig. 1b Type II. Local WSS distributions were approximately same for most phases except the peak systole.
Fig. 1c Type III. Local WSS distribution varied with the cardiac phases.

Fig. 2. Velocity contour line maps for the CCA.

CONCLUSION
Significant intersubject variations were found in magnitude, spatial distribution and temporal gradient of WSS at CCAs. Complicated flow patterns were found in CCAs, especially in the end-systole and early-diastole.

KEY WORDS: MR flow imaging, wall shear stress, carotid artery

Paper 182 Starting at 11:01 AM, Ending at 11:09 AM
Characterization of Carotid Plaque Hemorrhage: A CT Angiography and MR Imaging Intra Plaque Hemorrhage Study
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PURPOSE
Decision-making regarding revascularization in carotid atherosclerosis is based on luminal narrowing. There is, however, growing evidence that morphologic features of vulnerable plaques, such as intraplaque hemorrhage (IPH), ruptured fibrous cap or large lipid core, may be better predictors of stroke risk than luminal stenosis. MR-IPH is a recent but robust technique, able to detect IPH in vivo with excellent diagnostic accuracy and reproducibility(Figure 1A)(1). The main objective of this study was to identify CT angiography(CTA) features which may predict presence of carotid IPH, as defined by MR-IPH.

MATERIALS & METHODS
One hundred sixty-seven consecutive patients (mean age 69 years, SD 12.8, 58 females) underwent MR-IPH and CTA within 3 weeks. One hundred fifty-three patients were symptomatic, with suspected strokes or TIAs. MR-IPH was performed at 1.5T, using neurovascular phased-array coil, as a...
coronal T1-weighted magnetization-prepared 3D GRE acquisition with fat-suppression (TR 10.3ms, TE 4.0ms, TI 20ms, FOV 350 × 300mm). MR-IPH was reviewed by one of four neuroradiologists, as to presence or absence of IPH. CT angiography was performed using either a 4 or 64 slice machine, using standard angiography protocols. Images were reviewed in axial plane and on coronal and sagittal MPR images. CT angiography was evaluated, blinded to MR-IPH findings, for (1) plaque density (2) presence or absence of plaque ulceration. Plaque density was defined as mean HU of plaque at site of maximum stenosis and two sections above and below, measured using circular ROI in non-calcified portions. Plaque ulceration was defined as contrast outpouching into plaque at least 2mm deep on any single plane (Figure 1B).

RESULTS
Fifteen arteries were excluded due to occlusions or previous surgery, yielding 319 arteries for analysis. MR-IPH showed 56 cases of IPH. Mean CT plaque density was higher for plaques with MRI-defined IPH (HU 47) compared to without IPH (HU 43) (p = 0.02). However, significant overlap between distribution of plaque densities suggest that plaque density is of limited value in distinguishing between the two groups. CT plaque ulceration had excellent diagnostic accuracy for presence of MRI-defined IPH (Sensitivity 80%, Specificity 93%, PPV 72% and NPV 95%).

Figure 1A: MR-IPH showing IPH at left ICA origin. Figure 1B: CT angiography in same patient showing plaque ulceration.

CONCLUSION
Presence of CT plaque ulceration, but not plaque density, was useful for prediction of MRI-defined IPH.

REFERENCES

KEY WORDS: Carotid, plaque hemorrhage, MRI

Paper 183 Starting at 11:09 AM, Ending at 11:17 AM
Using Baseline Perfusion CT to Evaluate Vasospasm Development Following Aneurysmal Subarachnoid Hemorrhage

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1New York Presbyterian Hospital, New York, NY, 2New York College of Osteopathic Medicine, Old Westbury, NY, 3NewYork Presbyterian Hospital/Weill Cornell Medical College, New York, NY

PURPOSE
The purpose of this study was to examine the utility of baseline CT perfusion (CTP) for evaluating vasospasm development following aneurysmal subarachnoid hemorrhage (A-SAH).

MATERIALS & METHODS
Retrospective analysis was performed on all adult patients admitted to our institution with A-SAH from 12/2004-2/2007. Inclusion criteria were patients with baseline CTP performed on day 0-3 following aneurysmal rupture and no contraindications to iodinated contrast administration. Clinical data was obtained regarding age, gender, aneurysm size and location, type of aneurysm treatment and Hunt Hess (HH) grade on presentation. CTP was performed on a 16-slice multi-detector scanner using cine 4i mode with four contiguous 5 mm-thick sections. Images were transferred to a post-processing workstation for construction of the parametric maps. Cerebral blood flow (CBF), cerebral blood volume (CBV) and mean transit time (MTT) maps were qualitatively analyzed to determine the presence of focal perfusion defects. Additional quantitative analysis was performed of the identified perfusion abnormality, as well as ROI sampling of the anterior, middle, and posterior territories. The outcome of vasospasm was primarily determined by digital subtraction angiography (DSA). In those patients who did not undergo DSA, development of vasospasm was determined utilizing a combination of imaging criteria, clinical criteria, and response to medical treatment for vasospasm.

RESULTS
A total of 75 patients were included in the study. Median age was 48 years, range 28-73 years. Twenty-three (31%) males and 52 (69%) females were included. The aneurysm location was 57 (73%) in the anterior circulation and 21 (27%) in the posterior circulation. Forty-one (55%) patients underwent neurosurgical clipping, 33 (44%) had endovascular coiling, and 1 had both. The median HH grade on presentation was 2. Twenty-one (28%) patients had grade 1 HH, 24 (32%) had grade 2, 21 (28%) had grade 3, 8 (11%) had grade 4, and 1 (1%) had grade 5. Twenty-eight (37%) patients developed vasospasm, 26 of which demonstrated angiographic vasospasm. Thirty-nine (52%) patients were treated for vasospasm with medical HHH therapy and/or endovascular treatment. All patients received the baseline CTP exam following aneurysm rupture from day 0-3 with the median at day 2. Several threshold values for CBF and MTT were used to determine sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV). Using a baseline CBF threshold < 38 mL/100gm/min yielded a 61% sensitivity, 53% specificity, 44% PPV and 69% NPV. However, using a baseline CBF threshold < 25 mL/100gm/min yielded...
a 46% sensitivity, 89% specificity, 72% PPV and 74% NPV. A baseline CBV threshold 5 sec yielded a 61% sensitivity, 64% specificity, 50% PPV and 73% NPV.

**CONCLUSION**

Baseline CTP performed following A-SAH has limited value for detection of vasospasm development using the quantitative threshold parameters above. However, further statistical analysis using receiver operator characteristic (ROC) curves to define the optimal threshold value with the qualitative perfusion defects may improve these test characteristics.

**KEY WORDS:** Vasospasm, Perfusion CT, Subarachnoid Hemorrhage

**Paper 184 Starting at 11:17 AM, Ending at 11:25 AM**

**Perfusion CT and CT Angiography in Evaluation of Extracranial-Intracranial Bypass Grafts**

Langner, S. · Fleck, S. · Baldauf, J. · Hosten, N. · Kirsch, M. Ernst-Moritz-Arndt University Greifswald Greifswald, GERMANY

**PURPOSE**

Extracranial-to-intracranial (EC-IC) bypass surgery remains an important treatment alternative for patients with occlusive cerebrovascular disease. The aim of our study was to use CT perfusion (CTP) and CT angiography (CTA) to evaluate cerebral hemodynamics and bypass patency in such patients before and after EC-IC high-flow surgery.

**MATERIALS & METHODS**

Six patients underwent CTP and CTA studies before, 1 week after and 6 months after bypass surgery. Preoperatively we also performed digital subtraction angiography. Surgery consisted of middle cerebral artery-superficial temporal artery bypass with saphenous vein grafts. CT perfusion was performed at the level of the basal ganglia (2 slices, 12mm slice thickness, 1 scan/s for 40s, 40ml contrast agent, flow 5.9 ml/s). Color-coded perfusion maps for rCBV, rCBF and TTP were calculated. CT angiography reached from the level of vertebra C6 to the roof of the lateral ventricles. Vessels were analyzed using axial source images, MIP- and VRT-reconstructions.

**RESULTS**

Preoperative CTP showed significant prolonged MTT and reduced rCBF of the affected hemisphere. No patient developed neurologic deterioration after operation. Proximal and distal anastomosis as well as the course and caliber of the bypass could be evaluated by CTA. Patency of the bypass could be visualized by CTA in all patients. Postoperative CTP showed improved cerebral hemodynamics with a return of perfusion parameters to nearly normal values.

**CONCLUSION**

CT perfusion can be used for the pre and postoperative evaluation of patients who receive EC-IC bypass grafts. CT angiography is a viable alternative to DSA to assess the patency of these bypass grafts.

**KEY WORDS:** Bypass, perfusion CT, CT angiography

**Paper 185 Starting at 11:25 AM, Ending at 11:33 AM**

**High-Resolution Intracranial MR Angiography at 7 T Using Autocalibrating Parallel Imaging:** Initial Experience in the Evaluation of M1 Segment MCA Stenosis

Purcell, D. D. · von Morze, C. · Xu, D. · Hess, C. P. · Vigneron, D. B. · Mukherjee, P.

University of California San Francisco San Francisco, CA

**PURPOSE**

Increases in magnetic field strength improve three-dimensional (3D) time-of-flight (TOF) MR angiography (MRA) of the intracranial circulation by improving the signal-to-noise ratio and by increasing the T1 relaxation times of background brain tissue. Both these mechanisms improve the contrast-to-noise ratio (CNR) of blood vessels, resulting in significant advantages of 3T MRA over 1.5T MRA. The goal of this study was to investigate whether a further increase in field strength to 7T yields a similar improvement in CNR, such that intracranial atherosclerosis is characterized with greater certainty.

**MATERIALS & METHODS**

Three adult volunteers with atherosclerotic stenosis of the proximal MCA visualized on 1.5T and 3T MRA, were scanned using a 7T MRA protocol developed at our institution (matrix 512x384, FOV=22, TR/TE=30/2.6ms, flip=25, readout BW = 62.5kHz). The acquisition was divided into 4 slabs of 38 0.5-mm thick partitions each employing the multiple overlapping thin slab acquisition (MOTSA) technique. Data were undersampled along the phase-encoding direction with outer reduction factor of two and reconstructed using the GRAPPA (generalized autocalibrating partially parallel acquisitions) technique.

**RESULTS**

Visual comparison of intracranial TOF MRA obtained at 7T demonstrated improved image quality compared with MRA performed at lower field strengths (1.5 and 3T). In two cases, the degree of MCA stenosis was overestimated at lower field strength. In all cases, small caliber branch arteries (e.g., anterior choroidal) and deep perforators (e.g., lenticulostriate arteries) were visualized more reliably at 7T. In one case, the degree of stenosis estimated at 7T was confirmed by catheter angiography. In this case, planned MCA stent placement based on the results of 1.5T MRA was not performed due to overestimation of stenosis at the lower field strength.
Intracranial 3D TOF MRA at 7T appears to offer more reliable estimates of intracranial MCA stenosis compared with lower field strength systems. Overestimation of vessel narrowing, a known shortcoming of TOF MRA, may be overcome by the improvements in CNR found at 7T.

CONCLUSION

Intracranial 3D TOF MRA at 7T offers more reliable estimates of intracranial MCA stenosis compared with lower field strength systems. Overestimation of vessel narrowing, a known shortcoming of TOF MRA, may be overcome by the improvements in CNR found at 7T.

KEY WORDS: 7 T, MR angiography, intracranial atherosclerosis

PAPER 186 STARTING AT 11:33 AM, ENDING AT 11:41 AM

Use of MR Imaging for Evaluation of Underlying Structural Vascular Abnormality in Patients Presented with Spontaneous Intracerebral Hemorrhage: A Review of 151 Cases

Wong, G. K. C. · Siu, D. · Ahuja, A. · Yu, S. · Poon, W. S.
The Chinese University of Hong Kong Hong Kong, HONG KONG

PURPOSE

We aim to investigate whether MR imaging, in the subacute stage of intracerebral haematoma, had a high enough positive and negative predictive value to screen for the presence of vascular abnormality in the routine clinical setting, reserving digital subtraction angiography (DSA) for those MR imaging positive cases to further evaluate the vascular abnormalities.

MATERIALS & METHODS

The study was carried out in a regional neurosurgical center in Hong Kong. A total of 206 patients had DSA performed as investigations of underlying vascular malformation of intracerebral haematoma within the 6-year period. One hundred fifty-one patients, with both MR imaging and DSA done as investigations for underlying structural vascular abnormalities, were reviewed retrospectively.

RESULTS

A total of 70 (46%) vascular lesions accountable for the hemorrhage was found for patients with vascular abnormalities. They tended to be younger patients aged 33+/-15 (mean+/-SD) years, less likely to be hypertensive (6.3%), more likely presented with headache (60%) and without neurologic deficit (59%). In terms of cerebral arteriovenous malformation and dural arteriovenous fistulas, MR imaging had a positive predictive value of 0.98 and negative predictive value of 1.00.

CONCLUSION

MR imaging was able to pick up the presence of most structural vascular abnormalities, reserving DSA for patients suspicious of peripheral intracranial aneurysms or angioarchitecture assessment.

KEY WORDS: Intracerebral hemorrhage, arteriovenous malformation, MR imaging

PAPER 187 STARTING AT 11:41 AM, ENDING AT 11:49 AM

Quantomo: Validation of a Computer-Assisted Method used in the PREDICT Trial for Volumetric Analysis of Hematoma in Intracerebral Hemorrhage

Kosior, J. C. · Dowlatshahi, D. · Idris, S. · Tymchuk, S. · Alzawahmah, M. · Eesa, M. · Sharma, P. · Hill, M. D. · Frayne, R. · Demchuk, A. M. · PREDICT Study Investigators

1University of Calgary, Calgary, AB, CANADA, 2Calgary Stroke Program, Calgary, AB, CANADA

PURPOSE

The ABC/2 method is the most commonly used method for quantifying intracerebral hemorrhage (ICH) volume. However, computer-assisted techniques may provide more reliable volume measurements because they do not depend on hematomas matching an assumed shape (e.g., ABC/2 assumes that hematomas are ellipsoids) and instead rely on radiologic interpretation. In this work, we validate a computer-assisted method for ICH volume measurement used in the PREDICT trial called Quantomo (for quantitative tomography).

MATERIALS AND METHODS

Quantomo was developed using threshold-based region growing algorithms (ITK; National Library of Medicine). Raters measure ICH volumes using Quantomo by (1) selecting a hematoma with a cursor (2) adjusting an intensity threshold (in Hounsfield Units) and (3) manually adding or removing regions to the computer-selected region at their discretion. Four raters (2 stroke neurologists, 2 neuroradiologists) measured ICH volumes from 29 randomly selected CT scans four times, presented in random order over four reading sessions separated by at least 5 days. Quantomo was used for the first two readings and ABC/2 for the latter two. Raters were blinded to the results of their measurements, as well as patient identities and clinical presentations. Estimates of interrater and intrarater reliability (including the minimum detectable difference, MDD) were calculated simultaneously using a two-way random effects ANOVA for both techniques.

RESULTS

The mean and standard deviation of ICH volume measurements across all raters and sessions was 33.0 ml ± 26.5 ml and 47.6 ml ± 42.3 ml for Quantomo and ABC/2, respectively. The ANOVA analysis (Table) revealed that Quantomo is capable of reliably detecting smaller changes in ICH volume (i.e., lower MDD) compared to ABC/2. ABC/2 approximates hematomas as ellipsoids, which results in large errors for irregular hematomas compared to Quantomo (Figure).

Two-way random effects ANOVA reliability analysis

<table>
<thead>
<tr>
<th>Method</th>
<th>Intra-rater ICC (95% LCI)</th>
<th>MDD (ml)</th>
<th>Inter-rater ICC (95% LCI)</th>
<th>MDD (ml)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ABC/2</td>
<td>0.982 (0.934)</td>
<td>16.0</td>
<td>0.901 (0.811)</td>
<td>37.6</td>
</tr>
<tr>
<td>Quantomo</td>
<td>0.996 (0.994)</td>
<td>4.9</td>
<td>0.989 (0.986)</td>
<td>8.0</td>
</tr>
</tbody>
</table>

ICC - intra-class correlation coefficient; LCI - lower confidence interval; MDD - minimum detectable difference
**PURPOSE**
Milano, ITALY
I.R.C.C.S. San Raffaele

Fast imaging with steady-state precession (FISP) imaging (3D) was acquired, starting 5 minutes after contrast injection. Row
matrix 512x512; flip angle 30°; field of view 240 mm) was
3.7 msec; slices number: 100-140; slice thickness 0.5 mm;
resolution 3D-FFE steady-state sequence (TR 25 msec; TE
contrast media was injected with a power injector. A high-
sequences; a maximum dose of 0.2 ml/Kg of blood-pool
was inclusive of FLAIR, T1- and T2-weighted precontrast
Medical System, the Netherlands). MR acquisition protocol
studies were performed on a 3.0 T scanner (Intera, Philips
Bayer Schering Pharma) within 24 hours after DSA. All MR
angiography with blood-pool contrast agent (Vasovist®,
sequence angiography (DSA).

**MATERIALS & METHODS**
Between April and December 2008, 11 consecutive patients
(8 female, 3 male) with 11 intracranial AVMs previously
were treated with gamma knife radiosurgery, underwent regular
follow-up DSA in order to assess the definitive obliteration
of the malformation. The mean age was 48.7 (range 28-70)
years, the mean A VM volume was 2.8 cm³ (range 0.3-9.6
cm³) and the mean time between treatment and control
imaging (1.5T Philips Achieva). All studies were performed
that contained intraluminal thrombus were studied with MR
imaging the vessel wall. We investigated the ability of T1-
appreciation of both the vascular lumen and intraluminal
thrombus. The formation of thrombus on the luminal wall,
however, is typically not evident on imaging modalities that
specifically targets free lumen morphology. The delineation
and characterization of intraluminal thrombus, in addition
to free lumen geometries, may be highly relevant to under-
standing disease progression. Magnetic resonance methods
are capable of both angiographic evaluations and directly
imaging the vessel wall. We investigated the ability of T1-
weighted, T2-weighted and steady state techniques to delin-
erate thrombus morphology and reveal changes over time.

**RESULTS**
The overall complete angiographic obliteration rate was
45% (5/11). In 6/11 (55%) patients with still patent AVM,
control angiograms allowed the depiction of three residual
nidi, 11 small feeding arteries and seven slight draining
veins. The overall MR obliteration rate matched completely
with DSA. The evaluation of MR angiography with high-
resolution 3D-FFE steady-state sequences correctly identi-
fied five obliterated and six patent AVMs and enabled the
detection of the three residual nidi, 11 feeding arteries and
of the seven small draining veins.

**CONCLUSION**
Quantomo is capable of reliably detecting more subtle
changes in ICH volume compared to the traditional ABC/2
method, and therefore, is more appropriate for ICH growth
definition in ICH clinical trials.

**KEY WORDS:** Intracerebral hemorrhage volume, PREDICT, Quantomo

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**Paper 188 Starting at 11:49 AM, Ending at 11:57 AM**
**Prospective Comparative Study of High Spatial Resolution Steady State MR Angiography at 3.0 T versus DSA in the Follow Up of Brain Arteriovenous Malformations Treated with Gamma Knife Radiosurgery**

Civelli, V. · Scomazzoni, F. · Righi, C. · Iadanza, A. · Cadioli, M. · Snider, S. · Scotti, G. · Anzalone, N.
I.R.C.C.S. San Raffaele
Milano, ITALY

**PURPOSE**
To prospectively evaluate the feasibility and the diagnostic
value of contrast-enhanced magnetic resonance angiography
(MRA) with blood-pool contrast agent (Vasovist®, Bayer
Schering Pharma) in the assessment of complete obliteration
of intracranial arteriovenous malformations (AVMs) after
gamma knife radiosurgery, compared with digital subtraction
angiography (DSA).

**MATERIALS & METHODS**
Between April and December 2008, 11 consecutive patients
(8 female, 3 male) with 11 intracranial AVMs previously
were treated with gamma knife radiosurgery, underwent regular
follow-up DSA in order to assess the definitive obliteration
of the malformation. The mean age was 48.7 (range 28-70)
years, the mean AVM volume was 2.8 cm³ (range 0.3-9.6
cm³) and the mean time between treatment and control
angiogram was 49 months (range 36-57 months). All
patients then were submitted to contrast-enhanced MR
angiography with blood-pool contrast agent (Vasovist®,
Bayer Schering Pharma) within 24 hours after DSA. All MR
studies were performed on a 3.0 T scanner (Intera, Philips
Medical System, the Netherlands). MR acquisition protocol
was inclusive of FLAIR, T1- and T2-weighted precontrast
sequences; a maximum dose of 0.2 ml/Kg of blood-pool
contrast media was injected with a power injector. A high-
resolution 3D-FFE steady-state sequence (TR 25 msec; TE
3.7 msec; slices number: 100-140; slice thickness 0.5 mm;
matrix 512x512; flip angle 30°; field of view 240 mm) was
acquired, starting 5 minutes after contrast injection. Row
images were sent on a separate workstation (Viewforum
Release 5.1. Philips Medical system) and reconstructed in
multiplanar MIP projection. Digital subtraction angiography
images and 3D steady-state sequences then were reviewed
by two independent neuroradiologists with regard to persist-
ence of nidi, arterial feeders, and venous drainage.

**RESULTS**
The overall complete angiographic obliteration rate was
45% (5/11). In 6/11 (55%) patients with still patent AVM,
control angiograms allowed the depiction of three residual
nidi, 11 small feeding arteries and seven slight draining
veins. The overall MR obliteration rate matched completely
with DSA. The evaluation of MR angiography with high-
resolution 3D-FFE steady-state sequences correctly identi-
fied five obliterated and six patent AVMs and enabled the
detection of the three residual nidi, 11 feeding arteries and
of the seven small draining veins.

**CONCLUSION**
Magnetic resonance angiography with blood-pool contrast
agent at 3.0 T had 100% agreement with DSA with regard to
assessment of complete obliteration and detection of residual
nidi, arterial feeder and draining veins of intracranial arteri-
ovenous malformations (AVMs) and might be considered as
a possible substitute to DSA in the follow-up studies of AVM
previously treated with gamma knife radiosurgery.

**KEY WORDS:** AVM, blood pool, gamma knife

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**Paper 189 Starting at 11:57 AM, Ending at 12:05 PM**
**Steady State MR Imaging for Characterizing Thrombus Within Neurovascular Aneurysms**

Martin, A. J. · Wintermark, M. · Higashida, R. · Young, W. · Halbach, V. · Dowd, C. · Lawton, M. · Saloner, D.
University of California San Francisco
San Francisco, CA

**PURPOSE**
A comprehensive evaluation of aneurysmal disease requires
appreciation of both the vascular lumen and intraluminal
thrombus. The formation of thrombus on the luminal wall,
however, is typically not evident on imaging modalities that
specifically targets free lumen morphology. The delineation
and characterization of intraluminal thrombus, in additional
to free lumen geometries, may be highly relevant to under-
standing disease progression. Magnetic resonance methods
are capable of both angiographic evaluations and directly
imaging the vessel wall. We investigated the ability of T1-
weighted, T2-weighted and steady state techniques to delin-
erate thrombus morphology and reveal changes over time.

**MATERIALS & METHODS**
A total of eight patients with basilar or vertebral aneurysms
that contained intraluminal thrombus were studied with MR
imaging (1.5T Philips Achieva). All studies were performed
with the approval of our institutions committee for human
research and all patients signed informed consent. Imaging
included contrast-enhanced angiography to reveal the free
lumen and T1-weighted spin echo (2D), 3D T2-weighted
spin echo, and 3D steady state (BFSE) sequences for imaging
the surrounding thrombus and tissue. All patients under-
went at least two studies that were separated by 4-15 months.
Signal intensity analysis was performed in matched regions for each patient to determine mean signal from thrombus, blood, CSF, and brain. Signal intensities were normalized to that of brain and contrast was established between thrombus and the remaining tissue types for all MR sequences.

RESULTS
Thrombus could be appreciated with all image types (Figure) and was generally consistent between sessions. Thrombus signal was highest on T1-weighted imaging and lowest with T2-weighted imaging. Thrombus produced signal intensities that were comparable to brain with T1 and steady state techniques and lower than brain with T2. Heterogeneity within the clot was evident in 50% of patients, with peripheral hyperintensity being the most common feature. Contrast between luminal blood and thrombus was significantly greater with steady state techniques and contrast between thrombus and CSF was greatest with T2 and steady state techniques.

CONCLUSION
3D steady state imaging was found to be superior to T1- and T2-weighted imaging for detecting and delineating intraluminal thrombus within aneurysms.

KEY WORDS: Aneurysm, MR imaging, thrombus

Paper 190 Starting at 12:05 PM, Ending at 12:13 PM
Local Hemodynamics at the Locations of Bleb Development in Cerebral Aneurysms
Cebrał, J. R.¹ · Putman, C. M.²
¹George Mason University, Fairfax, VA, ²Inova Fairfax Hospital, Falls Church, VA

PURPOSE
To investigate possible associations between the local hemodynamics and wall shear stress and the formation of blebs in cerebral aneurysms.

MATERIALS & METHODS
A total of 19 patients with intracranial aneurysms harboring well defined blebs and imaged with 3D rotational angiography (3DRA) were selected from our database. The sample included aneurysms in the middle cerebral artery, anterior communicating artery, posterior communicating artery, internal carotid artery (the ophthalmic origin and carotid terminus), and basilar artery. Computational fluid dynamics models were constructed from the 3DRA images. For each patient, a second model representing the aneurysm before the formation of the bleb(s) was created by removing the bleb(s) from the original reconstruction. Computational fluid dynamics simulations of the aneurysm before and after bleb formation were performed under pulsatile conditions derived from phase-contrast magnetic resonance of normal subjects. Visualizations of flow structures, wall shear stress (WSS), and wall shear stress gradient (WSSG) were used to analyze the local hemodynamics in the region of the aneurysm that developed the bleb.

RESULTS
Most blebs (80%) occurred at or adjacent to the aneurysm region with the highest WSS before bleb formation, and near the flow impaction zone. Most blebs (83%) were found in regions of the aneurysm previously subjected to high or moderate WSS, and with bleb formation progressed to a lower WSS state. Most blebs (77%) were aligned or adjacent to the inflow jet, 17% were aligned with the outflow jet, and only 6% were not aligned with the flow. Additionally, 90% of the aneurysms had maximum WSS higher than or similar to the parent artery. Finally, 57% of blebs were found in regions of positive WSSG (flow acceleration zones), 16% in negative WSSG (flow deceleration zones) regions, and 27% in borderline regions (stagnation regions).

CONCLUSION
Aneurysm blebs are found most commonly in regions of the aneurysm previously subjected to locally elevated wall shear stress induced by the blood flow. Bleb formation results in the creation of a new flow recirculation region and a reduction of the wall shear stress. These findings are consistent with the hypothesis that WSS and WSSG gradients may play a role in the focal wall injury thought to be related to aneurysm progression and rupture.

KEY WORDS: Cerebral aneurysm, blebs, hemodynamics

Paper 191 Starting at 12:13 PM, Ending at 12:21 PM
Neuroimaging in Patients with Intracardiac Myxomas: A 15-Year Review Including CT, MR Imaging, MR Angiography, and Cerebral Angiography
Marlow, M. J. · Morris, J. M. · Cloft, H. J. · Kallmes, D. F. · Brown, R. D. · Thielen, K. R.
Mayo Clinic
Rochester, MN

PURPOSE
Atrial myxomas are the most common benign primary tumor of the heart in adults. Seven - 45% of patients are reported to have a central nervous system (CNS) complication in their lifetime. Our purpose is to review the incidence of CNS involvement and review and illustrate the spectrum of neuroimaging findings a radiologist can encounter in these patients.

MATERIALS & METHODS
With institutional review board approval we searched a pathology database at our institution for any diagnosis coded as myxoma cross-referenced with cardiology origin from 1995 - 2008. This resulted in 400 patients. After reviewing the medical records, we created a second list of 98 patients who had undergone some form of neuroimaging [CT, MR imaging
(MRI), MR angiography (MRA), cerebral angiogram]. Two radiologists reviewed all of the imaging, one staff neuroradiologist and one resident.

RESULTS
Of our 98 patients, 24 (24.5%) had cortical infarcts, found on MRI or CT. Seven (7%) individuals had intracranial aneurysms, three discovered with conventional angiography and four imaged with MRA. The aneurysms ranged from solitary large and fusiform to multiple small and peripheral. In one of the seven aneurysms, there is pathologic proof of tumor invasion into the vessel wall. One (1%) had a frontal lobe intraparenchymal hemorrhage. In 47 (48%) patients, we found either nonspecific T2 hyperintensities in the white matter or old lacunar infarcts. The remaining 21 (21.4%) patients had negative examinations.

CONCLUSION
We present, to our knowledge, the largest series of patients with atrial myxomas focused on neuroimaging. The rate of CNS complications that can be attributed to an atrial myxoma was 8% in our series, which is lower than other published reports. The most common finding in these patients is stroke, which is potentially treatable and most cases due to surface thrombus. Surgery is generally curative and late embolic phenomenon is rare. Intracranial aneurysm was the second most common finding in our series. Aneurysm formation is not well established but there are two main theories. First is postembolic damage to the vessel wall resulting in scarring, altered flow dynamics, thus promoting aneurysm formation. Second is direct invasion of the vessel wall by tumor emboli, which was the case in at least one of our aneurysms. Aneurysm formation can be a late finding and has been reported up to 5 years after cardiac resection most likely due to continued growth within the vessel wall. Other less common findings that have been reported include hemorrhage, vasculitis, and intracranial mass from metastatic myxoma. The neuroradiologist should be aware of these findings and in patients with a history of atrial myxoma MRA, CTA, or cerebral angiogram should be considered along with standard neuroimaging.

KEY WORDS: Myxoma, infarct, aneurysm

Paper 192 Starting at 12:21 PM, Ending at 12:29 PM
Postcontrast CT Extravasation Is Associated with Hematoma Expansion in CT Angiography Spot Negative Patients
Aviv, R.1 · Demchuk, A.2 · Chia, T.1 · Gladstone, D.1 · Dowlatshahi, D.2 · BenDavat, G.1 · Wong, K.1 · Symons, S.1 · Ederies, A.1
1Sunnybrook Hospital, Toronto, ON, CANADA, 2Foothills Medical Centre, Calgary, AB, CANADA

PURPOSE
To assess the effect of postcontrast CT leakage (PCL) on hematoma growth in CT angiography (CTA) spot negative patients.

MATERIALS & METHODS
A retrospective study of 61 patients presenting within 6 hours of primary ICH onset imaged with CTA and postcontrast CT (PCCT). Presence of CTA spot sign and PCL were documented. Postcontrast CT leakage was defined as the presence of contrast extravasation on the PCCT study at a location remote from the CTA spot sign if present. Hematoma expansion was defined as >6 mL or 30% hematoma enlargement. Patients were dichotomized by CTA spot sign presence and PCL and compared for baseline demographic data, hematoma size and growth using the unpaired T test and Mann Whitney test for continuous and categorical data respectively. A p value <0.05 was considered significant.

RESULTS
Postcontrast CT leakage was present in 11/61 patients (18%) occurring in five without a spot sign (45%). Spot negative PCL patients demonstrated larger absolute (p=0.02) and percentage hematoma growth (p=0.02) compared to those without PCL. The mean volume and percent increase was 6.7 mL and 26% respectively. Inclusion of PCL together with CTA spot sign as risk factor for hematoma expansion increased sensitivity from 0.78 (95% CI; 0.52-0.94) to 0.94 (95% CI; 0.72-1.00) and NPV from 0.90 (95% CI; 0.76-0.97) to 0.97 (95% CI; 0.85-1.00).

CONCLUSION
Inclusion of PCCT in the investigation of ICH patients allows detection of PCL which, together with the CTA spot sign, increases sensitivity and negative predictive value for predicting hematoma expansion. This finding should be validated in larger studies.

KEY WORDS: ICH, spot sign, extravasation

Tuesday Morning
10:45 AM – 12:30 PM
Room 1

(18d) Pediatric: Functional Imaging
(Scientific Papers 193 – 205)

See also Parallel Sessions
(18a) Adult Brain: Neoplasms I
(18b) Interventional: New Devices & Techniques
(18c) Adult Brain: Vascular, Extracranial & Vascular, Intracranial II
(18e) Excerpta Extraordinaire: Interventional & Spine

Moderators: Jill V. Hunter, MD
James L. Leach, MD
PURPOSE
Diffusion tensor imaging (DTI) has facilitated the study of white matter architecture. However, alterations in image processing and analysis can lead to important differences in tractography results and therefore clinical interpretation. Current tractography protocols have been developed and optimized for use in the normal mature brain where apparent diffusion coefficient (ADC) is uniform. In every day clinical practice, pathologic changes resulting in altered ADC can significantly alter 3D tract reconstruction. We explore the changes in tractography that occur with modifications in the diffusion reconstruction, different fractional anisotropy (FA) thresholds and different tracking algorithms in brains that have uniform ADC background, compared to those with regions of increased or decreased ADC. Our hypothesis is that brains that have regional variation in ADC are more sensitive to processing parameters compared to those with uniform background in ADC.

MATERIALS & METHODS
Twenty pediatric patients were chosen from our clinical diffusion database. Four types of subjects were selected: five normal subjects with fully myelinated white matter and uniform ADC values; five subjects with diffusely increased ADC (Canavans, diffuse white matter disease, prematurity, leukodystrophies); five subjects with focally decreased ADC (methotrexate, stroke), and five subjects with focally increased ADC (MS, prematurity). Diffusion tensor imaging data were acquired with a GE scanner with 5 b=0 and 29 diffusion directions at b=1000s/mm2. Each data set was reconstructed using both a DTI or HARDI model. Two tracking algorithms were compared, FACT and RK2 with and without FA thresholds of 0.15. Tractography of the whole brain were obtained and histograms of mean length and standard deviation of tracts, mean ADC and FA, as well as visual inspection was evaluated.

RESULTS
With a DTI reconstruction using FACT for tracking, and a threshold of 0.15 FA, the fiber tracts that are reconstructed are all compact and shortest. Without an FA threshold, the fiber tracts extended past the most compact fiber regions, through regions of altered ADC. HARDI reconstructions and RK2 tracking algorithms both increased mean fiber length and resulted in tracts that were dispersed more radially. As with DTI, removing the FA threshold improved ability to track through regions of altered ADC.

CONCLUSION
The choice of diffusion reconstruction, tracking algorithms and FA threshold have a large impact on the resulting fiber tracts, particularly in regions of altered ADC.

KEY WORDS: Diffusion tensor imaging, tractography, pediatrics
RESULTS

Age-related increases in FA varied with location. The most marked changes in callosal FA were seen within the midcallosal body (slope 0.016) with minimal changes in the callosal genu (slope 0.002) and splenium (slope 0.008). Age-related changes in FA were seen in the PLIC (RT slope 0.0246, LT slope 0.020) and cingulum (slopes 0.016-0.023), SLF (slopes 0.009-0.014) and IFO-ILF (slopes 0.011-0.02) and were more marked in the left SLF (slope 0.014) than the right (slope 0.009).

Table 1. Regions of interest FA data with areas of greatest slope (change in FA with age) highlighted.

<table>
<thead>
<tr>
<th>Region</th>
<th>MNI location</th>
<th>R2</th>
<th>p value</th>
<th>slope</th>
<th>Group FA</th>
<th>mean (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Genu CC</td>
<td>0,31,2</td>
<td>0.095</td>
<td>0.213</td>
<td>0.002</td>
<td>0.892 (0.023)</td>
<td></td>
</tr>
<tr>
<td>Midbody CC</td>
<td>-0.13,27</td>
<td>0.347</td>
<td>0.010</td>
<td>0.016</td>
<td>0.619 (0.095)</td>
<td></td>
</tr>
<tr>
<td>Splenium CC</td>
<td>-0.36,18</td>
<td>0.378</td>
<td>0.006</td>
<td>0.008</td>
<td>0.866 (0.049)</td>
<td></td>
</tr>
<tr>
<td>RT PLIC</td>
<td>15, -11, -9</td>
<td>0.839</td>
<td>1.79E-07</td>
<td>0.025</td>
<td>0.719 (0.093)</td>
<td></td>
</tr>
<tr>
<td>LT PLIC</td>
<td>-13, -11, -7</td>
<td>0.811</td>
<td>4.17E-07</td>
<td>0.020</td>
<td>0.694 (0.079)</td>
<td></td>
</tr>
<tr>
<td>RT SLF</td>
<td>38, -22, 29</td>
<td>0.258</td>
<td>0.031</td>
<td>0.009</td>
<td>0.503 (0.059)</td>
<td></td>
</tr>
<tr>
<td>LT SLF</td>
<td>-37, -23, 30</td>
<td>0.552</td>
<td>0.0004</td>
<td>0.014</td>
<td>0.532 (0.067)</td>
<td></td>
</tr>
<tr>
<td>RT ILF-IFO</td>
<td>41, -36, 7</td>
<td>0.667</td>
<td>3.50E-05</td>
<td>0.019</td>
<td>0.625 (0.085)</td>
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</tr>
<tr>
<td>LT ILF-IFO</td>
<td>-42, -40, 4</td>
<td>0.537</td>
<td>0.0005</td>
<td>0.011</td>
<td>0.634 (0.054)</td>
<td></td>
</tr>
<tr>
<td>RT ANT CINGULUM</td>
<td>11, 37, 7</td>
<td>0.658</td>
<td>4.40E-05</td>
<td>0.019</td>
<td>0.538 (0.079)</td>
<td></td>
</tr>
<tr>
<td>RT MID CINGULUM</td>
<td>10, 20, 24</td>
<td>0.646</td>
<td>5.70E-05</td>
<td>0.016</td>
<td>0.651 (0.068)</td>
<td></td>
</tr>
<tr>
<td>RT POST CINGULUM</td>
<td>8, -22, 34</td>
<td>0.691</td>
<td>1.90E-05</td>
<td>0.016</td>
<td>0.532 (0.069)</td>
<td></td>
</tr>
<tr>
<td>LT ANT CINGULUM</td>
<td>-7, 3, 20</td>
<td>0.647</td>
<td>2.91E-05</td>
<td>0.017</td>
<td>0.644 (0.075)</td>
<td></td>
</tr>
<tr>
<td>LT MID CINGULUM</td>
<td>-7, 3, 32</td>
<td>0.690</td>
<td>1.58E-05</td>
<td>0.019</td>
<td>0.625 (0.083)</td>
<td></td>
</tr>
<tr>
<td>LT POST CINGULUM</td>
<td>-11, 44, 23</td>
<td>0.808</td>
<td>4.17E-07</td>
<td>0.023</td>
<td>0.517 (0.089)</td>
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</tr>
</tbody>
</table>

CONCLUSION

Diffusion tensor imaging at 3T using TBSS in children known to be normal by extensive cognitive testing suggests white matter maturation proceeds at different rates in different parts of the brain and that normative FA values for older children and adolescents cannot be used for younger children.

REFERENCES


KEY WORDS: DTI, anatomy, developmental
Figure. Cluster regions on FA skeleton where FA vs. age slope is significantly different between dyslexia and control subjects are overlaid in color on mean FA image. Arrows indicate visual form recognition region at left temporal-occipital junction.

CONCLUSION
Diffusion tensor imaging at 3T using TBSS suggests widespread lack of age-related maturational changes in dyslexic subjects and alterations in white matter composition including a critical visual form recognition region at the left temporal-occipital junction.

KEY WORDS: Pediatrics, dyslexia, DTI

Paper 196 Starting at 11:09 AM, Ending at 11:17 AM
Pontine Tegmental Cap Dysplasia: MR Imaging and Diffusion Tensor Imaging Features of Impaired Axonal Navigation

Jissendi-Tchofo, P.1-2,3 · Doherty, D.4 · McGillivray, G.5 · Hevner, R.6 · Shaw, D.7 · Ishak, G.7 · Leventer, R.6 · Barkovich, A. J.2
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PURPOSE
Malformations of the brain stem are uncommon. We present MR imaging and diffusion tensor imaging (DTI) features of six patients with pontine tegmental cap dysplasia, characterized by ventral pontine hypoplasia and a dorsal “bump,” and speculate on potential mechanisms by which it forms.

MATERIALS & METHODS
Birth and developmental records of six patients were reviewed. We reviewed MR imaging studies of all patients and DTIs of patient three. Potential developmental causes were evaluated.

RESULTS
All patients were born uneventfully after normal pregnancies except patient six (in utero growth retardation). They presented with multiple cranial neuropathies and evidence of cerebellar dysfunction. Variable hypotonia and motor dysfunction were present. Imaging revealed ventral pontine hypoplasia and mild cerebellar vermian hypoplasia, in addition to an unusual rounded to beaklike “bump” on the dorsal surface of the pons, extending into the fourth ventricle. Color fractional anisotropy maps showed the bump to consist of a bundle of axons directed horizontally (left-right). The bump appeared, on morphologic images, to be continuous with the middle cerebellar peduncles (MCPs), which were slightly diminished in size compared with those in healthy infants. Analysis of the DTI was, however, inconclusive regarding the connections of these axons. The decussation of the MCPs, transverse pontine fibers, and longitudinal brain stem axonal pathways was also abnormal.

CONCLUSION
Our data suggest that the dorsal transverse axonal band in these disorders results from abnormal axonal pathfinding, abnormal neuronal migration, or a combination of the two processes.

KEY WORDS: Pontine malformation, diffusion tensor imaging, axonal navigation

Paper 197 Starting at 11:17 AM, Ending at 11:25 AM
Longitudinal Diffusion Tensor Imaging Study of White Matter Development and Radiation-Induced White Matter Injury

Tannazi, F. · McNutt, T. R. · Ardekani, S. · Wharam, M. D. · Horska, A.
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Baltimore, MD

PURPOSE
The goal of our longitudinal study was to apply diffusion tensor imaging (DTI) for early detection and monitoring of brain tissue injury due to radiation treatment (RT) in children with brain tumors and ALL.

MATERIALS & METHODS
Sixteen pediatric patients (3 girls, 5.5-18.6 years) and 36 healthy children (21 girls, 5.5-18.3 years) were examined. All subjects were examined at baseline (before completion of RT for patients), 6, 15, and 27 months follow ups (after the end of RT for patients). Diffusion tensor imaging data were acquired at a 1.5 T scanner using single-shot EPI (15 diffusion gradient directions, b=1000 s/mm2, 24 axial slices, 96*96 matrix, FOV 240 mm2). Regions of interest (ROIs) were drawn on color maps two times. The measurements (performed in both hemispheres) were averaged after overlaying the ROIs on FA and ADC maps. In order to assess the dose delivered to the ROIs, FA maps were registered with the
treatment plan. Linear Mixed Effects models were used to determine factors associated with changes in ADC and FA. Statistical significance was set to p<0.05.

RESULTS
Significant differences in individual white matter regions between patients and controls for both FA (p<0.0001) and ADC (p=0.03) were detected. Significant FA and ADC differences among regions and over the examined age range (p < 0.025) and over time (p<0.0001) also were detected. While healthy children demonstrated regional age-related increases in FA and decreases in ADC, FA tended to decrease and ADC to increase in patients (Figure, genu). The decrease in FA in the patient group was due to increased radial diffusivities. At the last follow up, the most pronounced abnormalities were observed in the genu of the corpus callosum, with a 10.4% lower mean FA (p=0.019) and a 18.6% higher mean ADC (p=0.033) in patients.

CONCLUSION
Despite normal appearance on conventional MR imaging, widespread regional white matter abnormalities were detected in patients suggestive of higher DTI sensitivity to radiation effects. Reduction in FA corresponding to reduced radial diffusivity may suggest reduced compactness or density of fiber bundles and/or demyelination. Of the examined brain regions, the most pronounced differences in FA between healthy children and patients were detected in the genu. Our results suggest a higher radiosensitivity of the genu to early delayed and late radiation injury (1,2).

REFERENCES

KEY WORDS: DTI, radiation, pediatrics

Paper 198 Starting at 11:25 AM, Ending at 11:33 AM
Evaluation of Alterations in White Matter Following Treatment for Childhood Leukemia Using Diffusion Tensor Imaging

Rollins, N. K. · Winick, N. · Gimi, B. · Glasier, P. · Chia, J. · Stavinoha, P. · Wang, J.
Childrens Medical Center, Dallas, TX. University Texas Southwestern Medical Center, Dallas, TX. Philips Healthcare Systems, Cleveland, OH

PURPOSE
To determine if diffusion tensor imaging (DTI) can detect differences in normal-appearing white matter between children treated for leukemia (ALL) and controls.

MATERIALS & METHODS
Control subjects (n=25, mean 7.5 years) had normal routine MR imaging and no pre-existing developmental delay or cranial irradiation. DTI was done at 1.5T (TR /TE = 8237/74 msec, 56 slices, 2 mm thick, voxel 2 mm, b = 700 s/mm², 30 gradient directions). DTI data were processed with FSL (FMRIB Software Library, http://www.fmrib.ox.ac.uk/fsl) using voxel-based nonparametric statistical inference and threshold-free cluster enhancement yielding maps of corrected p-values for differences in mean FA between the two groups without the effects of age, and differences in slope of FA vs age between groups. Regions of interest (ROI)-based FA analysis was performed using in-house software. Ongoing neuropsychologic evaluations include IQ, single-word receptive and expressive vocabulary, verbal and nonverbal memory, executive functions, emotional/behavioral adjustment, executive functions, and adaptive functioning.

RESULTS
Compared to controls, children treated for ALL showed significant decreases in FA in the cingulum, callosal genu, subfrontal and medial temporal white matter, anterior commissure, dorsal medial thalami, and PLIC (Figure 1). Figure 2 shows reduction in FA values of callosal genu in subjects treated for ALL.

CONCLUSION
DTI suggests chemotherapy causes abnormalities in tracts involved in higher order executive functioning, memory and cognition. Correlation with results of the neuropsychological testing in progress is needed to determine if these abnormalities correlate with cognitive deficits.

Acknowledgment: This study was supported in part by NIH-COG AALL06N1 and U10 CA98543-05.

KEY WORDS: Pediatrics, methotrexate, DTI
Paper 199 Starting at 11:33 AM, Ending at 11:41 AM

Longitudinal Dynamic Susceptibility Contrast-Enhanced Perfusion and Diffusion Tensor Imaging in Crossed Cerebellar Diaschisis in Patients with Supratentorial Hemispheric High-Grade Gliomas after Surgery

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St. Jude Childrens Research Hospital
Memphis, TN

PURPOSE
Diaschisis is a functional impairment of brain tissue in areas remote from a site of primary brain injury. Crossed cerebellar diaschisis (CCD) is the most commonly observed manifestation of this phenomenon. In a pilot study we found a measurable drop of perfusion in cerebellar cortical grey matter (CCGM) and evidence of cerebellar white matter (CWM) damage in patients with extensive contralateral supratentorial destructive processes (tumor and surgery) using dynamic susceptibility contrast-enhanced (DSC) perfusion MRI and diffusion tensor imaging (DTI) on early postoperative MRI examinations. Here we investigated the longitudinal evolution of these changes using the same CCD model.

MATERIALS & METHODS
Four patients (M/F:3/1, age range:13-24 year) with supratentorial high-grade neoplasms (1 AA, 1 GBM, 1 anaplastic ganglioneuronal tumor, 1 anaplastic oligoastrocytoma) who received surgery were recruited from an IRB-approved clinical trial. Initial MRI studies were performed 19-54 days after surgery. Further follow-ups (3 for each patient) were done at 3 months intervals. For each study parametric maps (CBV, CBF and FA) of the cerebellum were generated and coregistered to 3D T1-weighted images. ROIs were drawn on T1 images and segmented into gray and white matter. Aggregate mean values of CBV, CBF and FA were obtained separately for CCGM and CWM and asymmetry indices (AI:xL-xR/xL+xR) were calculated. In all patients 18-FDG-PET studies were reviewed for evidence of CCD.

RESULTS
In three patients 18FDG-PET showed metabolic depression within cerebellar hemispheres contralateral to the supratentorial lesion. In one patient PET findings were equivocal. CBF, CBV and DTI changes were consistent with PET findings in three patients. In the patient with ambiguous PET findings, CBF and CBV changes also were inconsistent. The observed CBF, CBV and FA changes are summarized in the Figure.

CONCLUSION
1. DSC MRI and DTI are adequate surrogate MRI biomarkers of cortical perfusion and white matter integrity changes in cerebellar parenchyma in CCD, showing good correlation with 18FDG PET. 2. Hemodynamic changes are more robust, although less consistent in CCGM than in CWM. DTI changes are more robust and very consistent in CWM. 3. Hemodynamic alterations seem to occur quite rapidly initially, especially within CCGM, but a clear longitudinal trend is not recognized in our limited series. Conversely, CWM changes appear to be progressive. 4. Although the clinical impact of CCD is poorly understood, it is important to investigate the dynamics of underlying pathophysiologic processes in order to institute appropriate and timely rehabilitative measures if and when possible.

KEY WORDS: Diaschisis, perfusion, diffusion

Paper 200 Starting at 11:41 AM, Ending at 11:49 AM

Spontaneous BOLD Fluctuations for Evaluating Development in Preterm Infants

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Washington University School of Medicine
St. Louis, MO

PURPOSE
Resting state functional connectivity MR imaging has been utilized successfully to identify networks of functional neural connections through measurement of temporal correlations in low frequency, spontaneous fluctuations in BOLD signal. Investigation in preterm and term infants enables characterization of early network maturation and its role in neurodevelopment. The purpose of our study is to characterize early neural network development by performing longitudinal, resting state network analysis in a cohort of preterm infants.
MATERIALS & METHODS
Six preterm infants (mean gestational age at birth 27.3 weeks, range 25.6-29 weeks) were studied at 30.3 weeks (29.7-31.3), 34.1 weeks (32.7-34.9), and 38 weeks (35.9-39) postmenstrual age (PMA). Images were collected using a Siemens 3T scanner with an EPI sequence (TR/TE 2900/28 ms, 2.4 mm³) over 10 minutes. Three healthy term control infants also were studied. Infants were scanned without sedating medications. Images were analyzed utilizing seed correlation analysis.

RESULTS
Resting state networks were identified in the occipital cortex, temporal cortex, sensorimotor cortex, parietal cortex, prefrontal cortex, and thalamus. At 30 weeks PMA networks were predominantly unilateral. Interhemispheric correlation developed by 34 weeks PMA, though temporal cortex connections remained unilateral. Networks became increasingly robust by 38 weeks PMA. Resting state networks at 38 weeks PMA approached but were not identical to those identified in healthy term controls. This was evident in the development of the thalamo-cortical connections which were more robust in the term controls.

CONCLUSION
Multiple resting state networks are present as early as 30 weeks PMA. These networks undergo gradual maturation through development of interhemispheric connections and refinement of existing connections. Connections in term equivalent infants differ from those in healthy term controls. Study of the development of functional connectivity in preterm infants could provide valuable clinical information.

KEY WORDS: Functional MRI, pediatric neuroradiology

Assessment of Cerebrovascular Reactivity Using Real Time BOLD MR Imaging in Children with Moyamoya Disease

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¹The Hospital for Sick Children, Toronto, ON, CANADA, ²Sree Chitra Tirunal Institute for Medical Sciences & Technology, Trivandrum, INDIA

PURPOSE
To validate the clinical utility of assessment of cerebrovascular reactivity (CVR) with real time BOLD MRI (rtfMRI) in comparison to standard off-line processing in children with moyamoya disease who are potential candidates for surgical cerebral revascularization.

MATERIALS & METHODS
Cerebrovascular reactivity can be estimated using MR imaging by altering PaCO2 through changes in ventilation and measuring the resultant BOLD signal. Real time BOLD fMRI can analyze functional imaging studies in real time while scanning the patients. Seven patients (ages 4 - 17 years, 4 female, eight sessions of study) with moyamoya cerebral arteriopathy had undergone BOLD MR imaging CVR studies either on a 1.5T or on a 3T scanner for evaluation for potential surgical cerebral revascularization. For awake patients, PaCO2 was manipulated by deliberate breath holding for 30 sec followed by 60 sec of free breathing during BOLD acquisition. Three patients were evaluated under general anesthesia (GA) and had their ventilation decreased for 120 sec followed by 120 sec normal ventilation. One patient had undergone CVR study initially without and later with GA. A rise of end tidal PaCO2 of 8 to 10 mm Hg took between 60 to 100 seconds in the ventilated patients. All cases were analyzed with standard off-line analysis (1) and also with the vendor-supplied rtfMRI software. Blinded comparison of off-line and real time analysis was performed.

RESULTS
Both techniques were comparable with regard to adequacy of the activation, presence or absence of abnormal reactivity, location, pattern and extent of abnormal activation (absence of response or paradoxical response). In all cases rtfMRI results were identical to that of standard off-line analysis. One patient with excessive movement had to have a repeat study under GA as the results were inconclusive on both off-line and rtfMRI analysis.

CONCLUSION
Real time BOLD fMRI of CVR results are comparable to that of standard off-line analysis. Off-line analysis results are available several hours after the MR imaging has been completed. This delay precludes immediate assessment of the success of the CVR study. Availability of real time processing enables neuroradiologists to incorporate BOLD fMRI in routine clinical practice.

REFERENCES

KEY WORDS: Cerebrovascular reactivity, fMRI, moyamoya disease
Validation of Clinical Real Time BOLD Functional MR Imaging in Children on 3 T

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PURPOSE
To evaluate the clinical utility of real-time fMRI analysis done in pediatric subjects on 3 T compared to off-line processing as the reference standard.

MATERIALS & METHODS
Real-time fMRI analysis of simple motor and language tasks in seven pediatric subjects who were undergoing clinical BOLD fMRI studies on a 3 T magnet (Achieva, Philips, Best, Netherlands) was done using incremental method to calculate t statistics for activated voxels with vendor supplied software. Motor tasks were obtained in all the children and at least two language paradigms were done in six of them. This was compared with activations obtained by conventional fMRI analysis with off-line processing using AFNI software (http://afni.nimh.nih.gov/afni/), regarding location, size and extent of activation. Child friendly paradigms of finger tapping for motor task and various verbal fluency and verb generation tasks for language lateralization were used.

RESULTS
Activation on real-time fMRI matched in location and extent to those of off-line processing in five cases each of motor and language studies. Two sets of motor and one set of language tasks showed significant motion artifacts and could not be analyzed either by real-time fMRI or by AFNI. In addition, real-time fMRI gave real time information about the adequacy of activation patterns and helped to obtain (to avoid) repeat fMRI runs. However a higher threshold generally was needed to be used in off-line processing compared to real-time fMRI in order to overcome unrealistically large areas of activation. Threshold for optimal activation was needed to be adjusted in each subject and for different paradigms.

CONCLUSION
Real-time fMRI is an easily performable and reliable technique in evaluation of fMRI data in children and can significantly reduce the turn-around time of information crucial in the clinical decision-making process. 3 T provides the higher signal-to-noise ratio for this. Availability of real-time processing enables neuroradiologists to incorporate BOLD fMRI in routine clinical practice.

KEY WORDS: Real time fMRI, children, MRI

Magnetic Resonance Spectroscopy of the Fetal Brain: Does It Work without Sedation?

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1Medical University of Vienna, Vienna, AUSTRIA, 2Medical University of Vancouver, Vancouver, BC, CANADA

PURPOSE
MR Spectroscopy (MRS) has been established to be useful in understanding pathophysiologic mechanisms of fetal brain injury; it is becoming an important adjunct to morphologic imaging that can offer more accurate diagnosis and predict prognosis. However, quality of the spectroscopic studies may be limited because of unrestricted fetal movements. The aim of this study was to assess the quality and feasibility of brain proton spectroscopy in unsedated fetuses.

MATERIALS & METHODS
Sixty single voxel spectroscopy studies of the fetal brain, done for different clinical indications, performed on 1.5T (Philips) at gestational week (GW) 18 to GW 37, were evaluated retrospectively. A sense cardiac coil and two MRS acquisition sequences were used: point-resolved spectroscopy (PRESS, spin echo - SE) with a long echo time (TE = 144 ms) and a stimulated echo acquisition mode (STEAM, stimulated echo - ST) with a short echo time (TE = 31 ms). The minimal acceptable volume of interest (VOI) size was 2.7cm³. Duration of the sequence (including shimming time) was up to 5 minutes. The position of the fetal head with respect to the maternal pelvis was recorded. Quality of spectroscopy was rated to have a good quality when a clear recognition of choline (Cho), creatine (Cr) and N-acetylaspartate (NAA) peaks (TE 144ms), and additionally myoinositol (myo-ino) and glutamine/glutamate (Gln/Glu) (TE 31ms) was possible.

RESULTS
Forty-four (73.3%) spectroscopy studies were rated to be readable; the head position of the fetus was cephalic in 31/44 studies (70.5%), in 9/44 studies (20.5%) breech and in 4/44 studies (9%) in other position with a mean gestational age of 28 GW. Sixteen (26.7%) spectroscopy studies were not readable with cephalic head position in 14/16 (87.5%) and breech position in 2/16 (12.5%) studies. The mean gestational age was 29GW.
The imaging results were documented separately for conventional MR images and MR spectroscopy into three categories: “normal”, “abnormal without contribution to a diagnosis”, and “abnormal with contribution to a diagnosis”. The coincidence of diagnostic outcomes between conventional MR and MR spectroscopy were determined in both groups and results were compared. 2. Pictorial essay of MR spectroscopy and conventional MR imaging findings.

RESULTS
The total number of MR spectroscopy (MRS) studies that were performed over the 12-month period was 153. Out of these, 85 were ordered by the referring physician and 68 were added on by the radiologist on the day of the conventional MR imaging (cMRI) study. Overall, 50 MR imaging studies had a normal MRS in conjunction with a normal cMRI. In 41 studies there was a normal MRS in conjunction with an abnormal cMRI. In 62 patients both MRS and cMRI were abnormal. We found no studies in which the MRS was abnormal in conjunction with a normal cMRI. Out of the 62 studies with abnormal MRS and cMRI, it was felt that the MRS significantly contributed to making the diagnosis in 44 patients and was noncontributory in 18 cases.

CONCLUSION
Our data show that MR spectroscopy was not abnormal in the presence of a normal conventional MR imaging. We also found that MRS was significantly contributing to the diagnosis in 33% (44/154) of patients. Imaging resources may be used more economically if MR spectroscopy is directed to patients with abnormal conventional MR imaging and/or high clinical suspicion for a leukodystrophy.

KEY WORDS: Spectroscopy, metabolic disorders, pediatric

Paper 205 Starting at 12:21 PM, Ending at 12:29 PM
Predicting Survival of Pediatric Patients with Diffuse Intrinsic Pontine Glioma Using Proton Magnetic Resonance Spectroscopy

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PURPOSE
Diffuse intrinsic pontine gliomas (DIPG) are diagnosed and managed using MR imaging. Diffuse intrinsic pontine gliomas are heterogeneous and tissue characteristics are poorly understood. MR spectroscopy (MRS) is a technique that allows noninvasive monitoring of metabolite changes in discreet tissue regions. It is used for treatment planning, diagnosis, and tissue characterization in other CNS tumors. This study assessed the prognostic value of metabolic markers using two MRS techniques.

MATERIALS & METHODS
Eligible patients had a brainstem mass consistent with DIPG based on MR imaging and clinical assessment. Single (SVS) and multivoxel (MVS) MRS data were collected during the same imaging session on a 1.5 T MR scanner. Regions of interest were selected to include the bulk of the tumor. Choline/n-acetylaspartate (Cho/NAA) and cho/creatine (Cho/Cr) ratios and the presence of lactate (+Lac) were recorded for each MRS scan. Maximum ratio values were
used for multivoxel MRS. We examined the prognostic effects of baseline SVS and MVS data on survival time of pediatric patients with DIPG. Longitudinal data were analyzed using a Cox proportional hazards model with time-dependent covariates to estimate the predictive value of MRS.

RESULTS
Thirty-four patients were eligible for this study (16 male, 18 female; median age at diagnosis 6.0 years, range 1.5 - 14.9 years). Baseline spectroscopy was obtained on 27 patients using SVS and 28 patients using MVS. Twenty-five patients have died of disease. Median survival was 53.4 weeks (range 20.2 - 112.9 weeks). Median follow up for survivors (n=9) is 51 weeks (range 22.1 - 466.4 weeks). Median time from baseline scan to death or last follow up was 28.8 weeks (range 0.0 - 322.0 weeks). Cox proportional hazards model and a log-rank test did not show a statistically different effect of baseline SVS or MVS on prognosis. Longitudinal SVS was obtained on 32 patients, with a median of three scans per patient (range 1 - 19 scans). MVS longitudinal data were collected on 30 patients, with a median of three scans per patient (range 1 - 19 scans). A Cox proportional hazards model with time-dependent covariates did show a statistically significant effect on survival. Relative risk of death was 1.80 (p=0.002) for SVS Cho/NAA, 1.65 (p=0.002) for MVS Cho/NAA, 1.87 (p=0.04) for MVS Cho/Cr, and 3.56 (p=0.02) for presence of lactate on MVS.

CONCLUSION
To our knowledge, this is the first study to demonstrate a short-term prognostic effect of metabolic markers obtained by MRS in pediatric patients. Multivariate analyses indicate that MVS Cho/NAA may be an independent factor for monitoring patient survival. A larger study is needed to confirm these results. The increase in multivoxel metabolic markers over time all show a significant effect on patient prognosis in this study with increasing maximum Cho/NAA and Cho/Cr ratios predictive of poor prognosis. These results indicate that following MRS over time is more useful for predicting outcome for patients with DIPG than baseline MRS.

KEY WORDS: Pediatric brain tumors, survival, MR spectroscopy
to the left MCA region with increased values compared to the normal contralateral side on the apparent diffusion coefficient map. The patient’s neurologic symptoms gradually resolved over the following 4 days, with normalization of his conventional CT imaging findings. Previous reports have described CT perfusion showing increased cerebral blood volume and high signal DWI findings on MR imaging. Our patient’s imaging findings suggest a loss of autoregulatory ability and consequent vasogenic edema in the left MCA territory, as reflected by increased ADC and CBV values on MR imaging and CTP, respectively. This particular pattern has not been described previously.

**Summary**

We suggest that cerebral hyperperfusion syndrome may occasionally have low signal DWI/high ADC abnormalities. This may reflect impaired autoregulation of the cerebral vasculature of the affected area after stent-assisted carotid angioplasty with consequent vasogenic edema in the hyperperfused vascular territory.

**Key Words:** Hyperperfusion, stent, carotid

**Paper 207 Starting at 10:50 AM, Ending at 10:55 AM**

**Reduction of Intracranial Aneurysm Coil and Clip Artifacts on MDCT: A Novel Technique Utilizing Retrospective ECG-Gating**

Kovacs, A. · Flacke, S. · Schild, H. H. · Urbach, H.

1 University of Bonn, Bonn, GERMANY, 2 Tufts University Medical School, Burlington, MA

**Purpose**

Starburst artifacts caused by aneurysm coils and clips severely impair the image quality in computed tomography. With current technologies in clinical practice, there is no effective way to eliminate streak artifacts in MDCT entirely. We propose a technique to minimize the impact of streak artifacts using retrospectively ECG-gated angiography by utilizing shifts in the reconstruction window.

**Case Report**

With a gantry rotation time of 400 ms and a four-segment multicycle reconstruction algorithm, the resulting temporal resolution is as low as 50 ms. To achieve the very best temporal resolution, that occurs only in dedicated frequency spectra an external pacemaker is utilized and cable-connected to the MDCT. The benefits of this improved temporal resolution are narrower reconstruction windows and consequently minimized motion artifacts with different orientations.

**Imaging Findings**

Using retrospective ECG-gating and different reconstruction windows the position of artifacts can be rotated such that the starburst rays of high and low attenuation do not cross the region of interest, subsequently allowing an unimpaired assessment of adjacent vessels for example.

**Summary**

The use of retrospective ECG-gating and different reconstruction windows is a promising novel technique to reduce streak artifacts in patients treated with coils and clips.

**Key Words:** Aneurysm coil, computed tomography, streak artifact

**Paper 208 Starting at 10:55 AM, Ending at 11:00 AM**

**Onyx Embolization of an Indirect Carotid Cavernous Fistula via Direct Transorbital Percutaneous Puncture of the Cavernous Sinus Through the Superior Orbital Fissure**

Amiridze, N. · Soloveychik, N. · Zoarski, G.

University of Maryland

Maryland, MD

**Purpose**

Carotid cavernous fistulas (CCFs) are classified as direct (Barrow type A) and indirect (types B-D). Treatment of indirect CCFs is challenging because of the small size of the feeding arteries. Endovascular treatment options include transvenous and transarterial embolization. When standard treatment options are impractical due to anatomy, a direct transsuperior orbital fissure (SOF) approach to the cavernous sinus previously was implemented in a few cases (1), and CCF embolization was performed with coils. This is, to our knowledge, the first case report of embolization of an indirect CCF utilizing a direct transorbital percutaneous puncture of the cavernous sinus with Onyx as an embolic device.

**Case Report**

A 61-year-old woman with progressive ocular symptoms resulting from an indirect bilateral (Barrow B) carotid cavernous fistula required urgent interventional therapy.

**Imaging Findings**

MR imaging of the brain and orbits with MRA and MRV revealed asymmetric dilatation of the right superior ophthalmic vein and mildly increased flow within the right cavernous sinus, suggesting CCF. An indirect CCF to the right cavernous sinus supplied by multiple bilateral cavernous carotid branches and venous outflow into right orbital veins was documented. An initial attempt at endovascular occlusion of the CCF through the inferior petrosal sinuses was
unsuccessful. A trans-SOF approach to the right cavernous sinus was performed utilizing a 4-French micropuncture introducer set. The path of the needle along the inferolateral floor of the right orbit was monitored almost continuously with biplane fluoroscopy. Hyperglide balloon within right ICA served as a guide to mark the position of the cavernous right ICA. An Eshelon-10 microcatheter over an X-pedion-10 microguidewire was placed into the posterior aspect of the cavernous sinus. Embolization of the CCF with Onyx 34 was performed during inflation of the balloon within the right cavernous ICA in order to prevent retrograde flow of Onyx into the ICA lumen. Complete occlusion of CCF was achieved (Figure).

SUMMARY

Although the transarterial or transvenous routes for endovascular embolization remain the most commonly used for access and treatment of indirect CCFs, direct percutaneous puncture of the cavernous sinus through the SOF may be warranted in certain cases. Embolization of dural CCF with Onyx resulted in a complete and durable cure without complications in our patient.

REFERENCES


KEY WORDS: CCF, dural AVF, embolization

Paper 209 Starting at 11:00 AM, Ending at 11:05 AM

Stent-in-Stent Placement for Small, Wide-Necked, Acutely Ruptured, Left Posterior Communicating Artery Aneurysm

Mathur, S. · Deib, G. · Brown, S. · Wappalapati, S. · Patankur, T.

Hope Hospital
Manchester, UNITED KINGDOM

PURPOSE

Small, wide-necked posterior circulation aneurysms remain a formidable challenge to the neurornterventionalists. Stent-in-stent placement has been shown in the literature to be a viable treatment option. This case study is a good demonstration of the successful use of this technique and outlines how this modality of treatment confers significant patient benefit in an otherwise difficult to treat subset of aneurysms. Notably, the hazards of either combination therapy or potentially incomplete treatment can be avoided.

CASE REPORT

A 62-year-old female presented to the emergency department after being found collapsed at home and unresponsive. GCS on arrival was 10 (E4, V1, M5). Diffuse SAH was shown on CT. The patient had a WFNS grade 4 SAH, and was admitted to ICU. CT angiography demonstrated a small aneurysm of the left posterior communicating artery. This was confirmed by digital cerebral angiography. The multidisciplinary neurovascular team discussed potential treatment options. Surgical clipping, stent-assisted coiling and double stenting across the neck of the aneurysm were considered. Stent-in-stent was thought to be the best option as surgery was not an option at all. The patient made a good recovery from the SAH and was seen in the outpatient clinic. A follow-up cerebral angiogram showed complete occlusion of the aneurysm.

IMAGING FINDINGS

CT revealed Fisher Grade 4 subarachnoid hemorrhage with blood seen most prominently in the left Sylvian fissure. CT angiography demonstrated a right infundibulum of the right posterior communicating artery and a small aneurysm of the left posterior communicating artery. Digital cerebral angiography confirmed the left posterior communicating aneurysm. No other aneurysms were seen. The aneurysm measured less than 2mm with a wide neck and was therefore not amenable to unassisted coil occlusion. Two Neuroform 4.5 x 20 stents were placed across the aneurysm neck with stent-in-stent deployment. IV Aspirin anticoagulation was given immediately after stent placement. The following day the patient was placed on continuous aspirin and clopidogral therapy. Effective remodelling of the parent vessel was achieved. Angiography performed immediately after the procedure revealed a significant reduction in aneurysm filling. Total occlusion of the lesion was observed after 7 days and confirmed 6 months later. By placing one stent inside the other, stent permeability can be reduced, which may result in significant hemodynamic changes with accelerated aneurysm thrombosis.

SUMMARY

The authors present a case of a small, acutely ruptured, wide-necked aneurysm of the left posterior cerebral artery that was not amenable to conventional coil embolization or stent-assisted coil embolization and was instead treated by means of a double-stent method in which one stent was placed inside another. This double-stent method may represent a therapeutic alternative, especially in cases of small, wide-necked aneurysms in which conventional endovascular techniques or stent-supported coil embolization is not considered feasible or is believed to be too dangerous, and surgical treatment is contra-indicated.

KEY WORDS: Stent, aneurysm, double-stent
Embosed Angio-Seal Plug: Pathologic Confirmation and Discussion of Potential Complications Associated with the Device

Choi, J. · Cacayarin, E. · Supsupin, E.
University of Texas Houston Health Science Center Houston, TX

**PURPOSE**
To present a case of a thrombosed Angio-Seal plug and to discuss potential complications of this vascular closure device.

**CASE REPORT**
A 44-year-old female with transient right sided hemiparesis and dysarthria was found to have occlusion of the left common carotid artery on CT angiography. The patient underwent conventional angiography to demonstrate extent of occlusion and collateralization. Following catheter angiography, hemostasis at the right common femoral artery access site was achieved with the Angio-Seal vascular closure device. Approximately 30 minutes following the end of the procedure, the patient complained of severe right lower extremity pain. Examination revealed pallor of the toes and absent dorsalis pedis pulses on the right. Stat ultrasound Doppler examination showed absent flow at the level of the popliteal trifurcation and distally. The patient underwent emergent surgical thrombectomy which revealed the Angio-Seal plug lodged at the trifurcation.

**IMAGING FINDINGS**
Ultrasound images showed no flow at the level of the trifurcation and below. Gross pathologic specimen showed the Angio-Seal plug recovered from the thrombectomy sample.

**SUMMARY**
Although complications are rare with the Angio-Seal vascular closure device, the most clinically dire is that of an embolized collagen plug. We present a case report with gross pathologic confirmation of the embolized plug at the level of the popliteal trifurcation and discuss potential complications associated with use of this device.

**KEY WORDS:** Angio-Seal, complications, vascular closure device

**Paper 211 Starting at 11:10 AM, Ending at 11:15 AM**
Covered Stent Graft Exclusion of Iatrogenic External Carotid Artery Pseudoaneurysms without Compromise of an Osseomusculocutaneous Flap

Gluncic, V. · Gottlieb, L. J. · Ansari, S. A.
University of Chicago Medical Center Chicago, IL

**PURPOSE**
Some of the most complex head and neck surgeries are microvascular free-flap transfers which have become an accepted method of head and neck reconstruction with success rates close to 90% and excellent aesthetic and functional results. Iatrogenic postsurgical pseudoaneurysms of the carotid arteries are infrequent complications with an estimated incidence of 0.3-0.6%. The location of pseudoaneuerysms often makes surgery difficult and may lead to perioperative cranial nerve injuries. The technical difficulty and morbidity associated with surgical treatment of ICA, ECA and CCA pseudoaneurysms makes an endovascular approach an attractive alternative.

**CASE REPORT**
We present a case of a 45-year-old patient with recurrent squamous cell carcinoma of tongue that underwent radical neck resection and subsequent reconstruction with free ilium osseomusculocutaneous flap. The vascular supply for the free tissue flap was from the deep circumflex iliac artery which was anastomosed to the ECA. Eight weeks following surgery, the patient developed acute onset of massive neck swelling indicative of a carotid blow-out. Two ECA pseudoaneurysms were treated by emergent placement of a covered stent graft across the carotid bifurcation excluding the ECA. Subsequently, surgical drainage of the deep neck hematoma and exploration of the ECA origin was performed in anticipation of free flap revision. Although the endovascular procedure dissociated the main arterial supply of the free ilium osseomusculocutaneous flap, the flap vascularization was found not to be compromised.

**IMAGING FINDINGS**
Initial angiogram demonstrated extravasations from the proximal ECA forming a 12 mm pseudoaneurysm cavity. A second extravasation was demonstrated 2 cm distally where the ECA had been surgically clipped, turned inferiorly and anastomosed to the muscle graft pedicle forming a large 20x40mm pseudoaneurysm. Postprocedure, there was accurate stent deployment and expansion with complete exclusion of the ECA from the ICA circulation. There was no evidence of residual pseudoaneurysm opacification, major collateral supply to the free flap, or stent graft-related complications such as in-stent thrombus formation or flow limitation into the distal right ICA.

**SUMMARY**
This case provides further evidence that covered stent grafts are a safe and effective alternative to conventional surgery in the treatment of traumatic or iatrogenic carotid artery injuries with an ability to salvage intracranial blood supply. More importantly, it offers insight into the neovascularization of a thick osseomusculocutaneous flap in the setting of head and neck tumor resections and reconstruction. In our current experience, these flaps possess the potential to be independent of their anastomosed blood supply in less than 2 months.

**KEY WORDS:** Carotid stenting
Direct Percutaneous Embolization of a Carotid Body Tumor with Onyx

Gemmete, J. J. 1 · Chaudhary, N. 1 · Ansari, S. A. 2
1 University of Michigan Health System, Ann Arbor, MI, 2 University of Chicago Medical Center, Chicago, MI

PURPOSE
Preoperative tumor embolization has been shown to allow safe and complete resection of hypervascular head and neck tumors. However, endovascular embolization of hypervascular tumors in the head and neck may be challenging due to small diameter arterial pedicles or short segment feeders in proximity to the carotid bifurcation. Careful attention is required to prevent reflux of embolic agents or opening of ECA to ICA collaterals that may lead to catastrophic complications. We present a technique for the direct devascularization of a carotid body tumor using percutaneous embolization with Onyx (EV3, Irvine, CA).

CASE REPORT
A 33-year-old gentleman presented with left-sided neck mass. Subsequent imaging revealed bilateral carotid body tumors. He underwent genetic testing and was positive for the SDHD (mitochondrial complex II gene) mutation, which confirmed the suspected diagnosis of familial paragangliomas syndrome. The larger carotid body tumor in the left neck was first resected. A second operation was performed to remove the right-sided carotid body tumor. We were requested to perform preoperative embolization to minimize intraoperative blood loss allowing safe and complete surgical resection. Preoperative embolization was initiated after induction of general anesthesia. A 6 French Cordis MPC guide catheter (Cordis Neurovascular, Miami Lakes, FL) was placed in the right common carotid and external carotid artery. Initially, an Echelon 10 microcatheter (EV3, Irvine, CA) was placed into the spinomuscular branch of the ascending pharyngeal artery and embolization with 100-300 microns embospheres (BioSphere Medical, Rockland, MA) was attempted. However, the catheter was occlusive with poor antegrade flow and endovascular embolization was terminated since the remaining branches of the ECA supplying the tumor were also extremely small and tortuous. Therefore, the patient’s right neck was prepped and draped to access the tumor percutaneously. Under fluoroscopic and ultrasound guidance, three 3.5 inch x 20 gauge spinal needles were localized into the tumor. Intratumoral angiography then was performed through the spinal needle to confirm its position within the tumor vascular bed. Subsequently, embolization was accomplished under negative roadmap fluoroscopy with slow infusion of 3.5 ml of Onyx 18. Less than 50 ml of blood loss was documented after surgical resection.

IMAGING FINDINGS
Initial angiography reveals a highly vascular tumor splaying the right internal carotid artery (ICA) and external carotid artery (ECA), supplied by diminutive branches of the ECA (ascending pharyngeal artery and artery of the carotid body). Following percutaneous access, intratumoral angiography delineates the vascular cascade and tumor blush consistent with a hypervascular lesion. Postembolization angiography demonstrates Onyx infiltration and casting of the tumor vascular bed with complete devascularization of the tumor.

SUMMARY
This case illustrates the value of percutaneous embolization with Onyx in the devascularization of head and neck tumors not amenable to particle embolization. In our limited experience, direct percutaneous tumor embolization appears to be safe and effective by independently reducing intraoperative blood loss. In patients at high risk for endovascular embolization, percutaneous Onyx embolization offers an adjunctive or even alternative approach, but further studies are needed for valid comparative assessment.

KEY WORDS: Onyx, percutaneous, embolization
**PURPOSE**

Albuquerque, NM

University of New Mexico Health Sciences Center

The patient was a 27-year-old male who presented to his primary care physician at an outside institution with reports of an 8-week history of increasing back pain and right lower extremity weakness. Initial imaging work up for the back pain included MR imaging of the brain and spine. Imaging studies demonstrated an intramedullary lesion at T11/T12, in addition to multiple lesions within the axial skeleton, and a lesion of the pituitary infundibulum. Image-guided core biopsy of a skeletal lesion yielded the diagnosis of anaplastic astrocytoma.

**IMAGING FINDINGS**

MR imaging of the thoracic and lumbar spine demonstrated multiple T1 hypointense and T2 hyperintense enhancing lesions throughout the imaged axial skeleton. An expansile, heterogeneously enhancing intramedullary lesion was noted at the T11/T12 level. CT imaging demonstrated the sclerotic nature of the skeletal lesions. MR imaging of the brain demonstrated an additional enhancing lesion of the pituitary infundibulum measuring approximately 6 mm in size. CT-guided biopsy of a right iliac lesion was achieved with an 11 gauge Murphy biopsy needle. Comparative pathology of the initial bone biopsy matched that of the open surgical T11/T12 biopsy with both demonstrating typical findings of an anaplastic astrocytoma.

**SUMMARY**

Anaplastic astrocytomas of the central nervous system are relatively common with typically reported routes of spread via contiguous white matter tracts, ependyma, leptomeninges and CSF. Much less rarely reported in the literature is spread to the axial skeleton. We demonstrate one example of this rare occurrence, an anaplastic astrocytoma presenting as painful bone metastasis.

**KEY WORDS:** Astocytoma, vertebral metastasis

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**Paper 214 Starting at 11:25 AM, Ending at 11:30 AM**

**Metastatic Anaplastic Astrocytoma Presenting as Painful Bone Metastasis**

Hayek, R. A. · Hart, B. L. · Medina-Flores, R.

University of New Mexico Health Sciences Center

Albuquerque, NM

**PURPOSE**

To review the case history, imaging findings and pathologic features of an unusual case of metastatic anaplastic astrocytoma presenting as painful bone metastases in a 27-year-old male.

**CASE REPORT**

The patient was a 27-year-old male who presented to his primary care physician at an outside institution with reports of an 8-week history of increasing back pain and right lower extremity weakness. Initial imaging work up for the back pain included MR imaging of the brain and spine. Imaging studies demonstrated an intramedullary lesion at T11/T12, in addition to multiple lesions within the axial skeleton, and a lesion of the pituitary infundibulum. Image-guided core biopsy of a skeletal lesion yielded the diagnosis of anaplastic astrocytoma. The patient subsequently underwent surgical biopsy of the intramedullary lesion at the T11/T12 level. We compare the pathologic features of the two biopsies.

**IMAGING FINDINGS**

MR imaging of the thoracic and lumbar spine demonstrated multiple T1 hypointense and T2 hyperintense enhancing lesions throughout the imaged axial skeleton. An expansile, heterogeneously enhancing intramedullary lesion was noted at the T11/T12 level. CT imaging demonstrated the sclerotic

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**REFERENCES**


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**KEY WORDS:** Perimedullary AV fistula, Onyx

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**Paper 215 Starting at 11:30 AM, Ending at 11:35 AM**

**Percutaneous Transosseous Approach for Thecal Sac Access in Ankylosing Spondylitis**

Aghaei Lasboo, A.1 · Rozenfeld, M.1 · Liu, B.1 · Hijaz, T. A.1 · Futterer, S. F.1 · Walker, M. T.1

1Northwestern University, Chicago, IL, 2Touro University College of Osteopathic Medicine, Vallejo, CA

**PURPOSE**

To present a novel percutaneous transosseous approach to the lumbar subarachnoid space in a patient with complete spinal ankylosis.

**CASE REPORT**

A 44-year-old man with advanced ankylosing spondylitis (AS) presented with progressive myelopathy. CT and MR imaging were attempted as diagnostic tools but were limited due to metal artifact from prior spinal surgeries. A total spine myelogram was ordered via the C1-2 approach. Review of prior imaging showed complete ankylosis from the cranio-cervical junction to the sacrum in addition to a diminutive CSF space at the C1-2 level. A C1-2 approach was deemed unsafe. A decision was made to attempt a myelogram via the lumbar approach using CT guidance. The CT showed complete ankylosis across the facets joints and between the laminae resulting in a complete osseous barrier to thecal sac access. Transforaminal options also were not favorable. It was decided to use a coaxial technique and attempt to drill through the lamina for access. A left paramedian approach at L2-3 was selected due to the relative thickness of the osseous fusion. Through a small incision a 14G Bonopty® Penetration cannula and stylet (Radi Medical Systems AB, Sweden) were advanced towards the targeted area. Upon reaching the bony surface, the stylet was exchanged for a 20G Biopty® needle and stylet (Bard Biopsy Systems, AZ). This needle was advanced through the cannula into the dorsal epidural space. The stylet was...
exchanged for a 22G long spinal needle, and the thecal sac was accessed. Cerebrospinal fluid was obtained, and approximately 13 cc of Omnipaque-240 was injected. The patient was transferred back to his stretcher and manipulated to allow the contrast to move throughout the spinal subarachnoid space (SAS). The patient then was placed back on the CT table, and a CT of the spine was obtained.

**IMAGING FINDINGS**
CT-myelogram revealed innumerable, complex subarachnoid adhesions with compartmentalization of the SAS in the lower thoracic region and cord compression. The patient was taken to surgery. A T5 to T8 laminectomy and decompression with lysis of subarachnoid adhesions was performed. Postoperatively, the patient improved symptomatically.

**SUMMARY**
This case demonstrates an alternative approach to access the lumbar SAS in patients with osseous fusion, in this case complete osseous fusion in AS.

**KEY WORDS:** Ankylosing spondylitis, bonopty bone biopsy system, thecal access

**Paper 216 Starting at 11:35 AM, Ending at 11:40 AM**
**Giant Vertebral Artery Pseudoaneurysm Complicating Posterior Cervical Spinal Surgery**

Yang, L. · Pride, G. L. · Chason, D. P.
University of Texas Southwestern Medical Center
Dallas, TX

**PURPOSE**
To describe a case of postoperative development of a large vertebral artery pseudoaneurysm following posterior cervical spinal arthrodesis.

**CASE REPORT**
A 62-year-old male with history of recent anterior cervical fusion underwent C2 to T2 posterior cervical arthrodesis for progressive kyphotic deformity and instability. Intraoperatively, brisk arterial bleeding was noted while dissecting over the left C2 lamina and a vertebral artery injury was suspected. Immediate postoperative CT angiogram of neck revealed no evidence of vascular injury or fluid collection. Patient was transferred to rehabilitation facility for improving mobilization. A follow-up noncontrast CT of cervical spine for assessment of fusion revealed a large fluid collection in posterior paraspinal region extending from skull base to C5 level. A CT angiogram of neck subsequently was ordered and demonstrated a pseudoaneurysm with arterial jetting. This pseudoaneurysm was treated endovascularly with a covered stent. Follow-up study showed significant reduction of pseudoaneurysm. Six months after surgery, patient was admitted back to the hospital for hypotension, renal failure, and failure to thrive and subsequently expired.

**IMAGING FINDINGS**
Noncontrast CT revealed a large low-density fluid nonloculated collection in left posterior paraspinal space extending to right of midline at the site of surgery measuring approximately 6 AP cm x 4 Transverse cm x 6 CC cm, originally thought to represent a pseudomeningocele or less likely abscess. CT angiogram, however, demonstrated near complete contrast opacification of this fluid collection with contrast jetting from left vertebral artery, consistent with a pseudoaneurysm. Catheter angiogram confirmed these findings and subsequent placement of a covered stent significantly reduced the size and velocity of contrast entering the pseudoaneurysm. Follow-up MR angiogram showed complete resolution of pseudoaneurysm.

**SUMMARY**
When postoperative fluid collection is encountered following cervical spine surgery, differential diagnosis routinely includes seroma, pseudomeningocele, abscess, and pseudoaneurysm. Pseudoaneurysm should still be included in the differential even if the fluid collection is large. Vertebral artery injury from posterior cervical surgery particularly at C1-C2 is reported in 1-3% of cases. Injury to the vertebral artery can result in dissection, narrowing, pseudoaneurysm, occlusion, or arteriovenous fistula. As this case illustrates, delayed complications of vascular injury can occur and follow-up study, such as CT angiogram, may be necessary.

**REFERENCES**
1. Wright NM, Lauryssen C. Vertebral artery injury in C1-2 transarticular screw fixation: results of a survey of the AANS/CNS section of disorders of the spine and peripheral nerves. *J Neurosurg* 1998;88:634-640

**KEY WORDS:** Pseudoaneurysm, vertebral artery, postoperative complication

**Paper 217 Starting at 11:40 AM, Ending at 11:45 AM**
**Intraosseous Cerebrospinal Fluid Fistula in a Patient with Gorham Syndrome Resulting in Intracranial Hypotension**

Adler, F. · Hess, C. P. · Gupta, N. · Lakshmi, M. · Dillon, W. P.
University of California San Francisco San Francisco, CA

**PURPOSE**
To present an unusual case of a patient with Gorham syndrome and features of Chiari I malformation, likely secondary to intracranial hypotension in the setting of a spinal cerebrospinal fluid (CSF) fistula.

**CASE REPORT**
Gorham syndrome, or massive osteolysis, is a rare progressive musculoskeletal disorder characterized by abnormal proliferation of lymphatic channels resulting in osseous matrix destruction. Extension of disease into the pleural space and/or mediastinum from involved adjacent bone
resulting in chylous pleural and pericardial effusions has been reported, as has one patient with CSF pleural fistula. At least two patients also have been described with “Chiari I malformation” and angiomatosis of bone, a disorder with features similar to Gorham syndrome. We present a 7-year-old girl with a history of headaches since infancy who was found to have low-lying cerebellar tonsils and a cervicothoracic syrinx at 22 months of age. She underwent craniocervical junction decompression for presumed Chiari I malformation, with moderate but incomplete reduction of headaches over the next several years. Two years prior to the most recent clinical presentation, the patient’s headaches increased in intensity and were positional in nature. The patient was admitted for investigation of worsening headaches.

IMAGING FINDINGS
MR imaging showed features of intracranial hypotension, including posterior fossa sagging and enlarged dural venous sinuses. A progressive diffuse permeative osteolytic process throughout the entire lumbosacral spine and pelvis was documented over several years on MR scans, characterized by fatty marrow replacement and subsequent fluid-intensity signal in the posterior elements and vertebrae. This was consistent with a diagnosis of Gorham syndrome. CT myelography showed a rapid fistula between the right L4 nerve root sleeve and the L4 and L5 expanded vertebral bodies, with contrast-enhanced CSF quickly spreading into the paraspinous soft tissues and retroperitoneum. The patient underwent two CT-guided blood patch procedures for treatment of CSF leak, with improvement of headache.

SUMMARY
We suspect the “Chiari malformation” in this patient with Gorham syndrome was, in fact, secondary to intracranial hypotension caused by the spinal CSF fistula. Prior to surgical decompression for Chiari I malformation, the radiologist should assess the scans for features of intracranial hypotension, such as sagging of the posterior fossa structures and floor of the third ventricle, and dural venous sinus enlargement.

KEY WORDS: Intracranial hypotension, Gorham syndrome, Chiari

Paper 218 Starting at 11:45 AM, Ending at 11:50 AM
Radiation-Induced Intraneural Synovial Sarcoma of the Brachial Plexus

Raghavan, P. · Mukherjee, S. · Gaughen, J. · Kreitel, D. · Phillips, D. C.
University of Virginia
Charlottesville, VA

PURPOSE
We describe a case of synovial sarcoma (SS) involving the upper trunk of the left brachial plexus in a patient who had undergone external beam radiation to the region for Hodgkin’s lymphoma 27 years previously.

CASE REPORT
A 53-year-old female patient was evaluated for an insidious year-long history of left upper extremity and shoulder pain and parasthesia. She had undergone external beam radiother-apy for Hodgkin’s lymphoma to her neck and chest 27 years previously. Examination revealed marked atrophy of her left deltoid and trapezius muscles, grossly diminished power in her shoulder abductors, biceps and triceps and absent biceps and triceps reflexes. EMG and nerve conduction studies were compatible with chronic ongoing upper trunk brachial plexopathy. The presence of pain and absence of myokymia on EMG was worrisome for a neoplastic process. MR imaging was precluded by a pacemaker and a CT myelogram therefore was obtained. The patient was subjected to an excision biopsy of her brachial plexus, which intraoperatively revealed marked thickening of the upper trunk and the proximal phrenic and supracapular nerves. Microscopic examination and immunohistochemistry demonstrated an infiltrative spindle cell neoplasm, with positivity for EMA and BCL-2 and negative staining for S-100, cytokeratin, P16, desmin, CD56, CD57, ER, PR and CD99, which were compatible with synovial sarcoma.

IMAGING FINDINGS
CT myelography demonstrated diffuse cord-like thickening of the upper trunk of the left brachial plexus. The process was found to extend into the dorsal and ventral nerve roots of C5 and C6 into the intradural compartment. Marked atrophy of the musculature of the shoulder girdle was evident. A malignant peripheral nerve sheath tumor and lymphoma were the primary diagnostic considerations.

SUMMARY
Synovial sarcoma only rarely has been reported to occur as a complication of radiation. 1. Intraneural SS is a rare entity that has been known to involve peripheral nerves. 2. An intraneural SS, affecting the C6 and C7 nerve roots has been reported. 3. A single report of a SS involving the brachial plexus exists. 4. These however bore no relationship to prior radiotherapy. Also, all these tumors demonstrated a nodular or mass-like pattern of growth as opposed to the diffusely infiltrative pattern in our case. Our case, to the best of our knowledge is the first reported case of a radiation-associated intraneural synovial sarcoma affecting the brachial plexus.

REFERENCES

KEY WORDS: Brachial plexus, neoplasm, radiation
Osteolytic Mass Bridging Two Cervical Vertebrae: Unusual Presentation of a Vertebral Body Hemangioma

Krishnan, A. · Sag, A. A. · Vartanian, S. · Silbergleit, R. · Roy, A.
William Beaumont Hospital Royal Oak, MI

**Purpose**
To discuss the imaging features in a patient who presented with a markedly enlarged thyroid gland and a mass that bridged two cervical vertebral levels that pathologically was a hemangioma.

**Case Report**
A 70-year-old with a complex medical history underwent imaging for respiratory insufficiency. A large enhancing mass was seen in the neck. In addition a destructive process was seen in the right side of the C3 and C4 vertebrae. A spine MR imaging also was performed. The patient was intubated for airway protection and then underwent a biopsy of the thyroid that demonstrated benign thyroid tissue. Subsequently a CT-guided biopsy was performed of the osteolytic process in the cervical spine. Pathologic samples demonstrated a vascular neoplasm composed of dilated vascular spaces with patchy areas of blood compatible with a hemangioma.

**Imaging Findings**
A markedly enlarged and heterogeneous thyroid gland was seen on the CT of the neck with a second relatively hypodense mass seen at C3 with encasement of the vertebral artery and extension into the epidural space. On the coronal images this mass extended contiguously from the C3 to the C4 vertebral bodies and on the bone windows had corticated bone along its medial aspect. On the MR imaging it was hyperintense on T2 and bridged the vertebrae. Based on the contiguous extension from one cervical vertebra to the other, the working diagnosis was of a chordoma, which have been reported to extend across disk space levels. Other conditions including myeloma and metastasis (including from the thyroid while awaiting the thyroid biopsy) were considered.

**Summary**
Vertebral body hemangiomas often are detected incidentally in the spine. On CT, the resorption of bone by the enlarged venous channels, results in the “polka-dot” or “honeycomb” appearance. They can extend into the epidural or paravertebral soft tissues and can be aggressive. Our case is peculiar as the hemangioma bridged one vertebral level to the other, and encased the vertebral artery. Infectious processes and chordomas, among tumors, are well known to bridge disk spaces but have a more destructive appearance. The discussed hemangioma also was more hypodense than usual and had probably destroyed the trabecular pattern to such an extent that it failed to demonstrate its characteristic CT pattern. The presence of a markedly enlarged thyroid gland, a distracter no doubt, further confounded the picture.

**Key Words:** Hemangioma, vertebra, bridging
SUMMARY
Complications related to balloon kyphoplasty most commonly occur in an immediate setting during the procedure. We present an unusual, delayed complication of dislodgment and mobility of the cement mass with associated fracture of the adjacent vertebral body.

KEY WORDS: Kyphoplasty, complication, inflammation

Paper 221 Starting at 12:00 PM, Ending at 12:05 PM
Retropharyngeal Fluid as a Manifestation of Unsuspected Vascular Injury in Patients Receiving MR Imaging Examination of the Cervical Spine after Trauma

Simonetta, A. B. · Supsupin, E. · Sitton, C.
University of Texas Health Science Center at Houston
Houston, TX

PURPOSE
MR examinations of the cervical spine are often performed in patients with persistent neck pain after trauma when CT fails to demonstrate a fracture. Prevertebral edema, more easily identified on MR imaging, can be a manifestation of fracture or ligamentous injury. This should be distinguished from retropharyngeal fluid which can be seen in patients with otherwise unsuspected vascular injury.

CASE REPORT
Two patients admitted for trauma at a level 1 trauma center having persistent neck pain are presented.

IMAGING FINDINGS
Initial CT examination revealed no evidence of a vertebral fracture (one suffered a fracture of the hyoid bone). MR examination confirmed the absence of osseous trauma to the spine and failed to identify evidence of ligamentous injury. However, upper cervical retropharyngeal fluid was identified in both patients. In one case this was visible on CT and had increased significantly whereas, in the second, it was subtle on the initial exam and essentially unchanged. No air was present in the fluid collections, reducing the likelihood of pharyngeal trauma. Both patients had, in fact, suffered significant vascular injuries (carotid occlusion and/or carotid pseudoaneurysm) identifiable on the MR examinations. These subsequently were confirmed by CT angiography and conventional angiography.

SUMMARY
Although prevertebral edema on MR imaging of the cervical spine is more common, and associated with fracture or trauma to the ligaments, it must be distinguished from retropharyngeal fluid. The presence of the latter in the upper cervical region should lead to careful evaluation for vascular injury, particularly in the absence of air within the collection.

KEY WORDS: Spine trauma, Pseudoaneurysm, MRI

Paper 222 Starting at 12:05 PM, Ending at 12:13 PM
1H - MR Spectroscopy In the Evaluation of Osteoporotic and Neoplastic Vertebral Fractures Prior Percutaneous Vertebroplasty - ASSR 2009 Mentor Award

Massari, F.
University of Rome
Rome, ITALY

PURPOSE
The detection of spongious vertebral molecular variations can be utilized to distinguish the different sources of bone pathology. The relative water intensity correlates with hematopoietic elements dominating in youth. Instead fat cells proportion increases with age resulting in a conversion of red/yellow marrow.

METHODS & MATERIALS
The study was performed with a 3T Magnetic Resonance; we used a single voxel (SV) method (TR/TE 2000/40 msec) with point-resolved spectroscopy sequence (PRESS). We measured % FF and Lipid/Water ratio (LWR) in 46 subjects with MR findings of vertebral fractures related to osteoporosis, multiple myeloma and metastasis. The control group consisted of 48 subjects with no spinal pathologies.

RESULTS
In accordance with the relative presence of fat and water within the vertebral body, we found that in osteoporotic vertebral fracture and in hematopoietic diseases an inversion of physiological LWR is present. This is probably due to intraspongious edema and malignant cells infiltration with replacement of lipidcontaining cells.
CONCLUSION
1H MRS provides a fine evaluation of vertebral bone marrow changes due to primary or secondary pathologies and allows appreciated differences not easily assessable with conventional imaging. In the upcoming future, MR Spectroscopy may be powerful in identifying physiological as well as pathological biochemical changes in vertebral bone. This evaluation will be useful in pre-vertebroplasty planning in order to evaluate vertebrae must be treated.
Non-Traumatic Spinal Emergencies

Victor M. Haughton, MD

LEARNING OBJECTIVES
Upon completion of this presentation, participants will be able to:
1) Review imaging findings in emergent conditions involving the spinal cord.

PRESENTATION SUMMARY
In this session, MR imaging findings in a few common such emergency patients will be illustrated.

Demyelinating Disease
Demyelination may be a cause of acute myelopathy. One particularly virulent form of demyelination is Devic’s disease or neuromyelitis optica. It is characterized clinically by attacks of acute optic neuritis, usually in both eyes and by severe transverse myelopathy. This is characterized by numbness, muscle weakness, spasticity, incoordination, ataxia, urinary and bowel dysfunction and autonomic dysfunction. Recovery from attacks of Devic’s disease is poor. It is thought to be a variant of post-viral ADEM (varicella zoster virus).

Vascular malformations
Cavernous hemangiomas of the spinal cord may present as emergencies. These malformations bleed and enlarge periodically. Either the acute enlargement or the irritating effect of blood products may lead to the acute onset of motor or sensory symptoms that affect the upper or lower extremities depending on the location of the malformation. The MR features are similar to those of the cavernous malformation in the head, but they may be harder to recognize, especially if a gradient echo image is not obtained.

Dural arteriovenous malformation may present as emergencies. AV fistula of the medulla oblongata and upper cervical spinal cord may result in a rapidly progressive myelopathy and autonomic disorder. The fistulas have slow drainage through dilated perimedullary cervical veins. They may be associated with transverse sinus occlusion, in which case recovery is less complete. The key finding is high signal in the affected cord or brain stem on T2-weighted spin-echo sequences and enlarged vessels in the subarachnoid space.

Spontaneous spinal subdural end epidural hematomas
Cases with spontaneous lumbar epidural hematoma may have clinical findings identical to those in acute disk herniation. The majority are associated with small concomitant disk herniations or underlying annular tears. MRI findings are similar to those in extruded/free-fragment disk herniation. Tearing of fragile epidural veins lying adjacent to the displaced annulus or nucleus are the postulated cause of epidural hematoma.

Epidural hematomas in the thoracic region may be isointense, hyperintense or hypointense to spinal cord on T1-weighted images. The isointensity on T1-weighted images persistent (5 d). Often cord compression is seen. Conservative treatment is effective, symptoms resolving in 1 week in some cases

Subdural hematomas predominate in the thoracic region. They are less common that spinal epidural hematoma. Patients with subdural hematomas often have clotting deficiency (anticoagulation), spinal surgery, trauma, or vascular malformation. The cause for these hematomas may be bleeding in the subarachnoid space that penetrates into the subdural space, since few vessels are present in the spinal subdural space. They are thought to result from sudden increase in abdominal or thoracic pressure. In the acute stage they are isointense on T1 and heterogeneous on T2, similar to acute epidural hematoma. They are more often in the anterior spine than are epidural hematomas. They have typically a crescentic shape on axial images or a Mercedes star sign in lumbosacral region.

Infection
Infections that may present as emergencies include meningeal infection, spinal cord infection, and spinal column infection (diskitis and osteomyelitis). Spinal Cord Abscess is a rare cause of rapidly progressive myelopathy, but an important one to recognize and distinguish from a spinal cord tumor because treatment is different. It may occur in adults or children. It is characterized by intramedullary high signal on T2-weighted sequences with poorly defined marginal enhancement on T1-weighted images. After the initiation of therapy, T2 signal abnormalities decrease markedly and contrast-enhanced studies should show ring enhancement. Organisms in spinal cord abscesses are Streptococcus milleria, S. pyogenes, atypical mycobacteria, Mycobacterium tuberculosis, and Schistosoma mansoni 086.

Updates in Pediatric Spinal Cord Imaging
Andrea Rossi, MD

LEARNING OBJECTIVES
Upon completion of this presentation, participants will be able to:
1) Identify the appearance of malformative, infectious-inflammatory, neoplastic, and metabolic diseases of the pediatric spinal cord.
2) Cite advances in MR imaging in the detection and characterization of pediatric spinal cord disease.

PRESENTATION SUMMARY
MR is the imaging method of choice for the vast majority of pediatric spinal cord diseases, providing information concerning the extent, location, and internal structure of the lesion that critically narrow the differential diagnosis and, when indicated, guide surgery. Use of phase-array surface coils allows for evaluation of the entire spinal cord in a single sagittal sequence, thereby allowing for significant reduction of imaging time. In addition to conventional T1- and T2-weighted sequences, advanced imaging modalities such as diffusion-weighted imaging, diffusion tensor imaging, and MR spectroscopy are used increasingly for a functional characterization of pediatric spinal cord disease. Spinal dysraphisms are categorized into open and closed depending on whether the malformed neural tissue is exposed to the environment or covered by skin. Open variants, such as myelomeningocele, typically are associated with a Chiari II malformation. Closed variants comprise lipomyelocoele, lipomyelomeningocele, meningocoele, and myelocystocele, in which a subcutaneous low-back mass is clinically evident, and other entities such as diastematomyelia, caudal regression, tight filum terminale, and filar/intradural lipomas, mostly presenting with clinical signs of cord tethering. Infectious-inflammatory spinal cord diseases are represented mainly by acute transverse myelopathy (ATM), that can be caused by direct infection, postinfection or postvaccination
immune reactions. Postinfectious and postvaccination ATM is usually part of acute disseminated encephalomyelitis. The disorder commonly begins 1-2 weeks after a viral illness and is characterized by multiple intramedullary T2 hyperintense areas. Devic disease (neuromyelitis optica) is a demyelinating disorder affecting the spinal cord and optic nerves; MR shows cord swelling and T2 hyperintensity with frequent cavitation. About 30% of pediatric spinal tumors involve the spinal cord. The vast majority of intramedullary tumors is represented by astrocytomas, and a minority by ganglioglioma, whereas spinal cord ependymoma is exceptional outside the setting of neurofibromatosis type 2. The tumoral spinal cord is typically markedly enlarged. The spinal cord is rarely imaged in patients harboring metabolic diseases. However, the spinal cord may be involved, often not selectively but rather as a complement to intracranial abnormalities. These diseases mainly include Krabbe disease, Alexander disease, and leukoencephalopathy with brainstem and spinal cord involvement and high lactate.

REFERENCES

CT and MR Imaging of Spinal Vascular Lesions
Robbert Nijenhuis, MD

Robbert J. Nijenhuis was born on the 28th of February 1979 in the Netherlands. He studied Medicine at Maastricht University (1997-2004). Alongside his medical studies he participated in research at the departments of Medical Education and Radiology. In 2003 he started with his scientific thesis entitled “Non-Invasive Imaging of Spinal Cord Blood Supply”, which he finished in 2007. For this thesis he performed research at the departments of Radiology and Surgery in Maastricht (The Netherlands) and at the department of Neuroradiology (chairman professor A.K. Thron) in Aachen (Germany). During this period he obtained his MD degree (2004). He has written more than 20 articles and several book-chapters on noninvasive imaging of the spinal cord. A part of his thesis was nominated for the Annual Prize of the Dutch Radiological Society (2005). In 2006 he was awarded for giving the best oral presentation at the Annual Conference of the European Society of Neuroradiology (Geneva, Switzerland). Currently he works as a resident in St. Elisabeth Hospital (The Netherlands), where he is involved in research concerning Neuroradiology and Interventional Radiology.

LEARNING OBJECTIVES
Upon completion of this presentation, participants will be able to:
1) Detect the features of normal and abnormal spinal cord vasculature in non-invasive imaging.
2) Demonstrate the important aspects of non-invasive imaging techniques.
3) Specify the value of non-invasive imaging in patients suspected of having a spinal cord vascular malformation.

PRESENTATION SUMMARY
Spinal cord vascular malformations are a rare entity. To interpret diagnostic imaging findings of spinal cord vascular malformations, it is important to be aware of the normal arterial supply and venous drainage of the spinal cord. This allows one to classify normal from abnormal spinal cord vessels. Furthermore, when present the vascular lesion must be accurately localized and characterized as this determines the treatment strategy. Since, there are no MR-based predictors (such as location and extend of the cord edema) localizing a spinal cord vascular malformation [especially a spinal dural arteriovenous fistula (SDAVF)] with catheter angiography can sometimes be very difficult (1). This can often lead to lengthy and sometimes multiple catheterization procedures with high radiation exposures in which large volumes of potentially nephrotoxic contrast material are administered. Therefore, a preceding noninvasive examination is of use to detect and evaluate the vascular spinal cord pathology before the catheter angiography (1). In order to locate and classify a spinal cord vascular malformation the noninvasive imaging technique has to address three important requirements. These requirements are: 1) large spatial coverage, as the malformation may be located anywhere along the spinal column, 2) high spatial resolution since the vessels of interest are often submillimeter sized, and 3) high temporal resolution to detect the shunting site (2). Both spinal cord MR and CT angiography (2,3) are capable of diagnosing the presence or absence of vascular spinal cord malformations. There are, however, differences in diagnostic performance which are mainly dependent on patient characteristics. The value of noninvasive imaging is present especially in the detection or exclusion of a SDAVF. The arterial feeder of a SDAVF can be pinpointed accurately allowing focussing of the subsequent catheter angiography (2). For spinal arteriovenous malformations only the predominant arterial feeder can be visualized, and subclassification, which is relevant for the choice of treatment, should still be based on conventional catheter angiography (2).

REFERENCES
Debate: Anatomic versus Perfusion Imaging for Stroke Triage: Anatomic Only - CTA/MRA

— Don V. Heck, MD

Perfusion - DWI/PWI

Jeffrey L. Sunshine, MD, PhD

Learning Objectives
Upon completion of this presentation, participants will be able to:
1) Identify uses of brain imaging in acute stroke
2) Discuss the benefits of image data for treatment selection.
3) Distinguish recanalization rates from improved patient outcomes.

Presentation Summary
We will discuss the validity of generating fast image data for patients suffering very acute nonhemorrhagic ischemic stroke to provide critical work up and triage. We have for example reviewed nearly one hundred patients with MR imaging prior to treatment for acute nonhemorrhagic ischemic stroke. That study revealed a change of treatment in more than 25 percent of patients. This included approximately five percent who had their treatment plan upgraded to include invasive methods when either no direct treatment or only IV drugs had been intended prior to the MR data. This remains critical as we have established intraarterial thrombolysis, intraarterial thrombectomy or both as available tools for brain tissue salvage. We have had success at recanalization using these in the 60 to 80 percent range, yet the improvement in patient outcomes has not been as substantial. As pressures to improve the balances of cost, effort and results grow, the use of imaging remains an objective measure to add specificity of treatment to the particular individual disease presentation. Better matching of techniques to stratified presentations through imaging may provide a key to improved population outcomes.

Interventional Trials Update

Thomas A. Tomsick, MD

Learning Objectives
Upon completion of this presentation, participants will be able to:
1) Report MS III Trial Progress.

Presentation Summary
This presentation will update attendees on the progress of the IMS III Trial.
New Devices for Acute Stroke Intervention

Donald F. Frei, Jr., MD

Learning Objectives
Upon completion of this presentation, participants will be able to:
1) Describe various types of mechanical devices used in the endovascular treatment of acute ischemic stroke
2) Identify cerebrovascular anatomy or clot histology that may favor one type of device over another in the endovascular treatment of acute ischemic stroke.

Presentation Summary
Intravenous rt-PA has been FDA approved for the treatment of acute ischemic stroke for more than a decade. Intraarterial thrombolysis, although not FDA approved, has shown efficacy in clinical trials, and is a widely utilized therapy for acute ischemic stroke when a patient has a severe neurologic deficit and is either outside the time window for intravenous therapy, is excluded from intravenous therapy or has not responded to intravenous therapy. For many years, neurointerventionalists have used mechanical devices to treat stroke, such as: microguidewires and catheters to macerate clot and angioplasty balloons to increase clot surface area and restore flow. Recently, exciting mechanical devices have been specifically developed, tested and FDA approved for endovascular stroke therapy. New generations of approved devices and new devices are being developed and clinical trials are ongoing. Clot aspiration, clot extraction and ultrasound clot disruption are the currently FDA-approved devices. Newer devices, such as retrievable stents are being tested. The goal of any endovascular stroke device is rapid and safe recanalization. As more neurointerventionalists and our industry partners enter the acute stroke therapy arena, we will see higher recanalization rates, faster time to recanalization and fewer complications.

Integrated Functional Imaging Techniques for Brain Tumors and AVMs - Perfusion and MRS

Meng Law, MD

Learning Objectives
Upon completion of this presentation, participants will be able to:
1) Identify the different methodologies which can be used to obtain perfusion permeability and MR spectroscopy in brain tumors and appreciate the pitfalls, advantages and disadvantages of each method.
2) Discuss the role of perfusion, permeability and MR spectroscopy characterizing tumor biology/patient outcome as well as differentiating different pathologies.
3) Cite the role of perfusion, permeability and MR spectroscopy in the post therapeutic brain in the assessment of radiation necrosis, pseudoprogression and antiangiogenic therapies.
4) Describe an update on the literature and demonstrate how perfusion and MRS can be used in a multi-parametric algorithmic fashion in brain tumor diagnosis.

Presentation Summary
Perfusion, permeability and MR spectroscopy (MRS) now is widely utilized in the research and clinical settings. In the clinical setting, qualitative, semi-quantitative and quantitative approaches such as review of color-coded maps to region of interest (ROI) analysis and analysis of signal intensity curves are being applied in practice. There are a number of pitfalls with all of these approaches. We will review some of these
shortcomings such as the relative low sensitivity of metabo-
lite ratios from MRS and the effect of leakage on the appear-
ance of color-coded maps from DSC MRI perfusion imaging
and what correction and normalization methods can be
applied. This has important clinical implications as even
qualitative perfusion maps are altered significantly by the
leakiness of a lesion (1). We also will compare the relative
advantages for T1 DCE MRI with T2* DSC MRI in the esti-
mation of perfusion and permeability metrics in the clinic.
The role of perfusion, permeability and MRS in the charac-
terization of tumor biology and different pathologies will be
reviewed (2, 3). Differentiating between recurrent tumor and
therapeutic necrosis is often a challenge. We will review the
role of advanced imaging and also the effects of antiangi-
genic therapies on tumor microvasculature/microenvi-
ronment resulting in changes in diffusion, perfusion and MRS.
Note will be made of an entity called “pseudoprogression”
which is seen more commonly as a result of therapy with
temozolomide and radiation for high-grade gliomas (4).
Lastly to combine and apply these different imaging tech-
niques in a multiparametric algorithmic fashion in the clin-
ical setting can be shown to increase our diagnostic specifi-
city and confidence (5).

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Integrated Functional Imaging Techniques for Brain
Tumors and AVMs - DTI and Mapping
Jay J. Pillai, MD

LEARNING OBJECTIVES
Upon completion of this presentation, participants will be
able to:
1) List clinical uses of functional imaging in preoperative
evaluation of neoplasms and other surgical lesions of the
brain.
2) Explain the value of integration of physiologic imaging
modalities in brain lesion assessment.
3) Summarize the complementary roles of BOLD, DTI and
perfusion imaging

Presentation Summary
The roles of BOLD fMRI, DTI and perfusion imaging in the pre-
operative work up of brain tumors and other surgical lesions affect-
ning the brain are complementary. Integration of these modalities
allows for better presurgical risk assessments and permits more
detailed and effective surgical planning with the aim of minimizing
risk of postoperative neurologic deficits.

Tuesday Afternoon
1:30 PM - 3:15 PM
Room 2

(24) ASNR Business Center
Programming: Government and
Radiology Part II

(234) Federal Policy, Macroeconomics, and Their
Impact on Radiology in the USA
— Frank J. Lexa, VII, MD

(235) Preop: What Does Washington and Wall
Street Have in Store for the US?
— Jonathan Breslau, MD

(236) A Canadian Perspective: Healthcare,
Government, and the Impact on Radiology
Practice
— Bruce Forster, MD

Federal Policy, Macroeconomics, and Their Impact on
Radiology in the USA
Frank J. Lexa, VII, MD

Preop: What Does Washington and Wall Street Have in
Store for the US?
Jonathan Breslau, MD

A Canadian Perspective: Healthcare, Government, and
the Impact on Radiology Practice
Bruce Forster, MD
COMMENTARY FROM THE WASHINGTON TIMES

As politicians, economists, popular media and an ever increasing list of others convincingly proclaim cures for the ills of American health care, we Americans are subjected to a stream of opinion deriding as utterly miserable our health-care system compared to the rest of the developed world. Much of this chatter resonates with the public; many assume the arguments are sound and the expertise of the presenters profound because the calls for change are so ubiquitous and the topic so complex.

In their haste to address such serious challenges as escalating costs and the uninsured, many economists, government officials, insurers and academics alike are beating the drum for a far larger role for government in health care. In this interlude between health czar nominees, and before we legislate government as the solution and final arbiter of medical care, it may be a good time to consider a few unheralded facts about America’s health-care system. For instance, did you know:

(1) Americans have better survival rates from both common and rare cancers than Europeans? (Sources: Lancet Oncology, 7, No. 2 (February 2006): 132-40; Verdecchia et al., “Recent Cancer Survival in Europe : A 2000-02 Period Analysis of EUROCARE-4 Data,” Lancet Oncology, No. 8 (2007): 784-96.)

(2) Americans have significantly better survival rates from cancer than Canadians? (Sources: United States Cancer Statistics, National Program of Cancer Registries, Centers for Disease Control; Canadian Cancer Society/National Cancer Institute of Canada; also June O'Neill and Dave M. O'Neill, “Health Status, Health Care and Inequality: Canada vs. the U.S.” National Bureau of Economic Research, NBER Working Paper 13429, September 2007. Available at http://www.nber.org/papers/w13429.)

(3) Americans have better access to treatment for chronic diseases than Canadians? (Source: O’Neill and O’Neill, “Health Status, Health Care and Inequality: Canada vs. the U.S.”)

(4) Americans have better access to preventive screening for major cancers than Canadians? (Source: O’Neill and O’Neill, "Health Status, Health Care and Inequality: Canada vs. the U.S.")

(5) A marker for inequality of access and quality of health systems, the "health-income gradient" (i.e., that higher incomes achieve better health and lower incomes mean worse health) for adults 16 to 64 years old reveals a more severe disparity in Canada than in the United States? (Source: O’Neill and O’Neill, "Health Status, Health Care and Inequality: Canada vs. the U.S.")

(6) In the United Kingdom and Canada, patients wait far longer than Americans (about twice as long, sometimes even more than a year) to see a specialist, have elective surgery like hip replacements or cataracts, or get radiation treatment for cancer? (Sources: "Waiting Your Turn, (17th edition) Hospital Waiting Lists In Canada"; Critical Issues Bulletin 2007; N. Esmail, Michael A. Walker MA, and M. Bank, Studies in Health Care Policy, August 2008; N. Esmail and D. Wrona "Medical Technology in Canada," Fraser Institute; Sharon Wilcox et al., "Measuring and Reducing Waiting Times: A Cross-National Comparison Of Strategies," Health...
The Realities of 21st Century Neuroradiology Practice

Michael Brandt-Zawadzki, MD

LEARNING OBJECTIVES
Upon completion of this presentation, participants will be able to:
1) Identify the importance of sub-specialization in radiology.
2) Describe the challenge of the disaggregation of radiology as both a threat and an opportunity.

PRESENTATION SUMMARY
On August 22, 2007, the Advisory Board Company (a prominent hospital administration consulting group) sent out the following e-message to its subscribers: Faced with turf battles, St. Luke’s separated neuroradiology group. In light of its growth, St. Luke’s has struggled to staff an adequate number of neuroradiologists and neurointerventionalists for its acute stroke program. Since 1993, St. Luke’s grew its number of neurologists from three to twelve and its neurosurgeons grew from three to seven, but maintained only one neuroradiologist. The decision stemmed from St. Luke’s private practice radiology group’s refusal to hire additional neuroradiologists to keep pace with the rapidly expanding volumes of the stroke institute, forcing St. Luke’s neurologists and neurosurgeons to read their own patients’ brain images after hours. While Rymer (hospital administrator quoted throughout the communication) notes that St. Luke’s “crisis situation” of relying on one neuroradiologist was not unique, she says the hospital directly addressed its concerns by strategically moving its neurointerventionalists and neuroradiologists out of the radiology group. As a result, the current, independent neuroradiology group allows neuroradiologists and neurointerventionalists more control over the development of services, while also ensuring a more equitable call schedule and distribution of revenue. In addition, this new group resolves neuroradiologists’ dissatisfaction over taking more call than St. Luke’s other radiologists, not being compensated at a higher rate. Based in part on the strength of its regional stroke network, St. Luke’s has become the de facto neurosciences center in the region, with physicians from regional hospitals frequently referring any complex neurovascular case to St. Luke’s. The Advisory Board Company went on to point out that St. Luke’s has gone on to not only improve clinical outcomes, but has reaped an average 10% annual increase in stroke volumes. The hospital boasts an intervention rate of almost 30%, 10 times greater than the national average, for acute stroke admissions to the emergency room. The implications of this vignette are significant for neuroradiology.

Practice Improvement (PQI): What Is it and What Do You Need to Do?

Pina Sanelli, MD, MPH

LEARNING OBJECTIVES
Upon completion of this presentation, participants will be able to:
1) Review the current literature on CTA and CTP in aneurysmal subarachnoid hemorrhage patients.
2) Cite the evidence available in using CTA and CTP for diagnosis of vasospasm.

PRESENTATION SUMMARY
The presentation will include a comprehensive review of the current literature in using CT angiography and CT perfusion in aneurysmal subarachnoid hemorrhage patients.
Tuesday Afternoon

3:30 PM – 5:00 PM
Hall A

(26a) Adult Brain: Cerebrovascular Occlusive Diseases I
(Scientific Papers 241 – 251)

See also Parallel Sessions
(26b) Head & Neck: Orbit, Face and Salivary Glands
(26c) Spine: Interventions and Pain Management
(26d) Socioeconomics and Brain Anatomy

Moderators:  David B. Hackney, MD
TBD

Paper 241 Starting at 3:30 PM, Ending at 3:38 PM
Renal Safety of CT Angiography and Perfusion Imaging in the Emergency Evaluation of Acute Stroke

Aviv, R. · Symons, S. · Mallia, G. · Schiffer, J. · Fox, A. · Buck, B. · Black, S. · Hopyan, J.
Sunnybrook Hospital
Toronto, ON, CANADA

PURPOSE
Multimodal computed tomography (CT) imaging with contrast-enhanced CT angiography (CTA) and CT perfusion (CTP) is being used increasingly to guide emergency management of acute stroke. However, little has been reported about the safety of intravenous contrast administration associated with these studies in the acute stroke population, including cases in which baseline creatinine values are unknown. We investigated the incidence of contrast-induced nephropathy (CIN), defined as a ≥25% increase in baseline creatinine levels within 72 hours of contrast administration, and chronic kidney disease in patients receiving CTA +/- CTP at our regional stroke center.

MATERIALS & METHODS
We analyzed 198 patients who underwent contrast CT studies for evaluation of acute ischemic or hemorrhagic stroke at our center (2003-2007). Through retrospective chart abstraction, we analyzed serial creatinine levels (baseline to day 3), and later values (≥day 4) where available. The incidence of CIN and/or chronic kidney disease were documented. Following power analysis, CIN and non-CIN groups were compared using the unpaired T test, Wilcoxon rank sum test or Fisher exact test.

RESULTS
None of the 198 patients developed chronic kidney disease or required dialysis. Of 175 patients with serial creatinine measurements between baseline and day 3, 5 (2.9%) developed CIN. The incidence of CIN was 2% in patients who were scanned before a baseline creatinine level was available.

CONCLUSION
The incidence of renal sequelae is relatively low in acute stroke patients undergoing emergent multimodal CT scanning. Prompt CTA/CTP imaging of acute stroke, if indicated, need not be delayed in those with no history of renal impairment.

KEY WORDS: Contrast-induced nephropathy, stroke, CT angiography

Paper 242 Starting at 3:38 PM, Ending at 3:46 PM
Optimal Duration of Acquisition for Dynamic Perfusion-CT Assessment of Blood-Brain Barrier Permeability

Hom, J. · Dankbaar, J. · Cheng, S. · Bredno, J. · Wintermark, M.
University of California San Francisco
San Francisco, CA

PURPOSE
Symptomatic hemorrhagic transformation (HT) occurs in 5-10% of acute ischemic stroke patients treated with tPA. Because blood-brain barrier (BBB) damage plays a fundamental role in HT, early identification of significant BBB damage might predict which patient are going to develop HT and could constitute a contraindication to thrombolytic therapy. Perfusion-CT (PCT) can be used to assess BBB permeability (BBBP). A prior study demonstrated the necessity of using delayed acquisition data rather than first-pass data for accurate BBBP calculation according to the Patlak model, but it did not specify how long the delayed acquisition should be. The purpose of our current study was to determine the optimal duration of the delayed acquisition to obtain accurate BBBP measurements while minimizing potential motion artifacts and radiation dose.

MATERIALS & METHODS
We retrospectively identified 23 consecutive acute ischemic hemispheric stroke patients who underwent a PCT study using a prolonged acquisition time of up to 4 minutes. The Patlak model was applied to calculate the rate of contrast leakage out of the vascular compartment using the full delayed acquisition (90-240 seconds (s)) and also truncated acquisitions (90-210s, 90-180s, 90-150s, 90-120s). Patlak plots were created from the arterial and parenchymal time-enhancement curves obtained in multiple regions of interest (ROI) drawn in ischemic brain tissue and non-ischemic brain tissue. Linear regression of the Patlak plot was performed separately for the full and the truncated acquisitions. The slope of these regression lines was used as an indicator of BBBP. The Patlak linear regression models for the full and truncated acquisitions were compared in terms of the resulting BBBP values as well as their respective root mean squared errors (sqrt(MSE)) using generalized estimating equations with robust variance estimation. Sqrt(MSE) was used to measure the quality of the linear fit and to quantify
how well the assumptions of the Patlak model were met. Sqrt(MSE) is a measure of variability of data points around a straight line: a value close to 0 indicates a smaller spread of data points around the line, corresponding to a better fit.

RESULTS
BBBP values were similar for the full 90-240s acquisition (ROI-adjusted mean with 95% CI: 1.81 (1.53-2.15) ml x 100g⁻¹ x min⁻¹) and the 90-210s acquisition (2.05 (1.74-2.42) ml x 100g⁻¹ x min⁻¹). In contrast, BBBP values increased and differed in a clinically significant matter for the 90-180s (2.51 (2.14-2.95) ml x 100g⁻¹ x min⁻¹), 90-150s (3.29 (2.85-3.80) ml x 100g⁻¹ x min⁻¹) and 90-120s (4.62 (4.08-5.24) ml x 100g⁻¹ x min⁻¹) acquisitions. The quality of the Patlak fit was excellent for the full 90-240s acquisition (sqrt(MSE)=1.34 (1.13-1.58)) and the 90-210s acquisition (sqrt(MSE)=1.66 (1.41-1.95)), but it degraded for shorter delayed acquisitions (sqrt(MSE)=2.17 (1.84-2.55), 3.15 (2.66-3.73) and 4.86 (3.97-5.95) for the 90-180s, 90-150s and 90-120s acquisitions, respectively).

CONCLUSION
A delayed PCT acquisition of up to 210s leads to BBBP values similar to the ones obtained with a 240s acquisition while minimizing the risk of motion artifacts, time to treatment and radiation dose.

KEY WORDS: Permeability, Patlak, stroke

Paper 243 Starting at 3:46 PM, Ending at 3:54 PM
Predictive Modeling of Hemorrhagic Transformation and Symptomatic Intracerebral Hemorrhage in Acute Ischemic Stroke Using CT Angiography and CT Perfusion

Lin, K.1 · John, M.1 · Tsiouris, A. J.1 · Tekchandani, L.2 · Sanelli, P. C.1
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PURPOSE
A comprehensive CT protocol that includes noncontrast CT (NCCT), CT angiography (CTA), and dynamic CT perfusion (CTP) is gaining acceptance for use in triaging patients with acute ischemic stroke. The purpose of this study was to determine which clinical and imaging metrics from a comprehensive CT stroke protocol are most predictive of hemorrhagic transformation (HT).

MATERIALS & METHODS
Patients presenting to our institution’s emergency department were included in this retrospective study if (1) they presented <12 hours from onset of stroke symptoms, (2) they received NCCT, CTA, and CTP as part of their initial evaluation, and (3) they had follow-up imaging which confirmed acute nonlacunar MCA infarction. Patient charts were reviewed and the following clinical metrics were collected: age, time from stroke ictus to imaging, National Institute of Health Stroke Scale Score (NIHSSS), systolic and diastolic blood pressure, serum glucose concentration, serum platelet concentration, international normalized ratio, history of diabetes, and any definitive treatment given (intravenous thrombolysis or intraarterial therapy). Imaging metrics included leukoaraiosis on NCCT, the site of arterial stenosis/occlusion (ICA terminus, M1, M2, or M3) on CTA, and the Alberta Stroke Program Early CT Score (ASPECTS) on CTA-SI. Parametric maps of cerebral blood flow (CBF), cerebral blood volume (CBV), and mean transit time (MTT) were created using deconvolution-based software covering 20 mm centered at the basal ganglia. Four circular 15mm diameter regions of interest (ROIs) were placed on the most severely ischemic region based on qualitative inspection. From these ROIs, quantitative values of minimum CBV, minimum CBV, and maximum MTT were obtained as additional imaging metrics from CTP. Charts and follow-up imaging subsequently were reviewed to identify those patients who developed HT, defined as hemorrhagic infarction (HI, types 1 and 2) or parenchymal hematoma (PH, types 1 and 2) in accordance with the second European-Australasian Cooperative Stroke Study (ECASS-II). Patients with HT were further classified as having symptomatic intracerebral hemorrhage (SICH) if it was associated with clinical deterioration. Univariate and multivariate logistic regression analyses performed to identify significant clinical and imaging predictors of HT and SICH and their estimated odds-ratios (OR). A two-sided p-value <0.05 was considered significant.

RESULTS
Twenty-four patients were included in this study. Twelve (50%) patients developed HT (5 HI2, 6 PH1, and 1 PH2), six of which were SICH (2 HI2, 3 PH1, and 1 PH2). For HT, univariate logistic regression revealed NIHSSS (OR=1.22, 95%CI: 1.02-1.45), proximal site of arterial stenosis/occlusion (ICA terminus or M1) (OR=0.111, 95%CI: 0.018-0.705), ASPECTS (OR=0.430, 95%CI: 0.222-0.830), minimum CBV (OR=0.603, 95%CI: 0.402-0.904), and minimum CBV (OR<0.001, 95%CI: <0.001-0.174) as significant predictors, with multivariate analysis identifying minimum CBV as the best predictor. For SICH, univariate logistic regression revealed only ASPECTS (OR=0.522, 95%CI: 0.278-0.980) and minimum CBV (OR=0.009, 95%CI: <0.001-0.668) as significant predictors, with multivariate analysis identifying ASPECTS as the best predictor.

CONCLUSION
Minimum CBV on CTP (as a measure of the degree of ischemia) was the best predictor of any HT while ASPECTS on baseline CTA-SI (as a marker of infarct extent) was the best predictor of SICH.

KEY WORDS: CT angiography, CT perfusion, hemorrhagic transformation

Paper 244 Starting at 3:54 PM, Ending at 4:02 PM
Comparison of Shuttle CT Perfusion of the Brain with 123 IMP-SPECT

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Akita, JAPAN

PURPOSE
Cerebral blood flow (CBF) by CT perfusion using shuttle scan was compared quantitatively with CBF by 123IMP-SPECT in patients with cerebrovascular disorders.
MATERIALS & METHODS

Nineteen patients with infarction (n=7), steno-occlusive diseases of the internal carotid artery or middle cerebral artery (n=7), moyamoya disease (n=1), carotid cavernous fistulae (n=2), postoperative status after subarachnoid hemorrhage (n=1) and normal (n=1) were included. CT perfusion was acquired by shuttle scan using 64-row MDCT. Scan volume of 80mm was acquired by shuttle scan. Quantitative CBF by \(^{123}\)IMP-SPECT was acquired using autoradiography method. Regions of interest (ROIs) were set in the cerebellar hemisphere, and in the cerebral cortices, and central gray matter on both sides. Mean CBF in the frontal, temporal, parietal, and occipital lobes, and central gray matter, and cerebral hemisphere on both sides measured by CT perfusion were compared with that measured by \(^{123}\)IMP-SPECT.

RESULTS

Cerebral blood flow images by CT perfusion were qualitatively similar to those by \(^{123}\)IMP-SPECT images. Quantitatively, a significant correlation in CBF between CT perfusion and \(^{123}\)IMP-SPECT was acquired (r\(^2\)=0.61, p<0.001) by simple regression analysis.

CONCLUSION

The present study elucidated that CBF by CT perfusion using shuttle scan quantitatively correlated with CBF by \(^{123}\)IMP-SPECT, and showed the validity and usefulness of CT perfusion using shuttle scan.

KEY WORDS: CT perfusion, cerebral blood flow, SPECT
CONCLUSION

Both \( rR \) and \%\textit{Recovery} can be extracted readily from a standard 90s DSC data-set and each shows potential for delin- eating HT from non-HT infarcts.

REFERENCES

2. Kassner A, et al. \textit{JMRI} 2000;103-113

KEY WORDS: MRI, dynamic susceptibility contrast, acute ischemic stroke

Paper 246 Starting at 4:10 PM, Ending at 4:18 PM

\textbf{MR Imaging Texture Analysis versus Postcontrast T1w Enhancement for the Prediction of Hemorrhagic Transformation in Acute Ischemic Stroke}

Kassner, A.\textsuperscript{1,2} · Thornhill, R. E.\textsuperscript{1,2} · Liu, F.\textsuperscript{2} · Tomlinson, G.\textsuperscript{1} · Silver, F.\textsuperscript{2} · Mikulis, D. J.\textsuperscript{1,3}

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PURPOSE

Currently, the use of recombinant tissue plasminogen activator (rt-PA) therapy is restricted to acute ischemic stroke (AIS) patients who present within 4.5h of symptom onset due to the increased risk of hemorrhagic transformation (HT)(1). Early prediction of HT would improve the safety of rt-PA, thereby improving patient outcome. While visual evidence of gadolinium enhancement (VE) on T1-weighted (T1w) MR imaging has been associated with subsequent HT (2), VE may lack the sensitivity needed in the crucial hours following symptom-onset (3). A potential alternative to VE is texture analysis, which can quantify higher-order image statistics not visible to the human eye (4). We tested the hypothesis that texture features derived from pos-contrast T1w images can identify HT-prone infarcts with better sen- sitivity than VE.

MATERIALS & METHODS

Thirty-four AIS patients (66.4 ± 15.2 years) were examined within a mean of 3.5 hours following symptom onset. Fifteen patients received IV rt-PA. All imaging was performed on a 1.5T clinical MRI system (GE Signa LX 12.0, Milwaukee, WI). Standard anatomical, diffusion, permeability, perfu- sion-weighted as well as contrast-enhanced MRA were acquired prior to T1w imaging. Postcontrast T1w images were acquired using the following parameters: TR=750 ms, TE=20 ms, FA=90°, in-plane resolution=0.93x1.25 mm², slice-thickness=5 mm, and slices=22. HT was determined by follow-up CT or MRI 24-72h after initial imaging. Images were analyzed offline. Diffusion-weighted images were used to generate apparent diffusion coefficient maps, which then were used to guide the placement of two regions of interest (ROI); one ROI selected from within the area of reduced diffusion (‘Infarct’), and from the contralateral hemisphere (‘Contra’). Texture analysis was performed using MaZda 3.2 (PM Szczypinski, Technical University of Lodz). The following second-order textural features were extracted from each ROI(4): angular second moment (\( f1 \)), contrast (\( f2 \)), correlation (\( f3 \)), and entropy (\( f9 \)). A neuroradiologist inspected T1w images for VE. Data were grouped according to treat-ment and HT-outcome and significant differences were investigated by ANOVA. Receiver operating characteristics (ROC) were computed for predicting HT with textural features or VE.

RESULTS

Follow-up imaging identified 12 patients who developed HT, including six treated with rt-PA. Except for \( f9 \), infarct features were significantly different from Contra features (\( P<0.0001 \) for \( f1, f2, \) and \( f3 \)). No significant differences were detected between treated and untreated patients. The mean infarct \( f2 \) in the HT group was lower than in the non-HT group (1058 ± 356 v. 1568 ± 527; \( P=0.005 \)). The mean infarct \( f3 \) in the HT group was greater than for non-HT patients (0.67 ± 0.12 v. 0.54 ± 0.13; \( P=0.007 \)). ROC analysis indicated 92% sensitivity and 63% specificity for \( f2 \) (threshold=1396), 75% sensitivity and 68% specificity for \( f3 \) (threshold=0.61), and 33% sensitivity and 86% specificity for VE.

CONCLUSION

The results indicate that texture analysis can provide superior sensitivity to visual inspection of postcontrast T1w images for the prediction of HT in early AIS.

REFERENCES


KEY WORDS: MRI, texture analysis, acute ischemic stroke

Paper 247 Starting at 4:18 PM, Ending at 4:26 PM

\textbf{Correlation of Acute MTTLesion Volumes with Neurologic Deficits and Tissue Outcome Depends on Deconvolution Algorithm}

Wu, O. · Lu, L. · Benner, T. · Tiglias, V. · Copen, W. · Asarva, E. · Ay, H. · Gonzalez, R. G. · Schwamm, L. · Singhal, A. · Sorensen, A. G. · Schaefer, P. W.

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PURPOSE

Recent acute stroke trials have used diffusion-weighted imaging (DWI) and perfusion-weighted imaging (PWI) as patient selection criteria under the assumption that “mis-
sue who may benefit from therapy. However, degrees of these mismatches are dependent on the choice of perfusion metric. Our purpose was to compare lesion volumes on MTT maps generated with standard singular value decomposition (sSVD) and MTT maps generated with tracer-arrival insensitive circular deconvolution (oSVD) with respect to acute and follow-up clinical scores and follow-up lesion volume.

MATERIALS & METHODS
One hundred forty-four consecutive acute stroke patients who received DWI and PWI within 12 hours of stroke onset were studied. Perfusion-weighted imaging maps were calculated by deconvolution using standard truncated singular value decomposition (sSVD) and tracer-arrival insensitive circular deconvolution with oscillation-index regularization (oSVD). Arterial input functions were selected automatically. MTT maps were calculated as the ratio of CBV/CBF. MTT lesions were demarcated automatically as tissue > 2 standard deviations from mean contralateral white matter values, and then manually adjusted by two independent readers. The average lesion volumes were compared with acute NIHSSS, follow-up (F/u) lesion volumes obtained at least 5 days after stroke onset and 90 day clinical outcome scores (modified Rankin Score or NIHSSS) when available (Pearson’s product-moment correlation).

RESULTS
Median acute NIHSSS was 6, interquartile range(IQR) 3-11. Onset-to-MRI time was 4.7±2.3 hours, Median age was 72 years (IQR: 55-80). Seventy-six of 144 patients had left-sided strokes and 83/144 were male patients. Twenty-six received rt-PA prior to imaging. Twenty-nine had F/u lesion volumes, 92 patients had 3 month mRS scores (median 2) and 49 patients had follow-up NIHSS scores(median 1). sSVD calculated MTT (67±73 cm³) lesion volumes were significantly larger (P<0.001) than oSVD MTT (58±65 cm³) lesion volumes. oSVD MTT lesion volumes had higher correlation coefficients than sSVD MTT lesion volumes when compared with acute NIHSSS, F/u lesion volume, 90 day mRS and 90 day NIHSSS (Table).

Table: Correlation of acute MTT lesion volumes with acute chronic clinical scores and final infarct volume

<table>
<thead>
<tr>
<th></th>
<th>sSVD MTT</th>
<th>oSVD MTT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acute NIHSSS (N=144)</td>
<td>R=0.49</td>
<td>R=0.55</td>
</tr>
<tr>
<td>F/u Lesion (N=29)</td>
<td>R=0.29</td>
<td>R=0.57</td>
</tr>
<tr>
<td>90 day mRS (N=85)</td>
<td>R=0.30</td>
<td>R=0.35</td>
</tr>
<tr>
<td>90 day NIHSSS (N=49)</td>
<td>R=0.52</td>
<td>R=0.57</td>
</tr>
</tbody>
</table>

CONCLUSION
MTT maps generated using oSVD techniques correlate better with acute neurologic deficits and clinical and imaging outcomes than do MTT maps generated with sSVD techniques. MTT maps generated with sSVD techniques may overestimate tissue at risk of infarction due to tracer arrival delay. Decoupling delay from perfusion estimates will likely provide greater insight into stroke evolution and expected clinical and tissue outcome.

KEY WORDS: Acute stroke, perfusion imaging

Paper 248 Starting at 4:26 PM, Ending at 4:34 PM
CT Angiography Clot Burden Score and Collateral Score: Correlation with Clinical and Radiologic Outcomes in Acute Middle Cerebral Artery Territory Infarct

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PURPOSE
Clot extent and location and collateral integrity are important determinants of outcome in acute stroke. The purpose of this study is to assess the relationship between clot extent and collaterals with clinical outcome and amount of tissue at risk. We hypothesize that a novel clot burden score (CBS) and the collateral score (CS) are important determinants of clinical and radiologic outcomes and serve as useful additional variables in stroke outcome prediction.

MATERIALS & METHODS
One hundred twenty-one patients with anterior circulation infarct presenting within 3 hours of stroke onset were reviewed. Spearman’s correlation was performed to assess the correlation between CBS and CS and clinical and radiologic outcome measures. Patients were dichotomized using a 90-day modified Rankin score (mRS). Uni and multivariate logistic regression models were used to assess for variables predicting favorable clinical and radiologic outcomes. Receiver operating characteristic (ROC) analysis and intra-class correlation coefficient (ICC) analysis were performed. Diagnostic performance of a CBS threshold of >6 was assessed.

RESULTS
There were 85 patients (mean age 70±14.5 years). Patients with higher CBS and CS demonstrated smaller pretreatment perfusion defects, final infarct volume and better clinical outcome (all p<0.01). CBS (p=0.009) and recanalization (p=0.015) independently predicted favorable outcome. A CBS>6 predicted good clinical outcome with an area under the curve (AUC) of 0.75 (95% CI 0.65-0.84, p=0.0001), sensitivity 73.0 (95% CI 59.9 - 86.2) and specificity 64.6 (95% CI 49.5 - 77.8). The recanalization rate with IV rt-PA was higher in patients with CBS>6 (p=0.04, OR 3.2 CI 1.1 to 9.4). The ICC was 0.97 (95% CI 0.95-0.98) and 0.87 (95% CI 0.80-0.91) for CBS and CS respectively.

KEY WORDS: Clot burden, stroke, CT angiography
**PURPOSE**

The final infarct volume after intraarterial thrombolysis (IAT) for acute ischemic stroke depends on the time for and the degree of recanalization and the residual blood flow. The latter one is influenced by the extent of pial collateral formation during acute ischemic stroke. The aim of the study was to evaluate if the assessment of pial collateral formation with CT angiography (CTA) is predictive of the final infarct volume after IAT.

**MATERIALS & METHODS**

We prospectively included 22 consecutive patients (14 female, 8 male; mean age: 66.32 years ± 13.02 years) who underwent IAT within 6 hours after onset of symptoms. All patients underwent plain cranial CT (CCT), perfusion CT (PCT) and CTA prior to intervention. Follow-up CCT were performed immediately after, 24 hours and on day 5 after IAT. CT angiography was reconstructed using a thick slice MIP-algorithm (20mm slice thickness) in coronal and axial planes. The CTA dataset was evaluated from the skull base to the superior sagittal sinus. Pial collateral formations of the affected hemisphere were graduated in comparison to the nonaffected hemisphere using a 4-point score: 0 = no collaterals, 1 = 50% and <100% and 3 = 100%. The final infarct volume was calculated from the CCT on day 5. Final infarct volume and collateral score were correlated.

**RESULTS**

Good recanalization (TIMI 3 or 2) was achieved in 16 patients and poor recanalization in six. The mean final infarct volume was 75 ml ± 77.22 ml (min 0 ml, max 343.06 ml). The median collateral score was two. There was a significant correlation between the final infarct volume and the collateral score (r=-0.747, p<0.001).

**CONCLUSION**

The extent of pial collateral formation in acute ischemic stroke assessed with CTA allows prediction of the final infarct volume after IAT.

**KEY WORDS:** Infarct volume, intraarterial thrombolysis, prediction

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**PURPOSE**

Intracranial hemorrhage rarely can be seen in the setting of posterior reversible encephalopathy syndrome (PRES). The purpose of this study was to describe in detail, the imaging pattern of PRES-related intracranial hemorrhage observed at a tertiary hospital.

**MATERIALS & METHODS**

The radiology report database of our institution was searched to identify all cases in whom intracranial hemorrhage had been noted in the setting of PRES. Detailed evaluation of these patient’s clinical charts and imaging studies was done to confirm the diagnosis of PRES, presence of hemorrhage, and absence of other recognizable causes of intracranial hemorrhage. Intracranial hemorrhage was categorized as subarachnoid or parenchymal. In patients with parenchymal hemorrhage, diagnosis of PRES was made only if edema was seen in at least one area in addition to that surrounding the hemorrhage. Subarachnoid hemorrhage (SAH) was further characterized on the basis of location, amount, and its spacial relationship with parenchymal edema. Parenchymal hemorrhage was similarly characterized based upon its multiplicity, size, location, spacial relationship to parenchymal edema, associated mass effect, and need for surgical evacuation.

**RESULTS**

A total of 49 patients (6 males, 43 females; age 42.5 +/- 16.6 years) with PRES-related intracranial hemorrhage were found. Immunosuppressant toxicity, hypertensive encephalopathy, pre-eclampsia, and sepsis accounted for majority of these cases. Subarachnoid hemorrhage (SAH) was present in 13 cases, all with a small amount of blood along cerebral convexities. None of the cases showed blood filling the basal cisterns. In all but one case, SAH was seen overlying the edematous lobe of cerebral hemisphere. In eight cases, SAH accompanied parenchymal hemorrhage, which was noted in 44 patients. Multiple foci of parenchymal hemorrhage were seen in 26 patients. Most of these foci were small, not associated with any mass effect. Only three (6.8%) cases of parenchymal hemorrhage with mass effect were observed. Parenchymal hemorrhage was located mostly within cerebral hemispheres (86.6%), with cerebellum, basal ganglia, thalamus, and brain stem accounting for additional sites. The location of parenchymal hemorrhage matched that of edema in 94.5% of all patients. Although midline shift was present in two cases, surgical evacuation was not done in any of the cases.

**CONCLUSION**

Both subarachnoid and parenchymal hemorrhage can be seen in the setting of PRES. Patients with SAH usually present with a small amount of blood along the cerebral convexity, mostly overlying the edematous regions of brain parenchyma. Most cases of parenchymal hemorrhage involve small, single or multiple foci of parenchymal hem-
orrhage, in a location matching that of edema. Parenchymal hemorrhage is usually small in amount, not necessitating surgical evacuation.

**Key Words:** Posterior reversible encephalopathy syndrome, intracranial hemorrhage, MR imaging

### Paper 251 Starting at 4:50 PM, Ending at 4:58 PM

**Exhausted Cerebral Autoregulation Is Spatially Associated with Cortical Atrophy**

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**Purpose**
The physiologic impact of severely impaired cerebral autoregulation on gray matter integrity is unknown. We hypothesized that cortical gray matter supplied by a defective vascular system with exhausted autoregulation will show evidence of cortical atrophy.

**Materials & Methods**
One hundred fifty BOLD MR imaging cerebrovascular reactivity (CVR) studies were reviewed to identify patients with severe unilateral impairment in autoregulation (negative CVR) but with normal appearing gray matter on FLAIR. Patients with lacunar infarcts in the white matter were excluded. Ten patients were identified each having a high-grade stenosis or occlusion of the ICA or MCA on one side secondary to moyamoya, atherosclerosis, or unknown. Cerebrovascular reactivity studies were performed by applying precision control of end-tidal CO2 between 40 and ~50 mmHg during BOLD MR imaging acquisition on a GE 3T HDX MRI system (1). A 3D T1-weighted volume (voxel 0.78 x 0.78 x 2.2 mm) was acquired and analyzed for cortical thickness using Freesurfer (http://surfer.nmr.mgh.harvard.edu/). Cerebrovascular reactivity and cortical thickness maps were overlapped to determine a region of interest (ROI) encompassing the region of negative CVR. This ROI was mirrored to the normal hemisphere providing a normal vs. abnormal hemisphere ROI comparison in each patient. Mean cortical thickness between right and left hemispheric ROIs for each patient was measured and a paired t-test was applied.

**Results**
Cortex in the left hemisphere ROI was thinner than the right in 6 of 10 cases (left hemisphere cortex is normally thicker than the right’). The ROI with negative CVR showed thinner cortex in 8 of 10 cases. Mean cortical thickness was 2.33 mm +/- 0.015 on the abnormal side, and 2.35 mm +/- 0.014 on the normal side (p = 0.03). The figure shows the relationship between the spatial extent of abnormal CVR and the spatial extent of cortical thinning in one subject (decreased extent of yellow in right hemisphere = thinner cortex and increased extent of blue in right hemisphere = negative CVR). The data indicate that a spatial correspondence exists between exhaustion of autoregulatory capacity and cortical thinning. The findings imply that the inability to augment flow, as is normally seen with neuronal activation, may be deleterious to the health of the gray matter.

**References**
2. Luders, et al. Cerebral Cortex 2006;16:1232-1238

**Key Words:** Autoregulation, cortex, MRI

### Paper 252 Starting at 3:30 PM, Ending at 3:38 PM

**MR Imaging of the Optic Nerves with XETA FLAIR**

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**Purpose**
The eXtended Echo Train Acquisition (XETA), also known as “Cube”, is a relatively new 3D fast spin-echo (FSE) sequence that can be used to perform whole-brain fluid-attenuated inversion recovery (FLAIR) T2-weighted imaging at isotropic high spatial resolution. Any plane can be reconstructed from a single acquisition at high resolution, thus enabling reduction in total imaging time if multiple planes of FLAIR imaging are required. This high-resolution volumetric imaging coupled with both fat and fluid suppres-
sion permits evaluation of cranial nerve anatomy and signal abnormality. At our institution, we traditionally have employed 2 plane (axial and coronal) FLAIR sequences (5 min each), which we now have replaced with XETA FLAIR (8 min), performed in the sagittal plane with coronal and axial reformats. Our purpose was to evaluate the sensitivity of XETA FLAIR for abnormal signal in the optic nerve and to compare it to the coronal FSE T2-weighted sequence with fat suppression (FSE T2 FS).

**Materials & Methods**

After obtaining IRB approval, we retrospectively reviewed all patients who underwent XETA FLAIR imaging for optic neuritis from 9/2006 to 9/2008 on 1.5T or 3T MR imaging systems. Ten patients with a clinical diagnosis of optic neuritis met these inclusion criteria. Seven patients underwent a standard brain and orbit MR imaging including XETA and FSE T2 FS. In the remaining three patients, XETA was obtained as part of a routine brain protocol. There was a clinical suspicion for, or diagnosis of, demyelinating disease in nine patients, and postoperative vision loss after a meningioma resection in one patient. XETA parameters are as follows: TR 6000-8000/ TE minimum/ NEX 1 with 1.0mm section thickness, 25 cm FOV, 256 x 256 matrix interpolated to 512x512, and 2D ARC parallel imaging. An adiabatic spectral inversion pulse is used to null fat. Coronal FSE T2 FS sequence parameters are as follows: TR 3000/ TE 102/ with fat suppression, section thickness of 4mm (skip 1mm) and 256 x 256 matrix. Two CAQ certified neuroradiologists blinded to the clinical history and side of vision loss reviewed each study for the presence of signal abnormality on the XETA FLAIR and FSE T2 FS sequences.

**Results**

Signal abnormality was identified on the XETA sequence in all patients on the correct side of the patient’s vision loss. In the seven patients with brain and orbit imaging, reviewer #1 perceived the signal abnormality better on the XETA versus T2-weighted in four of seven cases and reviewer #2 in two of seven cases. None of the cases were seen better with coronal FSE T2 FS sequence by either reviewer. In one case, signal abnormality could not be seen on the coronal FSE T2 FS sequence, but was clearly evident on XETA.

**Conclusion**

XETA Flair outperformed coronal FSE T2 with fat suppression for imaging the optic nerves in patients with optic neuritis. The high-resolution volumetric imaging allows multiplanar evaluation of the brain with one acquisition, and additionally enables excellent detection of abnormal optic nerve signal.

**Key Words:** XETA Flair, CUBE, optic nerve

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**Paper 253 Starting at 3:38 PM, Ending at 3:46 PM**

**Graves’ Ophthalmopathy: Novel Quantitative Bony CT Features as Indicators of Optic Neuropathy**

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**Purpose**

To evaluate the usefulness of linear and angular bony CT features as indicators of optic neuropathy (ON) in patients with Graves’ ophthalmopathy.

**Materials & Methods**

Optic neuropathy (19 patients, 32 orbits) was diagnosed in 41 patients (24 women; mean age 49.1 years) with Graves’ ophthalmopathy based on clinical criteria. The CT scans were evaluated by two independent raters. Quantitative linear and angular measurements of both bony and soft tissue orbital structures, and categorical scores of apical crowding and intracranial fat prolapse were assessed on a clinical workstation. Inter and intrarater variability of these features was determined. The student’s 2-tailed t-test, Mann-Whitney and Pearson Chi square tests were used to compare the mean quantitative and categorical CT features between the two patient groups. Stepwise multivariate logistic regression also was performed with disease status (ON) as outcome and CT features as independent factors, adjusting for age and gender.

**Results**

Bony orbital angles (p < 0.005), length of lateral orbital wall (p < 0.05), muscular diameters (p < 0.0005), muscular bulk of medial rectus relative to bony orbit (p < 0.05) and apical crowding (p < 0.0005) were associated with clinical ON. Stepwise multivariate logistic regression analysis revealed the muscle diameter index, and medial and lateral wall angles to be independent predictors. Combining these in a single multivariate equation yielded sensitivity, specificity, and positive and negative predictive values of 73%, 90%, 82% and 85 % respectively.

**Conclusion**

Orbital wall angles, especially the medial wall, and muscular enlargement are independent risk predictors that may aid in the clinical diagnosis of ON in Graves’ ophthalmopathy. A larger prospective study would be useful to assess the clinical utility of these imaging parameters in the management of patients with Graves’ ophthalmopathy.

**Key Words:** CT, orbit, optic neuropathy
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PURPOSE
Masses of the carotid sheath/skull base often present with nonspecific clinical findings. Imaging plays a vital role in subsequent evaluation and provides both anatomical and physiologic information using MR imaging CT, and In-111 Octreotide scintigraphy. While In-111 Octreotide scintigraphy provides high sensitivity for detection of paragangliomas, schwannomas are known to express somatostatin receptors and can demonstrate false positive results. Subsequently, patients with presumptive diagnoses of paraganglioma versus schwannoma undergo angiography, considered the gold standard for distinguishing the hypervascular paraganglioma. We report the imaging findings in a series of paragangliomas and schwannomas with specific imaging characteristics, to provide an accurate, noninvasive preoperative diagnosis which may have a direct impact on surgical and clinical planning.

MATERIALS & METHODS
Two radiologists retrospectively and independently reviewed available preoperative MR and/or CT imaging in 14 patients with histologically proved schwannomas or paragangliomas. Specific assessment categories included: MR signal characteristics (T1/T2/contrast enhancement), flow voids, cystic change, and vascular displacement. CT evaluation included vascular displacement and osseous changes. In-111 Octreotide results were based on attending physician dictated reports.

RESULTS
Surgical findings showed six schwannomas (three cervical sympathetic chain, two vagal, and one facial nerve) and eight paragangliomas (one jugular paraganglioma, one jugulotympanic paraganglioma, one vagal paraganglioma, and five of the carotid body). All tumors involved the carotid sheath and/or skull base. All available (12) MR images demonstrated contrast enhancement, isointensity on T1, and hyperintensity on T2-weighted images. Eighty-six percent (6/7) of the paragangliomas contained flow voids on fast spin-echo sequences, while none of the schwannomas contained flow voids. Sixty percent (3/5) of the schwannomas showed cystic changes, with no such findings amongst the paragangliomas. Splaying of the ICA/ECA was present with all carotid body paragangliomas, but not with the two jugular paragangliomas, or one vagal paraganglioma. Vascular displacement was present to some extent with all schwannomas of the neck (three sympathetic chain, one vagal), however no splaying of the ICA/ECA was noted. All (3/3) sympathetic chain schwannomas displaced the IJV with the ICA while the single vagal schwannoma splayed the IJV away from the ICA. Both skull base paragangliomas (one vagal, one jugulotympanic) with CT imaging demonstrated osseous erosive changes while both schwannomas of the skull base (one facial nerve, one vagal) showed scalloping. All paragangliomas (8/8) were In-111 Octreotide avid. Half (3/6) of the schwannomas (two vagal, one sympathetic chain) also showed similar uptake.

CONCLUSION
Correlation of specific noninvasive imaging findings (flow voids, cystic change, vascular displacement, and osseous changes) can differentiate paragangliomas from schwannomas of the head and neck and may obviate the need for conventional angiography for diagnostic purposes.

KEY WORDS: Paragangliomas, schwannomas, glomus

Paper 255 Starting at 3:54 PM, Ending at 4:02 PM
Maxillofacial and Jaw Swellings: CT Assessment

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Riyadh, SAUDI ARABIA

PURPOSE
The jaw bones are unique bony structures which contain, besides skeletal and soft tissue elements, an odontogenic apparatus. These complex constituents may be the seat of many pathologic lesions whether developmental, inflammatory or neoplastic. This study was carried out to evaluate the role of CT in the diagnosis of tumors and tumor-like lesions of the jaws as compared with other imaging modalities, as regards behavior of the lesion; either aggressive or nonaggressive, soft tissue extension, associated bone destruction, and the characteristic features of such lesions.

MATERIALS & METHODS
The study comprised 42 patients; 26 adults and 16 children, presented either by cheek swelling, fullness of nasolabial fold or mandibular lesion. The patients were evaluated regarding their age, clinical history, radiographic examinations and CT scan. Ultrasonography was performed in eight patients. The imaging findings were compared with the histopathologic results.

RESULTS
Twenty-two of the patients had nonodontogenic lesions and 20 patients with odontogenic tumors. The patients were subdivided into six groups according to their histopathologic features. The rate of accuracy of CT in diagnosis of the jaws’ lesions in comparison with the histopathologic results was 97.6% for benign lesions and 97.5% for highly aggressive lesions.

CONCLUSION
CT is superior to conventional radiography and ultrasonography in distinguishing the benign from aggressive lesions and suggesting the probable diagnosis of the maxillofacial and mandibular tumors and tumor-like lesions.

KEY WORDS: Maxilla, mandible, jaws
Parapharyngeal Paragangliomas and Schwannomas: Growth Patterns - Beyond Carotid Splaying

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Cleveland Clinic Foundation
Cleveland, OH

PURPOSE
To retrospectively study and compare the typical and atypical growth patterns of parapharyngeal paragangliomas and schwannomas with clinical and surgical correlation.

MATERIALS & METHODS
Surgically proved cases of parapharyngeal (pre and poststyloid) space paragangliomas from 1997 through 2008. CT and/or MR soft tissue neck exams reviewed by a neuroradiologist. Clinical presentation and operative report also reviewed. We introduce a new classification for carotid body tumors growth pattern based on mediolateral growth pattern as the tumor grows out of the carotid fork in contrast to the anterio-posterior growth pattern used by Shamblin et al. A straight line drawn from ECA to ICA at the level of maximum lateral transverse dimension of the tumor: Type A- no greater than 60% mediolateral tumor growth on any side of ECA-ICA line, meaning typical carotid fork splaying , Type B- greater than 60% but not more than 90% tumor growth outside the fork, some splaying may still be present ,Type C- 10% or less of the tumor left in the for and Type D- no tumor in the fork, pertains to other parapharyngeal paragangliomas which may extend to the fork. Dominant growth pattern is medial (M) or lateral (L). Shamblin type also determined by imaging method ( Arya et al). Rest of the tumors are classified based on caroto-jugular displacement or splaying. Type S- splaying, typical for vagal tumors with oblique medio-lateral splaying, Type A- true anterior displacement, Type L or AL- typical for cervical sympathetic chain tumors, lateral or antero-lateral displacement, Type AM- anteriomedial caroto-jugular displacement and Type P-typical for large pre-styloid mass with posterior caroto-jugular displacement.

RESULTS
A total of 27 cases. Twelve carotid body tumors with following growth patterns: 4 Type A (3 Shamblin type I & 1 Shamblin type III), 6 Type B- all medial(M) except one (L) (4 Shamblin type I and 1 type II) and 2 Type C- all medial (all Shamblin type I). Fifteen noncarotid body tumors. Type S- 5 glomus vagale and 1 vagal schwannoma. Type A- a single case of vagal schwannoma. Type AL- 2 sympathetic plexus schwannomas, 3 sympathetic plexus paragangliomas. Type L- parapharyngeal schwannoma presumably of pharyngeal plexus origin. Type AM- parapharyngeal schwannoma of unknown origin. Type P- prestyloid trigeminal branch schwannoma. All the tumors were either incidental imaging findings or presented with palpable masses except each case of sympathetic plexus schwannoma and paraganglioma who presented with Horner’s syndrome.

CONCLUSION
Mediolateral growth patterns of carotid body tumors is likely related to tumor size, arterial tortuosity and or carotid body location variation. Growth pattern of rare sympathetic plexus paragangliomas is similar to sympathetic schwannomas. Vagal schwannoma may anteriorly displace rather than splay internal carotid artery and jugular vein. Unknown origin parapharyngeal schwannomas may represent origin from pharyngeal plexus or a major nerve branch.

KEY WORDS: Schwannomas, paragangliomas, carotid body tumors

Imaging Findings in Salivary Gland Transplantation

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PURPOSE
Xerostomia, or dry mouth, is an important adverse treatment outcome affecting the quality of life in head and neck cancer patients. Currently, treatment of xerostomia is predominantly supportive and based on salivary stimulation and moisturizing agents. Preventative strategies have been based either on improved targeting of the radiation beam or use of radioprotective agents. Salivary gland transplantation is a novel surgical procedure that is being used for the purpose of sparing the submandibular gland from the negative effects of radiation in hopes of preventing xerostomia. In this procedure, the submandibular gland contralateral to the patient’s primary tumor is transferred to the submental space prior to the initiation of radiation therapy. Our purpose is to demonstrate the CT appearance following salivary gland transplantation to avoid misinterpretation of these postoperative findings.

MATERIALS & METHODS
Three patients with a history of head and neck cancer and salivary gland transplantation were studied with helical CT.

RESULTS
Elongated, triangular-shaped foci of enhancing tissue located in the submental space and absence of the native submandibular gland contralateral to the site of the patient’s primary tumor was demonstrated following submandibular transplantation. Transplanted tissue measured 4.1 cm in length and 1.1 cm in width on average. Average attenuation was 111.7 HU, similar to the patient’s native submandibular gland. Associated surgical clips also were seen.
CONCLUSION
In a patient who has been radiated for head and neck cancer, the finding of a submental space mass similar in attenuation to other salivary tissue, in a patient whose native submandibular gland (contralateral to the site of the patient’s primary tumor) is absent, should be recognized as a salivary gland transplant and should not be misinterpreted as pathologic.

KEY WORDS: Salivary gland, transplantation

Paper 258 Starting at 4:18 PM, Ending at 4:26 PM
Value of Propeller Diffusion-Weighted MR Imaging in Comparison with Single-Shot Echo-Planar Diffusion-Weighted Imaging in Patients with Parotid Gland Tumors Using Different Settings of b-Values

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Erlangen, GERMANY

PURPOSE
To assess the value of propeller diffusion-weighted MR imaging in comparison with single-shot echo-planar diffusion-weighted imaging in patients with parotid gland tumors using different settings of b-values.

MATERIALS & METHODS
Patients underwent diffusion-weighted imaging (DWI) using a 1.5 T scanner with different b-value settings: a) 0, 1000 mm/s² (SS EPI DWI), 0/990 (BLADE DWI), n=28; b) 50, 700 mm/s² (SS EPI DWI and BLADE DWI), n=24; Scan parameters (field of view, slice thickness, gap, number of slices) were identical. Statistical analysis of calculated apparent diffusion coefficient (ADC) values were performed for obtaining (Spearman’s) correlation values within each group (a, b).

RESULTS
In all patients DWI with both SS EPI and BLADE sequences were technically possible. High image quality was found for both sequence types allowing accurate ADC value measurements. Strong positive correlation was found for both groups: a) rs=0.851, p<0.0001; b) rs=0.803, p<0.0001. BLADE DW images demonstrated less artifacts on overall but needed longer scanning time compared to SS EPI DWI.

CONCLUSION
BLADE DWI and SS EPI DWI lead to comparable ADC values in parotid gland tumors. Although acquisition time with BLADE DWI is longer, the sequence is less susceptible to artifacts and can be recommended in patients with metal dental hardware.

KEY WORDS: Parotid glands, neoplasm, DWI

Paper 259 Starting at 4:26 PM, Ending at 4:31 PM
Case of Bilateral Submandibular Gland Mucoceles

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Rochester, MN

PURPOSE
To describe the first known reported case of bilateral submandibular gland mucoceles.

CASE REPORT
A 42-year-old male noticed a painless right neck mass while shaving. It did not change appreciably in size over 2 months’ time, despite treatment with warm compresses and empiric amoxicillin therapy. He had no other symptoms or signs other than the palpable mass, including no odynophagia, dyspnea, trismus, or dysphonia. He had had no recent upper respiratory tract infection. On physical exam, he had a soft, mobile mass in the right submandibular region. The left submandibular region was normal on physical examination. The patient underwent elective transoral excision of the right-sided submandibular mass and submandibular gland, without complication. Histopathology revealed extravasated mucin forming a cystic mass consistent with a mucocele. The smaller, left-sided mass also is presumed to represent a mucocele and is being observed.

IMAGING FINDINGS
A CT scan with IV contrast showed circumscribed, fluid-density, cystic masses intimately associated with the bilateral submandibular glands, appearing to arise from them. The right-sided cystic mass was significantly larger, at 5x6 cm, while the left-sided mass measured 2x3 cm. The lesions were identical in imaging appearance other than size. There were no surrounding inflammatory changes. The sublingual glands and sublingual space were normal. The parotid glands were normal. No sialolithiasis was evident. There was no lymphadenopathy.
SUMMARY
Although common in the minor salivary glands, mucocele is very uncommon in the major salivary glands. In particular, only approximately 12 cases of unilateral submandibular mucocele have been described in the medical literature. We report the very unusual case of a patient with presumed bilateral submandibular gland mucoceles.

KEY WORDS: Submandibular gland, mucocele

Paper 260 Starting at 4:31 PM, Ending at 4:36 PM
Expansion of Miragel Scleral Buckle as a Late Onset Complication

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Miami, FL

PURPOSE
To show a patient with past history of Miragel scleral buckle for retinal detachment which presented as an enlarging orbital mass due to hydrophilic expansion as a late onset complication.

CASE REPORT
The patient is an 89-year-old male who underwent a right scleral buckle with a Miragel implant 15 years prior to presentation for a right retinal detachment. The patient complained of an enlarging right orbital mass with progressive pain, redness, tearing and discomfort over a 2-month period.

IMAGING FINDINGS
The patient underwent a CT of the orbits with contrast which showed deformity of the right globe. There is a large soft tissue mass with pockets of air surrounding the anterior right globe in the preseptal space without retrobulbar extension. There mass contains a focal dystrophic calcification superiorly. There is inflammatory change surrounding the mass. There are curvilinear densities in the lateral aspect of the deformed right globe consistent with chronic choroidal detachments.

SUMMARY
The case demonstrates an example of a late complication of the Miragel scleral buckle presenting as an orbital mass. The Miragel implant is composed of hydrogel which is a hydrophilic material and therefore permeable to water. It initially was developed due to a lower risk of infection with minimal early complications and the ability to absorb and release water-soluble substances such as antibiotics. However long-term complications relating to swelling of the implant were identified. The Miragel implant complications secondary to swelling were found to occur years after the procedure leading to limitation of ocular motility, diplopia, ocular pain and inflammation. The swollen scleral buckle can present as an orbital mass simulating an orbital tumor. The treatment is removal which is difficult due to fragmentation of the friable material and complications include dehiscence of the scleral bed, vitreous hemorrhage and vision loss. We are presenting a patient with long-term complication of swelling of the hydrophilic Miragel scleral buckle presenting as an orbital mass 15 years after the surgery.

KEY WORDS: Miragel scleral buckle, orbital mass, retinal detachment surgery
Paper 261 Starting at 4:36 PM, Ending at 4:41 PM

Optic Nerve Choristoma: Case Report of a Rare Entity

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Henry Ford Hospital
Detroit, MI

PURPOSE

Choristomas of the optic nerve are rare lesions composed of adipose tissue and smooth muscle with few reported cases in literature. This case report will demonstrate the clinical presentation and characteristic MR imaging findings of a unilateral choristoma and discuss differential diagnosis of fat-containing optic nerve lesions.

CASE REPORT

A 44-year-old male presented with progressive blurring of vision in his left eye over 3 years. On visual field testing he was found to have depression of his left temporal hemifield. Fundoscopy revealed a smaller left-sided optic disk and pallor of the left neuroretinal rim corresponding to the visual field defect. MR imaging subsequently was performed including T1-weighted fat-suppressed pre and post Gd-DTPA contrast, T2-weighted fast spin-echo and conventional short-T1 inversion-recovery (STIR) sequences.

IMAGING FINDINGS

The MR imaging demonstrated a rounded lesion perfectly circumscribing the proximal intraorbital portion of the left optic nerve. The lesion was hyperintense on T1-weighted images, demonstrated uniform signal loss on all fat-suppression sequences and did not demonstrate any enhancement postcontrast administration (Figure 1). Choristomas are rare lesions composed of proliferation of normal mature tissue at an abnormal location which have been reported in various parts of the body. In the case of optic nerve choristomas of which there are only a handful of papers outlining imaging characteristics and even fewer with pathologic correlates, adipose tissue and smooth muscle cells are seen to proliferate into the optic nerve sheath complex and are associated with progressive visual loss. On neuroimaging, the differential diagnosis for a fat-containing optic nerve lesion would include a lipid-laden meningioma or a lipoma. Given the circumferential involvement of the optic nerve and lack of enhancement neither of these was favored.

Figure 1A. Axial STIR sequence demonstrates fat intensity lesion within optic nerve sheath in postbulbar segment of left optic nerve (arrow). Figure 1B. Coronal postcontrast suppressed image demonstrates no evidence of enhancement in perfectly circumferential lesion.

SUMMARY

We present a case report of clinical findings and characteristic MR imaging features consistent with a choristoma of the optic nerve, an exceedingly rare entity.

KEY WORDS: Choristoma, optic nerve

Paper 262 Starting at 4:41 PM, Ending at 4:46 PM

Cervical Kaposiform Hemangioendothelioma: Clinical-Radiologic Correlation, the Essence of Diagnosis

Alomari, A. I. · Mulliken, J. B.
Children’s Hospital Boston
Boston, MA

PURPOSE

To demonstrate the imaging and clinical findings of kaposiform hemangioendothelioma (KHE); an uncommon locally aggressive tumor commonly misdiagnosed as a vascular malformation or hemangioma.

CASE REPORT

A 9-month-old male was referred to our hospital with the diagnosis of congenital “hemangioma of the neck with a cystic component” and thrombocytopenia. The lesion had been partially resected; the histopathology was interpreted as “cystic hygroma”. The lesion subsequently enlarged and multiple dark purple spots appeared (Figure 1). The infant was started on systemic corticosteroid and given platelets transfusions without benefit. Our clinical impression and imaging interpretation was highly suggestive of KHE. Corticosteroid and platelets replacement were discontinued and the infant was treated with vincristine for 1 year. The platelet count gradually improved to 150,000-280,000 cell/μL and the lesion stabilized, then began to regress.
**IMAGING FINDINGS**

MR imaging study showed an infiltrative hyperintense right cervical lesion involving the parotid, posterior triangle, parapharyngeal and masticator spaces (Figure 2, axial 2-weighted imaging with fat saturation). The subcutaneous fat demonstrated reticular stranding and thickening (curved arrows). A large cystic component containing a large clot was noted (straight arrows); very likely representing a lymphatic macrocyst. While the cystic component was similar to the commonly encountered lymphatic anomalies of the neck, the infiltrative component with cutaneous and hematologic abnormalities are not associated with macrocystic lymphatic malformations.

**SUMMARY**

Despite the biopsy diagnosis, the clinical-radiologic correlation established the correct diagnosis of kaposiform hemangioendothelioma with Kasabach-Merritt phenomenon. Abnormal lymphatic spaces are often seen in KHE specimens.

**KEY WORDS:** Kaposiform hemangioendothelioma, lymphatic malformation

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**Tuesday Afternoon**

**3:30 PM – 5:00 PM**

**Ballroom A**

(26c) Spine: Interventions and Pain Management

(Scientific Papers 263 – 273)

See also Parallel Sessions

(26a) Adult Brain: Cerebrovascular Occlusive Diseases I

(26b) Heat & Neck: Orbit, Face and Salivary Glands

(26d) Socioeconomics and Brain Anatomy

Moderators: Paul E. Kim, MD

Jeffrey A. Stone, MD

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**Paper 263 Starting at 3:30 PM, Ending at 3:38 PM**

**Percutaneous Vertebral Augmentation in Traumatic Injuries: Kyphoplasty with Two-Step Cement Injection to Seal Off Cortical Bone Defects**

De Simone, A.· Bruzzese, G.· Buono, G.· Sicignano, C.· Delehaye, L.· Apolito, R.

‘Ospedale San Giovanni Bosco - ASL Napoli 1, Napoli, ITALY, ‘Ospedale San Paolo - ASL Napoli 1, Napoli, ITALY

**PURPOSE**

Recently, percutaneous vertebral augmentation with vertebroplasty or kyphoplasty has achieved a high degree of popularity and the volume and rate of procedures are steadily increasing. Although osteoporotic and neoplastic vertebral body fractures usually are regarded as the main indication to vertebral augmentation, kyphoplasty can be a safe, effective and durable treatment also in neurologically intact patients with Magerl type A traumatic injuries who are candidates to nonsurgical treatment. At our institution, which is mainly an emergency hospital, patients are customarily offered the option between kyphoplasty and traditional triad of prolonged bed rest, external bracing and analgesia when harboring suitable lesions of the thoracolumbar spine. As cortical bone usually is violated in traumatic fractures and is not competent anymore to contain injected cement within vertebral body boundaries, we use a modified technique aimed to forestall cement leakage. In brief, we add an intermediate procedural step to dam up osseous defects by small amounts of cement spread out in a sealing-film fashion around the inflatable balloon-like bone tamp which is the distinguishing feature of kyphoplasty. Our technique and results are reported here.

**MATERIALS & METHODS**

From June 2005 to November 2008, 41 hospitalized subjects (age: 18-85 years; M: 23, F: 18) agreed to undergo kyphoplasty because of a traumatic injury involving the spine from T5 through L5. Standard technique was modified as follows. Once the cavity within the vertebral body had been remodelled, the balloon-like bone tamp was temporarily removed. Then, a small amount of doughy cement was injected. Thereafter, the balloon was reinserted and inflated to spread out cement as a sealing film. In case a comminuted fracture presented irregular gaps, cavity lining was performed in an incremental fashion, beginning in the anterior portion and, then, going posteriorly.

**RESULTS**

Mobilization on the second post-op day was obtained in all cases, provided that no other injury kept the patient bedridden. All subjects reported immediate pain relief. No clinical complications occurred. Radiographic improvement was only slight or moderate.

**CONCLUSION**

Conservative therapy of vertebral body fractures is neither benign nor risk-free as the term seems to imply and its complications are well documented, while vertebral augmentation can produce immediate improvement in a patient’s quality of life. Presently, such considerations hold true for osteoporotic and neoplastic lesions, but several attempts are underway to broaden the use of vertebral augmentation to traumatic injuries too. In this latter regard, our series is the
largest one so far reported and confirms that kyphoplasty can be safely and effectively performed also after trauma. In conclusion, appropriate patient selection and careful injection technique must be implemented for vertebral augmentation to fulfill the promise it seems to hold in traumatic vertebral body compression fractures.

REFERENCES

KEY WORDS: Percutaneous vertebral augmentation, spine injury, kyphoplasty

Paper 264 Starting at 3:38 PM, Ending at 3:46 PM
MR Variables as Predictors of Outcome in Patients with Osteoporotic Vertebral Compression Fractures

Rao, D.1 · Jarvik, J. G.1 · Comstock, B. A.1 · Wilison, D. J.2 · Yi, A.1 · Stout, L.1 · Kallmes, D. F.3
1University of Washington, Seattle, WA, 2Oxford University, Oxford, UNITED KINGDOM, 3Mayo Clinic, Rochester, MN

PURPOSE
MR imaging frequently is used to select patients for vertebral augmentation. We sought to determine which MR variables were associated with outcome among subjects enrolled in a randomized trial of vertebroplasty.

MATERIALS & METHODS
We report on the MR imaging of 131 subjects enrolled in the INvestigational Vertebroplasty Efficacy and Safety Trial (INVEST), a prospective, randomized, blinded multicenter, international trial comparing vertebroplasty to a “control intervention,” that simulates vertebroplasty but without the use of polymethylmethacrylate (PMMA). Our primary outcomes were the 1 month 24-point Roland Scale and an 11-point pain numerical rating scale, rating the average pain in the past 24 hours. At least two readers independently evaluated the MR imaging of enrolled subjects using a standardized reporting form. One reader (JGJ) reviewed all images and provided the final reading in cases of disagreement. We report on the degree of marrow edema, the presence of an intravertebral cleft and the degree of compression. We performed univariate and multivariable linear regression to determine if there was an association between these imaging variables and outcome.

RESULTS
To date, we have analyzed imaging data from 59 subjects, 32 assigned to vertebroplasty and 27 assigned to the control intervention. Eleven of 59(19%) had intravertebral clefts, 11/59(20%) had extensive vertebral flattening (actual or near vertebra plana), and 50/59(85%) had partial or diffuse marrow edema. Of these three variables, only extensive vertebral flattening was associated with outcome in subjects who underwent vertebroplasty, with subjects who had severe flattening having worse pain (beta=0.43, p=0.014) and Roland scores (beta=0.38, p=0.02) at 1 month. This association was not present in subjects not assigned to vertebroplasty.

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Baseline Roland Scale</th>
<th>Baseline Pain Scale</th>
<th>Mean (SD)</th>
<th>Mean (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline Roland Scale</td>
<td>17.3 (3.60)</td>
<td>11.4 (6.3)</td>
<td>7.0 (2.1)</td>
<td>3.9 (2.7)</td>
</tr>
<tr>
<td>Intravertebral cleft</td>
<td>17.6 (3.5)</td>
<td>11.3 (6.4)</td>
<td>6.8 (2.1)</td>
<td>3.6 (2.8)</td>
</tr>
<tr>
<td>Severe vertebral flattening</td>
<td>17.5 (3.7)</td>
<td>10.4 (6.4)</td>
<td>7.0 (1.9)</td>
<td>3.5 (2.7)</td>
</tr>
<tr>
<td>No severe vertebral flattening</td>
<td>16.2 (3.9)</td>
<td>11.8 (6.4)</td>
<td>7.2 (1.8)</td>
<td>4.8 (2.5)</td>
</tr>
<tr>
<td>Intravertebral cleft</td>
<td>17.3 (3.3)</td>
<td>15.3 (4.5)</td>
<td>6.3 (2.5)</td>
<td>5.2 (2.6)</td>
</tr>
<tr>
<td>No definite marrow edema</td>
<td>17.7 (4.9)</td>
<td>11.5 (8.5)</td>
<td>6.2 (1.7)</td>
<td>2.2 (2.5)</td>
</tr>
</tbody>
</table>

CONCLUSION
The degree of vertebral body flattening is a potentially important predictor of poor outcome following vertebroplasty for patients with osteoporotic compression fractures. Intravertebral clefts and degree of marrow edema were not associated with outcome.

KEY WORDS: Vertebroplasty, MRI, outcomes

Paper 265 Starting at 3:46 PM, Ending at 3:54 PM
Involvement of the Pedicle in Osteoporotic Compression Fractures

Ishiyama, M. · Fuwa, S. · Numaguchi, Y. · Kobayashi, N. · Saida, Y.
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Tokyo, JAPAN

PURPOSE
It is sometimes difficult to differentiate osteoporotic vertebral compression fractures from malignant compression fractures. MR imaging is known to be useful in differentiating the two. Pedicle involvement has been considered specific for malignant tumors. The aim of this study is to evaluate the prevalence and feature of pedicle involvement in painful osteoporotic compression fractures to determine if this finding is truly specific to malignancy.

MATERIALS & METHODS
We retrospectively reviewed MR imaging and CT of 200 consecutive patients who underwent percutaneous vertebroplasty for painful osteoporotic compression fractures. There were 140 patients (225 vertebrae, mean age 77 years) with osteoporotic fractures and 12 patients (19 vertebrae, mean age 61 years) with malignant fractures. Three radiologists evaluated the signal changes (T1-weighted, STIR, and contrast enhancement) on MR imaging by consensus. Pedicle involvement was defined as two of three sequences showing abnormal signal change. The CT findings of the pedicle including fracture and sclerotic change also were evaluated. The diagnosis of osteoporotic or metastatic compression fracture was made primarily by patient history and clinical findings, but biopsy was performed when malignancy was suspected.

RESULTS
Of the 225 vertebrae of osteoporotic fractures and 19 vertebrae of malignant fractures, pedicle involvement was seen in 144 (64%) and 16 (84.2%) vertebrae, respectively, and there was no statistically significant difference (p=0.065). Among osteoporotic fractures (n=225), 85 vertebrae (41.3%)
showed signal changes in both T1-weighted imaging and STIR and diffuse contrast enhancement of the pedicle. Positive pedicle involvement in osteoporotic fractures was seen in 84 (77%) of 109 vertebrae with acute and subacute fractures (shorter than 3 months) and 60 (51.7%) of 116 vertebrae with chronic fractures (longer than 4 months), and this was statistically significant (P < 0.001). Among 144 osteoporotic vertebrae which showed pedicle involvement on MR imaging, 45 (31%) vertebrae showed pedicle fractures and 55 (38.2%) showed sclerotic change on CT.

**CONCLUSION**
Abnormal signal intensity on MR in the pedicle is a frequent finding in osteoporotic compression fractures, especially in acute and subacute fractures. The differentiation of osteoporotic from malignant fractures may be difficult using only this sign. Pedicle fracture is not an uncommon finding in osteoporotic compression fractures.

**KEY WORDS:** Pedicle of the spine, osteoporotic compression fractures, metastatic spinal tumor

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**Paper 266 Starting at 3:54 PM, Ending at 4:02 PM**

**Reduction of Endplate Fracture after Vertebral Compression Fracture Restores Prefracture Disk Mechanics**

Renner, S. M.1 · Dimitriadis, A.1,2 · Havey, R. M.1 · McIntosh, B.1 · Voronov, L. I.1 · Carson, C.1 · Ty, D.1 · Patwardhan, A. G.1,2

1Edward Hines Jr. VA Hospital, Hines, IL, 2Loyola University Medical Center, Maywood, IL, 3Spine Wave, Inc., Shelton, CT

**PURPOSE**
Recent studies suggest endplate fracture incurred during vertebral compression fracture (VCF) alters adjacent intervertebral disk mechanics due to increased nucleus volume, and this altered disk behavior is a risk factor for adjacent VCF. This study tested the hypothesis that reduction of endplate fracture after VCF will restore prefracture disk mechanics.

**MATERIALS & METHODS**
Six thoraco-lumbar spine segments (T10-L2, T12-L4, or L1-L5 age:72.2±6.4years) were tested. A void was created under the upper endplate of the middle vertebra. The specimen was compressed via follower load until the weakened endplate fractured. The specimen then was compressed to create a VCF. The endplate fracture was reduced, as observed radiographically, using StaXx® FX Structural Kyphoplasty device (Spine Wave, Inc., Shelton, CT). Specimens were tested in flexion-extension (±6Nm) under 400N preload before and after endplate and vertebral fractures and after endplate fracture reduction. Lateral radiographs under 400N preload were used to measure amount of vertebral depression. Intradiskal pressure (IDP) in flexion-extension was recorded above and below the fractured body and normalized so pressure in neutral position was taken to zero.

**RESULTS**
Vertebral height after endplate and vertebral fracture was significantly less than intact (73.3±9.1% and 67.7±6.0% of intact respectively, p<0.001) (Figure 1A). Vertebral height was increased significantly after endplate fracture reduction (p<0.001), but remained significantly less than intact (89.0±9.3% of intact, p=0.014) (Figure 1B). After endplate and vertebral fractures the disk with endplate fracture developed significantly less IDP at maximum flexion than intact (32±19% and 34±7.8% of intact respectively, p<0.004). After endplate fracture reduction IDP during flexion was restored to near-intact levels (73±47%, p=0.162), and significantly improved compared to after endplate and VCF (p<0.03). The IDP during flexion was not significantly affected in the disk below the fractured vertebra where the endplates remained intact throughout testing.

**CONCLUSION**
The inability of the disk with a damaged endplate to develop normal intradiskal pressure during flexion previously was shown to increase loading of the anterior vertebral cortex, possibly increasing the risk of subsequent VCF. The significant endplate fracture restoration by StaXx FX, although not to the intact condition, improved the disk’s load sharing ability. Further studies are needed to investigate whether endplate fracture reduction will alleviate the risk of adjacent fractures.

**KEY WORDS:** Vertebral compression fracture, endplate deformity reduction, interventional procedure

![Figure 1: Lateral radiograph A) after endplate fracture (note migration of pressure sensor within endplate deformity), and B) after fracture reduction (note return of pressure sensor to initial position).](image-url)
Paper 267 Starting at 4:02 PM, Ending at 4:10 PM
Early Clinical Experience with Confidence Vertebral Body Augmentation System: Occurrence and Degree of Cement Leakage as Compared to Kyphoplasty

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PURPOSE
Vertebroplasty is known for its high leakage rate compared to kyphoplasty. High-viscosity cements were shown to significantly enhance uniformity of cement filling and decrease incidence of leakage. New products for vertebral body augmentation, such as Confidence, therefore are providing high-viscosity cements with precision delivery systems. In this study, the incidence and pattern of cement leakage with Confidence was compared to that of standard kyphoplasty.

MATERIALS & METHODS
Postoperative radiographs of patients treated with either kyphoplasty or Confidence were analyzed for cement leakage, using a stringent and thorough 4-point scale (none; mild; moderate; severe). When leakage was observed, location of cement leakage was also recorded as: diskal, venous (paravertebral), or epidural.

RESULTS
Sixty-five patients with 105 treated levels were included in this retrospective review. There were 47 kyphoplasty vs 58 Confidence levels, which ranged from T5 to L5. The average vertebral collapse reached 26% in the Confidence group vs 25% in the kyphoplasty group. There was no or minimal/mild leakage in 91% Confidence and 85% Kyphon cases. Severe leakage was only reported in one (2%) Confidence and one (2%) Kyphon cases. In both cases, the severe leakage was found in the disk space. No significant leakage was noticed that required any surgical intervention.

CONCLUSION
The high-viscosity Confidence cement results in comparable leakage rate to kyphoplasty. Highly viscous cement may increase the safety of standard vertebroplasty techniques.

KEY WORDS: Vertebroplasty, kyphoplasty, leakage

Paper 268 Starting at 4:10 PM, Ending at 4:18 PM
Comparing the Use of a Curved Nitinol Bone Catheter versus a Standard Trocar in Percutaneous Vertebroplasty

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PURPOSE
Vertebral compression fractures (VCF), most commonly associated with osteoporosis, typically involve the collapse and compression of the vertebral body with associated wedge deformity. Percutaneous vertebroplasty (PV) with a standard straight trocar is one method to treat this condition. Recently, curved nitinol bone catheters have been introduced for PV, allowing the operator to reposition the curved catheter in the vertebral body as needed to improve filling of the vertebral body; however, no study has evaluated the effectiveness and safety of the procedure. Evaluate the potential benefits or disadvantages of using a curved bone catheter, as compared to a standard straight trocar, by analyzing postoperative radiographs for quality of fracture filling, and the effect of repositioning the curved trocar on the quality of fracture filling.

MATERIALS & METHODS
Patient Selection: Patients selected underwent percutaneous vertebroplasty with PMMA at the University of Virginia Hospital, between March 2007 and May 2008. In total, 40 cases were studied; 20 consecutive cases involved the use of a curved-tip catheter, 20 consecutive cases during the same time period involved the use of a straight trocar. Quality of Fracture Filling: Post-op AP and lateral radiographs from all 40 cases were de-identified, and randomized. These images were then analyzed to assess the quality of vertebral body filling, as adequate or inadequate, in three planes: AP, transverse, and cranial-caudal. Adequate was defined as 2/3 of the vertebral body filled in that plane. Instances of repositioning the curved catheter within the vertebral body were recorded. Cement Leakage: Presence of extravasation was based on evaluation of the images and upon the description of extravasation, both clinically and nonclinically relevant, within each patient’s chart.

RESULTS
Quality of Filling: In total, 120 planes of filling were assessed as either adequate or inadequate in terms of fill quality. (adequate, inadequate) Transverse: curved (17, 3), straight (9, 11). Cranial-Caudal: curved (13, 7), straight (12, 8). AP: curved (18, 2), straight (13, 7). Total: curved (48, 12), straight (34, 26). Catheter Repositioning: Of the 20 curved-tipped procedures analyzed, five were completed with repositioning of the catheter with PMMA deployment at multiple sites within the vertebral body. Cement Leakage: Of the 20 curved-catheter cases analyzed, three instances of cement extravasation were documented, with no apparent clinical consequences. Of the 20 straight-catheter cases analyzed, two instances of cement extravasation were documented, with no apparent clinical consequences.

CONCLUSION
In reference to quality of vertebral body filling, those performed with the curved bone catheter were deemed superior to the straight catheter not only in total quality, but also in each of the three designated planes. Additionally, in five out of 20 cases, repositioning of the curved bone catheter allowed PMMA to be applied to parts of the vertebral body that could not have been reached with a standard single pedicle approach such as cavities near the superior endplate. On a final note, there were no complications related to the use of the curved catheter and there was no statistical difference in the presence of extravasation between the curved and straight catheters.

KEY WORDS: Vertebroplasty
PURPOSE
Percutaneous sacroplasty (PS) has been described as a safe and effective treatment for sacral insufficiency fractures. However, few reports have described PS for sacral metastatic tumors. The purpose of this exhibit is to present the detail PS techniques under CT, fluoroscopic guidance or their combination, including “long axis technique”.

MATERIALS & METHODS
A total of 29 PS sessions in 23 patients were reviewed. A total of 18 patients had metastatic tumors and five patients had unilateral or bilateral insufficiency fracture of the sacrum. There were 14 female and nine male patients with an average age of 63.2 years (range, 44-82 years). For planning of PS, careful evaluation of MR imaging and three-dimensional CT (3D CT) with multiplanar reconstructions (MPR) was performed. Using 11 gauge bone biopsy needles, cement injection was performed under the guidance of CT or biplane real-time fluoroscopy.

RESULTS
All procedures were performed without significant complications. The mean volume of cement injected into a unilateral sacral fracture was 4.5 ml. All patients tolerated the procedure well under intravenous sedation. Good cement distribution was obtained in most patients who were performed under fluoroscopic guidance but suboptimal cement volume was noted in some patients who underwent PS under CT guidance. The mean VAS score was 7.4 before PS and became 2.6 after PS. Over the course of the follow-up period, almost all patients experienced substantial pain relief that persisted over a 3-month period and beyond. There was no significant leakage of cement in the neural foramina in most of the patients. However, approximately one third of patients with sacral metastases developed transient pain or numbness in the lower extremity immediately after the procedure. After steroid administration for a few days, the symptoms disappeared in most of these patients.

CONCLUSION
Although PS is similar to vertebroplasty, there are several technical differences. Notably, it is difficult to locate the needle tip because the curved ventral cortical margin of the sacrum is difficult to see under fluoroscopic guidance. Another concern is the risk of cement migration into the sacral nerve root canal or into the sacral spinal canal. We believe PS can be performed safely under fluoroscopic guidance in most cases but careful preprocedural evaluation of MR and 3D CT is mandatory. In the cases of sacral metastases, transient pain or numbness in the lower extremity may develop although they usually disappear with short-term steroid therapy.

KEY WORDS: Sacroplasty, complication
procedure pain level was 0.8/10. In the 1-month interval reviewed, there were no physician or patient requests for repeat procedures due to failed therapeutic efficacy.

CONCLUSION
When interventionalists take an active role in the management of patients referred for treatment of degenerative spine disease, patient care is significantly improved. In addition to averting therapeutic procedures ordered incorrectly for administrative reasons, interventionalist experience combined with on-site CT imaging helps refine diagnoses and further optimize therapy.

KEY WORDS: Spine, intervention, pain

Paper 271 Starting at 4:34 PM, Ending at 4:42 PM
How Bad Is Your Pain? Depends How You Ask
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PURPOSE
Pain severity is a commonly measured outcome for spine intervention procedures. Little if any data are available regarding how reported pain severity correlates with exactly how the pain question is posed. We report variation in reported pain as a function of various, specific pain questions.

MATERIALS & METHODS
Eight consecutive patients presenting for potential vertebroplasty were asked to rate their pain on a 0-10 scale. Patients were asked to report their best and worst pain over the prior day and week, both at rest and with activity, and also were asked to rate with their average pain over the prior day. Mean severities were compared.

RESULTS
Mean reported pain severity ranged from 2.0+/−1.3 for “best pain at rest prior week” to 8.7+/−1.6 for “worst pain with activity prior week.” Average pain over the prior day was 5.2+/−2.7 (p=.01 versus “worst pain” and p=.02 versus “best pain”).

CONCLUSION
Depending on how pain questions are asked, reported mean values for the same group of patients can vary 6-7 points on an 11-point scale. Apparent treatment effects from spine intervention procedures might be biased toward efficacy if different questions about pain are posed before versus after the intervention. Research studies using pain severity as an outcome should carefully specify exactly how pain questions are posed.

KEY WORDS: Vertebroplasty, spine intervention

Paper 272 Starting at 4:42 PM, Ending at 4:50 PM
CT-Guided Percutaneous Rupture of Lumbar Facet Synovial Cysts for Treatment of Radicular Symptoms
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PURPOSE
Synovial cysts of the lumbar spine facet joints are an uncommon cause of radiculopathy. Incidence of synovial cysts is estimated at 0.6% of symptomatic patients(1), and 1.6% of pathologic specimens on retrospective review(2). Degeneration of facet joints and trauma are the most common etiologies of cyst formation. The most common symptoms are painful radiculopathy (85%), neurogenic single-root or multiroot claudication (44%), sensory loss (43%), and motor weakness (27%(3). Treatment options range from no treatment to surgical removal. Percutaneous treatments include CT-guided rupture, the treatment currently employed at our institution. The purpose of this presentation is to present a case series of treated patients.

MATERIALS & METHODS
Diagnosis was made by MR imaging in the majority of cases, CT in a minority and CT myelogram in one patient. All patients had radicular symptoms corresponding to the location of the cyst. Prone positioning and moderate sedation was used with intermittent CT fluoroscopy guidance to gain direct needle access to the facet joint. Continuity of facet joint to cyst was confirmed with dilute contrast. Cysts then were ruptured with a forceful injection of contrast. Cyst rupture was confirmed by the presence of contrast material in the epidural space, and by the loss of resistance to injection. After rupture, 80 mg of DepoMedrol was injected. Assessment of clinical outcome was by review of electronic medical records.

RESULTS
Eighty procedures were attempted in 59 patients. There were 46 females and 13 males, ages 40-87 years (average 64). Twelve patients had repeated procedures at a single facet; one patient had six procedures over 2 years. Injected facets included; 38 L4-5 (64%), 13 L5-S1 (22%), 6 L3-4 (10%), and 2 L2-3 (3%). Cyst rupture was technically successful 72 out of 80 attempts (90%). Complications included respiratory depression related to sedation in one patient, and temporary (< 24 hours) increase in local pain in two patients. No long-term complications occurred. Clinical follow up ranged from 1 week to 3 years. Forty (50%) procedures resulted in complete resolution of radicular symptoms. Pain recurred in 13 of 40 cases where complete resolution of radicular pain was achieved. Recurrence of pain ranged from 2 weeks to 3 years. Twenty procedures resulted in partial relief of radicular symptoms (including one case where cyst rupture was unsuccessful). Eleven procedures (14%) resulted in no change in clinical symptoms; including four cases with technically successful cyst rupture. Eighteen patients (30%) have had lumbar spine surgery for their symptoms. Clinical outcome data were unavailable in nine.
CONCLUSION

Percutaneous rupture of lumbar spine facet synovial cysts is technically successful 90% of the time, and can lead to resolution of symptoms in a significant number of patients. Future directions for research include identifying cyst characteristics predictive of successful pain relief, and more detailed and systematic clinical follow up.

REFERENCES

1. Eyster EF, Scott WR. Neurosurg 1989;24(1):112-115

KEY WORDS: Lumbar spine, Facet synovial cyst

Tuesday Afternoon

3:30 PM – 5:00 PM
Room 1

(26d) Socioeconomics and Brain Anatomy
(Scientific Papers 274 – 284)

See also Parallel Sessions
(26a) Adult Brain: Cerebrovascular Occlusive Diseases I
(26b) Head & Neck: Orbit, Face and Salivary Glands
(26c) Spine: Interventions and Pain Management

Moderators: Jerry G. Jarvik, MD
            William D. Keyes, MD
Contrast-Induced Nephropathy in Patients with Chronic Kidney Disease Undergoing CT Imaging

Kuhn, M. J.¹ · Chen, K.² · Chen, N.³ · Heiken, J. P.⁴ · Soulez, G.⁴ · Sahani, D. V.⁺ · Essig, M.⁷
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PURPOSE

Patients undergoing contrast-enhanced computed tomography (CECT) of the brain and spine or head and neck may possess multiple risk factors for the development of contrast-induced nephropathy (CIN), including advanced age, chronic kidney disease (CKD), diabetes mellitus (DM), or previous exposure to contrast agents or nephrotoxic chemotherapy agents. We evaluated the incidence of CIN in patients with chronic kidney disease (CKD) undergoing CECT after administration of a low- or an iso-osmolar contrast medium (CM).

MATERIALS & METHODS

Four hundred one patients with CKD (SCR ≥1.5 mg/dL and/or CrCl ≤60 mL/min) were randomized to receive either iopamidol-370 (IOP=202 patients) or iodixanol-320 (IODIX=199 patients) for their CECT procedure. Contrast medium was injected IV at 4 mL/sec followed by a 20 mL saline flush injected at the same rate. Of the 401 enrolled patients, 153 patients received 40g iodine (gI); the remaining patients received at least 65 mL. Contrast-induced nephropathy was defined as a SCR rise ≥25% from baseline at 48-72 hours after CM exposure.

RESULTS

Total iodine exposure was significantly higher in patients receiving iopamidol-370 due to the higher concentration of this agent. No other significant differences were seen in patient demographics or risk factors between the two groups. Baseline SCR level were similar (IOP 1.52±0.36 mg/dL vs. IODIX 1.49±0.38; p=0.48). No case of acute renal dysfunction was observed, and CIN rates were similar in the two groups (IOP=10 patients; IODIX=9 patients; p=1.0). Mean postdose SCR changes were comparable (IOP 0.03±0.22 mg/dL vs. IODIX 0.04±0.25 mg/dL, p=0.62). Similar findings were seen in patients (IOP=140, IODIX=144) with both CKD and DM (CIN in seven patients each group, p=1.0) or patients with greater baseline renal dysfunction (baseline SCR ≥2.0 mg/dL and/or baseline CrCl ≤40 mL/min; IOP=53, IODIX=40); CIN in two patients in each group, p=1.0). In a multivariate logistic regression analysis, no single risk factor predicted CIN, however hydration proved marginally beneficial (p=0.042).

CONCLUSION

The rate of CIN in large group of patients with CKD and other risk factors undergoing CECT is approximately 5%. Proper hydration is recommended in patients at risk for developing this complication. Both iopamidol-370 and iodixanol-320 may be used safety for CECT in patients at risk for the development of CIN.
CONCLUSION
The importance of NIH funding for neuro-oncology research in the United States and the world is increasing, and thus is likely to be highly sensitive to changes in NIH funding levels. Articles published by radiologists contribute substantially to this total, although less than several other specialties.

KEY WORDS: Funding, NIH, tumor

Paper 276 Starting at 3:46 PM, Ending at 3:54 PM
C1-2 Punctures: Below Standard of Care......Not!

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PURPOSE
Recently the performance of C1-2 punctures for cervical myelography was challenged in a medicolegal proceeding as being below the standard of care. We sought to examine current neuroradiologic practices and opinions on the technique.

MATERIALS & METHODS
An 11-question survey was sent to 120 program directors of neuroradiology via email links regarding cervical myelography via a C1-2 puncture. Repetitive reminders were sent over a 2-month period before data were finalized.

RESULTS
Eighty-five of 120 (71%) surveys were returned. Twelve of 85 (14.3%) of institutions had not performed a C1-2 puncture in the previous year. Thirty-two of 85 (38%) had performed five or more in the same period. Seventy-nine percent (54/68 responding) favor a lumbar approach to cervical myelography with 6% (4/68) having a predilection for a C1-2 puncture. Ninety-five percent (76/80 responding) felt that performing a C1-2 puncture for cervical myelography reflected the standard of care. Every institution but one had previously performed a C1-2 puncture. Ninety-three percent (78/84) of programs currently preferred method for performance at most institutions, continues to be practiced and is considered within standard of care by most neuroradiology programs across the country.

KEY WORDS: Cervical spine, techniques, medicolegal

Paper 277 Starting at 3:54 PM, Ending at 4:02 PM
Second Opinion Consultations in Neuroradiology: Assessment of Value

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PURPOSE
Review of studies from outside institutions is common at tertiary care facilities where subspecialty-trained radiologists are more prevalent. The value of “second reads” of neuroradiologic studies has not been established for routine consultations. The purpose of this study was to determine the degree to which changes in the interpretations of outside neuroimaging studies occurred over a one-year period, including both clinically important and nonclinically significant modifications. We hypothesized that there would be added benefit to patient care by having university-based subspecialists review such scans.

MATERIALS & METHODS
During a 12-month period, we reviewed all the cross-sectional neuroimaging studies (MRI and CT) that originated from outside the university hospital that had been reinterpreted by subspecialty-trained university neuroradiologists. The in-house second opinion reports were compared with the interpretations from the outside facilities (when available) by two independent radiologists who formed a consensus opinion on discrepancies. We used a grading system that included scores: 1: no discrepancy, 2: discrepancy in detection but not clinically significant, 3: discrepancy in interpretation but not clinically significant, 4: significant discrepancy in detection (e.g., a missed tumor), and 5: significant discrepancy in interpretation (e.g., calling a tumor an infection).

RESULTS
The total number of studies reviewed was 3315. One thousand ninety-six studies were excluded because the outside institution’s radiologic reports were not available. The discrepancy between in-house and outside institution reports were graded as 1 in 2054/2225 (92.3%), grade 2 in 39/2225 (1.8%), grade 3 in 5/2225 (0.1%), grade 4 in 99/2225 (4.4%), and grade 5 in 40/2225 (1.8%). Twelve reports had both grade 4 and grade 5 discrepancies. The correct diagnosis to confirm the accuracy of the 135 grade 4 and 5 significant differences was available in 83 cases (35 by pathology, 30 by clinical impression/laboratory results, and 18 by follow-up scans). Of the 83 discrepancies, 66 (79.5%) were accurately reported by the academic site and 17 (20.5%) were correct by the original outside interpretation.

CONCLUSION
Review of outside studies at a university facility by subspecialty-trained neuroradiologists resulted in significant changes that might affect patient care in 6.2% of cases, predominantly involving detection of significant abnormalities (4.4%). These second looks reveal error rates that exceed those acceptable for night hawk and emergency room radiologic services in the literature and justify a policy of reinterpretation of outside examinations.

KEY WORDS: Quality assurance, medical economics
Effectiveness of Nonphysician Personnel Assessing the Appropriateness of Outpatient Neuroradiologic Imaging Studies in a Radiology Benefit Management Program (HealthHelp)

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1Jefferson Medical College and Thomas Jefferson University Hospital, Philadelphia, PA, 2University of Washington Medical Center, Seattle, WA, 3HealthHelp, LLC, Houston, TX

PURPOSE
To provide an indirect measure of the effectiveness of nonphysician personnel assessing the appropriateness of high-cost, outpatient neuroradiologic imaging studies in a utilization management program.

MATERIALS & METHODS
HealthHelp is a radiology benefit management (RBM) company that provides utilization management (UM) programs. Using evidence-based rule sets derived from multiple sources, high-cost, outpatient neuroradiologic imaging studies are screened for appropriateness in the UM program by a customer service representative (CSR) (Level I). If a study fails to meet appropriateness criteria but is not withdrawn by the provider, further screening is performed by a registered nurse (Level II). If the study still does not meet appropriateness criteria, final evaluation is provided by a subspecialty academic neuroradiologist (Level III). The radiologist can approve the study based upon the electronic chart evaluation, or call the provider for further information. All information, as well as the evidence-based rule sets, is managed on a web-based program maintained by the RBM company. In this project, studies requiring a telephone consultation between the radiologist and provider were considered to be optimally screened at Levels I and II. Studies approved by the radiologist simply after electronic chart evaluation were considered to require expertise beyond the gathering and application of relevant clinical information to evidence based rule sets (i.e., beyond Levels I and II). The percentage of studies requiring a telephone consultation by the radiologist was considered to be an indirect measure of the effectiveness of nonphysician personnel in the UM screening process. The project period encompassed a 1-year interval (July 2006 - June 2007) and included the participation of seven neuroradiologists working in an academic radiology department. Data for neuroradiologic studies also were compared to the results for studies reviewed by the department of radiology as a whole (27 participating subspecialty radiologists). Patients were enrolled in national and local health plans.

RESULTS
A total of 2297 neuroradiologic imaging studies were reviewed. Of these, 1940 studies (84%) required a telephone consultation between the radiologist and the provider, since the determination of appropriateness could not be made based upon the available clinical information and the evidence-based rule sets. Only 357 studies (16%) were approved simply after review of the available clinical information. These results were similar to those of the radiology department as a whole (5497 studies reviewed; 4854 (88%) required a telephone consultation; only 643 (12%) approved after electronic chart review).

CONCLUSION
Based upon the cases reviewed by our radiologists, nonphysician personnel were sending mostly accurately screened cases for physician review. Only a small percentage of cases reaching Level III (subspecialty radiologist) were felt to be appropriate based upon the same information available to Levels I and II (CSR and nurse). These results also provide indirect evidence of the usefulness of evidence-based rule sets for radiology benefit management companies.

KEY WORDS: Utilization management, screening, neuroradiology

Academic Neuroradiologists Participating in a Radiology Peer-to-Peer Ordering Support Program: Implications for Radiology Benefit Management Programs

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1Jefferson Medical College and Thomas Jefferson University Hospital, Philadelphia, PA, 2University of Washington Medical Center, Seattle, WA, 3HealthHelp, LLC, Houston, TX

PURPOSE
To assess the variability in procedure withdrawal rates among academic neuroradiologists participating in a radiology peer-to-peer ordering support program.

MATERIALS & METHODS
Using evidence-based rule sets derived from multiple sources, a utilization management (UM) program directed by a radiology benefit management (RBM) company (HealthHelp) provides real-time decision support for physicians ordering high-cost, outpatient imaging studies on patients enrolled in national and local health plans. After initial consultation between RBM personnel and the referring physician’s staff, studies not meeting appropriateness criteria are referred to an academic neuroradiologist for further review. The radiologist can approve the study based upon the electronic chart evaluation, or call the referring physician for further information. After discussion between the ordering physician/designee and radiologist, possible outcomes for the study include: (1) approved by consensus, (2) approved, but no consensus, (3) study not performed by consensus, and (4) study changed by consensus. Eight neuroradiologists participated in this project. We analyzed the variability among the radiologists in the withdrawal rates [outcomes (3) and (4)] of outpatient, neuroradiologic CT and MR studies ordered during a 19-month interval (January 1, 2007 - July 30, 2008) and reviewed in the UM program. We also assessed the utilization of the “no consensus” option [outcome (2)].

RESULTS
A total of 4309 neuroradiologic studies were reviewed; the mean number of studies reviewed per radiologist was 539 (median, 600; range, 122-759). A total of 231 studies were changed by consensus, and 511 studies were not performed by consensus. The mean rate of procedures changed per radiologist was 5.4% (median, 5.0%; range, 3.3-10.7%). The mean rate of procedures not performed per radiologist was
11.9% (median, 10.8%; range, 7.1-19.9%). A total of 43 studies had no consensus reached; the mean rate per radiologist was 1.0% (median, 1.1%; range, 0.1-4.4%).

**CONCLUSION**

Despite the utilization of evidence-based rule sets, withdrawal rates among the participating radiologists varied by as much as a factor of three. Although differences in case mix may explain some of these results, it is likely that each radiologist’s unique medical experiences and personal biases contribute to this degree of variability. The “no consensus” option was rarely used; conflict avoidance is a possible explanation. Our results have implications for radiology benefit management programs.

**KEY WORDS:** Utilization management, withdrawal rates, variability

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**Paper 280 Starting at 4:18 PM, Ending at 4:26 PM**

**Quantification and Correlation of Normal Cerebrospinal Fluid Flow at the Craniovertebral Junction and of the Cerebral Aqueduct**

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1University Hospital, Ann Arbor, MI, 2University of Michigan Medical School, Ann Arbor, MI

**PURPOSE**

To establish a baseline of normal cerebrospinal fluid (CSF) flow rates at the craniovertebral junction (CVJ) and within the Sylvian aqueduct and also to explore the relationships between these values to establish baselines that might be compared to similar measurements in disease states to potentially identify patients who might benefit from interventions (e.g., Chiari malformation patients).

**MATERIALS & METHODS**

Eleven normal healthy volunteers were evaluated on a 3 T MR scanner. Two-phase contrast scans were performed perpendicular to the CVJ and aqueduct. Scan parameters were: TR/TE = min (typically 12.3 ms/8.2 ms), 2 averages, 10° flip angle, 250 x 180 mm FOV, 252 x 179 matrix, 4 mm sections, SENSE factor = 2, with flow compensation. Fifteen temporal phases during the cardiac cycle were acquired using a peripheral-pulse oxygenation signal for retrospective triggering. Scans were repeated with the neck in flexion, extension and neutral positions for a total of six phase contrast scans. Velocity encoding was optimized per individual (2 to 6 cm/sec). The data were analyzed with postprocessing software and the CSF flow velocities were calculated at the CVJ and aqueduct for all three neck position scans. A statistical model of the CSF flow dynamics was developed in order to evaluate differences in location and position using a Cosinor transformation (a mathematical analysis technique that can better model variables governed by cyclical rhythms).

**RESULTS**

Average velocity of CSF flow (cm/sec) in the aqueduct was $0.90 \pm 0.42$ in the neutral (N) position, $0.96 \pm 0.35$ in the flexed (F) position and $0.97 \pm 0.57$ in the extended (E) position. Flow at the CVJ was $1.09 \pm 0.20$ (N), $1.13 \pm 0.15$ (F) and $1.07 \pm 0.12$ (E). The Cosinor model fit our healthy volunteer data well as it allows for modeling cyclical data (such as pulsatile to and fro CSF motion) with a linear model. A significant difference in CSF flow between the aqueduct and the CVJ was seen. There were no significant differences in the CSF flow related to the position of the neck.

**CONCLUSION**

Normative data generated correlating CSF flow in the Sylvian aqueduct and at the CVJ might be used to assess the significance of abnormal CSF flow in these regions which may be present in conditions such as Chiari malformations where such CSF flow changes might help identify patients who could respond to surgery.

**KEY WORDS:** Cerebrospinal fluid, MRI, phase contrast imaging

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**Paper 281 Starting at 4:26 PM, Ending at 4:34 PM**

**Anatomy of the Nuclei and Fascicular Segments of the Mecencephalic and Pontine Cranial Nerves Using High Field 9.4 T MR Imaging. Correlation of Postmortem Images and Histopathology Specimens**

Miranda, M. A.1 · Massey, L. A.1 · Parkes, H. G.1 · So, P.1 · Holton, J.1 · Thornton, J. S.1 · Holton, J. S.2 · Mancini, L.1 · Al-Helli, O.1 · Cheshire, P.1 · Strand, K.1 · Lees, A. J.1 · Revesz, T.1 · Yousry, T. A.1

1Institute of Neurology, London, UNITED KINGDOM, 2Imperial College School of Medicine, London, UNITED KINGDOM

**PURPOSE**

To describe the normal anatomy of the nuclei and fascicular segment of the III, IV, V, VI, VII, and IX cranial nerves, boundaries, relationships and segments using high field 9.4T MR imaging (MRI) of post mortem pathologic specimens. The MRI identification of these structures remains elusive using conventional 1.5/3T clinical scanners. To correlate the high field MRI features with those found in histopathologic sections of the same specimens.

**MATERIALS & METHODS**

Formalin fixed specimens were obtained from the QS Brain Bank, IoN, UCL, London. Half-brain sections of the midbrain from controls with no neurologic disease were imaged using a Varian 9.4T system with a multimodal MR protocol including high resolution T2WI (in plane resolution 49-125 microns) in the transverse axis, and volumetric acquisitions. The samples then were stained for myelin and with a Nissl stain and histological sections compared with axial MR images at approximately the same level.
RESULTS
The nuclei of the III CN (main and accessory) were clearly identified. The fibers of its fascicular segment crossing the base of the red nuclei and leaving the interpeduncular fossa were seen and described for the first time using MRI. The nucleus of the IV CN and its relationship with the MLF is seen in different planes using 3D volumetric reconstructions. The fibers of the fascicular segment of this nerve crossing the midline and decussating on the superior medullary velum were identified. The mesencephalic and pontine nucleus of the V CN, the nucleus of the VI, VII and VIII CNs also were seen. The local relationships of this nuclei and the identification of vital histological structures such as the facial colliculus and their relationships with major tracts such as the fornix, the mamillothalamic, corticospinal, spinothalamic and spino cerebellar tracts, the medial and lateral lemnisci, and other ascending and descending tracts was achieved. All structures identified with MRI then were compared with the histological sections of the same sample at the same level, confirming the nature of these structures.

CONCLUSION
The identification of nuclei and fascicular segment of the mesencephalic and pontine CN previously has been elusive to conventional MRI. High-resolution sequences using a high field MRI of pathological specimens at 9.4T enables detailed visualization of midbrain structures with greater clarity than conventional MRI at 1.5/3T. The identification of the nuclei and fascicular segment of mesencephalic and pontine cranial nerves was for the first time achieved in this modality.

KEY WORDS: Cranial nerve, high field 9.4 T, nuclei

Paper 282 Starting at 4:34 PM, Ending at 4:42 PM
Perioperative Changes in Diffusion Tensor Imaging in Patients with Brain Tumors
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PURPOSE
Diffusion tensor imaging (DTI) is a relatively new MR imaging technique that allows the unprecedented in vivo evaluation of white matter tracts. Diffusion tensor imaging is proving to be useful in a range of applications, such as planning brain tumor surgery, glioma grading and image-modulated radiation therapy. Despite its growing role, the effects of surgery and associated perioperative medications (steroids, anesthesia and antibiotics) on DTI metrics are not well understood. The peritumoral region is an important area that may harbor infiltrating tumor cells in gliomas, and is also vulnerable to mechanical and ischemic injury during surgery. We hypothesize that the peritumoral region is susceptible to DTI-measurable changes after surgery.

MATERIALS & METHODS
Preoperative (preop) and postoperative (postop) MR images with DTI were performed in 17 patients (10 men, 7 women; median age 51 years) treated for brain tumors. The group included 8 gliomas, 7 metastases, and 2 radiation necrosis cases. Data analysis was performed using DTI Studio, and fractional anisotropy (FA), relative anisotropy (RA) and apparent diffusion coefficient (ADC) maps were constructed. Regions-of-interest (ROIs) were drawn on axial slices in corresponding areas on the preop and postop scans: tumor; peritumoral area; normal-appearing white matter (NAWM) immediately adjacent to the tumor; NAWM on a standard slice at the level of the internal capsule, thalamus and corpus callosum; posterior limb of the internal capsule; brachium pontis; corticospinal tract in the pons. The structures were analyzed separately for genu/splenium and left/right sides when appropriate, yielding a total of 13 brain areas examined. Global peak FA and ADC values were generated using AFNI. Statistical analysis was performed using both exact and asymptotic Wilcoxon signed-rank tests. Correlations between DTI metrics and glioma grade were examined using Kruskal-Wallis tests, repeated measures analysis of variance, and multivariate analysis of variance.

RESULTS
The peritumoral DTI metrics showed a significant change between the preop and postop scans, with increasing FA and RA and decreasing ADC (p<0.02). No difference was found between the glioma and nonglioma groups. No correlation was observed between the peritumoral metrics and glioma grade. The other 12 regions analyzed did not show any significant change after surgery (p>0.13). The global peak measurements also did not demonstrate any significant change (p>0.31).

CONCLUSION
Diffusion tensor imaging demonstrates changes in the peritumoral region immediately after surgery. The exact etiology of these changes remains uncertain. These changes occur in both glioma and nonglioma patients, although only the peritumoral region of gliomas reflects edema and infiltrating...
tumor cells. For gliomas, researchers have proposed using advanced MR imaging such as DTI to taper the peritumoral margins from the standard 2-3 margin, in order to construct individualized radiation therapy plans that would spare more normal brain and allow modest dose escalations. The implications of DTI on the optimal timing to perform the planning MR images after surgery are not well understood. Further research is necessary to better characterize the DTI changes and potential therapeutic implications.

**Key Words**: Diffusion tensor imaging, brain tumor, surgery

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**Paper 283 Starting at 4:42 PM, Ending at 4:50 PM**

**Anatomy of the Posterior Inferior Cerebellar Artery: Relevance for Cervical Myelography Through C1-C2 Punctures**

Brinjikji, W. · Cloft, H. · Kallmes, D. F.
Mayo Clinic
Rochester, MN

**Purpose**

Lateral C1-C2 puncture has been shown to be associated with a number of complications including damage of aberrant posterior inferior cerebellar arteries (PICA). We propose to determine the frequency of cases in which PICA originates or descends below C1, thus posing a risk to the patient undergoing lateral C1-C2 puncture.

**Materials & Methods**

Two hundred eleven consecutive patients who received bilateral or unilateral vertebral angiography for evaluation of intracranial vascular lesions were included in this study. In total, 346 vertebral arteries were studied. Lateral vertebral angiograms were analyzed for the location of the origin of PICA and the inferior-most portion of PICA relative to three anatomical regions. Region 1 was defined as the region above the foramen magnum. Region 2 was defined as the region below the foramen magnum but above the margin of the inferior cortex on the posterior arch of C1 as it crosses the spinal canal. Region 3 was defined as the region below the margin of the inferior cortex on the posterior arch of C1 as it crosses the spinal canal.

**Results**

In two of 346 angiograms (0.6%) and two of 211 patients (0.9%), the caudal loop of PICA descended to region 3, below C1. PICA did not originate in region 3 in any cases.

**Conclusion**

In approximately 1% of patients in our study, the caudal loop of PICA descended into a region that would have placed it at risk for damage during C1-C2 puncture. Our study suggests that it may be important for radiologists to assess the arterial anatomy of the C1-C2 region prior to performing C1-C2 puncture.

**Key Words**: Cervical myelography, posterior inferior cerebellar artery, anatomy

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**Paper 284 Starting at 4:50 PM, Ending at 4:58 PM**

**Fetal Origin of the Posterior Cerebral Artery Produces Asymmetry on MR Perfusion Imaging**

Wentland, A. L. · Rowley, H. A. · Vigen, K. K. · Field, A. S.
University of Wisconsin School of Medicine & Public Health
Madison, WI

**Purpose**

A fetal-type posterior cerebral artery (PCA) is a common anatomical variation of the circle of Willis in which the PCA originates from the internal carotid instead of the basilar artery, thus becoming part of the anterior cerebral circulation. Patients with a unilateral fetal PCA may demonstrate left-right asymmetry on cerebral perfusion images, as some of the commonly measured parameters are sensitive to macrovascular transit effects. Our aim was to investigate effects of a fetal PCA on MR perfusion imaging with attention to asymmetry that could mimic disease.

**Materials & Methods**

We retrospectively reviewed MRA and MR perfusion images of 37 patients (M/F 15/22; age-range/mean=19-87/60.4 years) presenting for contrast-enhanced MRI/MRA of the head/neck. Patients with imaging evidence of cerebrovascular disease were excluded. Noncontrast 3D time-of-flight MRA of the circle of Willis was acquired along with dynamic susceptibility contrast imaging using a gradient-echo echo-planar sequence [TR/TE/flip/BW = 1500-2000ms/45-60ms/60°/62.5kHz, FOV = 24cm, matrix 128x64 (1.5T) or 128x128 (3T), slice thickness/spacing = 7mm/2mm]. After gamma-variate fitting of tissue concentration-time curves and deconvolution with an automatically detected arterial input function (AIF), maps of relative cerebral blood volume and flow (rCBV, rCBF), mean transit time (MTT), and time to peak of the deconvolved tissue residue function (Tmax) were generated. The first-moment of the tissue concentration-time curve (FMT) without deconvolution also was mapped. A perfusion asymmetry index (AI) was computed for each parameter from regions of interest placed to the left and right of midline in the posterior circulation territory [AI=(L-R)/(L+R)]. A vascular AI (vAI) was computed from time-of-flight MRA images by scoring the relative diameters of posterior communicating (PCom) and P1 segments (1:No PCom, 2:PCom<P1, 3:PCom=P1, 4:PCom>P1, 5:No P1; vAI=L-R). Perfusion and vascular AIs were compared by Spearman’s rank correlation.

**Results**

Asymmetry of FMT (Figure) and Tmax (not shown) increased as PCA origin unilaterally became more “fetal” (Spearman’s rho=0.75 and 0.72, respectively; p<1x10-6 for each). Specifically, FMT and Tmax were shorter in fetal relative to standard PCA territories. No significant asymmetry was observed for rCBF, rCBV or MTT.
CONCLUSION
Unilateral fetal-type PCA produces substantial left-right asymmetry on MR perfusion imaging when parameters sensitive to macrovascular transit effects are employed (e.g., first-moment of tissue concentration-time curves). Knowledge of this normal variation is critical for the radiologist performing MR perfusion imaging, as the asymmetry may mimic cerebrovascular pathology.

KEY WORDS: Perfusion, normal variants, posterior cerebral artery

Tuesday Afternoon
3:30 PM - 5:00 PM
Room 11

(27) ELC Workshop: PowerPoint for Scientific Presentations and Exhibits

(28) (ASPNR) Pediatric Stroke Self-Assessment Module (SAM)**
Audience Response Plus (AR+)*
*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.
**Programming is currently under review for qualifications as a Self Assessment Module (SAM) through the American Board of Radiology (ABR)

(286) Understanding Pediatric Stroke - The Broadening Clinical Spectrum
— Gabrielle deVeber, MD

(287) Intracranial Aneurysms in Children
— Todd Abruzzo, MD

(288) Pediatric Cerebral Venous Thrombosis: Imaging Spectrum and Diagnostic Challenges
— James L. Leach, MD

Moderator: Blaise V. Jones, MD

Understanding Pediatric Stroke - The Broadening Clinical Spectrum
Gabrielle deVeber, MD

LEARNING OBJECTIVES
Upon completion of this presentation, participants will be able to:
1) Review the pathophysiology of vaso-occlusive pediatric stroke including the importance of arteriopathy.
2) Discuss the urgency of rapid specific imaging for acute stroke in children and nature and timing of optimal vascular imaging in children with stroke.
3) Cite the limitations of transposing adult treatment data for stroke to children and need for participation in developing safe evidence-based treatments.
Consequently, unusual or severe forms of vessel wall damage to hemodynamic wear and tear is very brief. Adverse outcomes are frequent. Acute mortality and neurological morbidity in over 50% drives the need for acute neuroprotective, neurosurgical treatments. Additionally recurrence in children with AIS, and thrombus propagation in neonates and children with CSVT occur. Close radiographic monitoring and urgent initiation of anti-coagulation or antiplatelet therapies is required to optimize outcomes. No randomized controlled trials assessing treatment are available in children with ischemic stroke. The data necessary for development of these trials is now being obtained in national registries and multi-centre consecutive cohort studies. Meanwhile several consensus-based treatment guidelines have become available.

References

Intracranial Aneurysms in Children

Todd Abruzzo, MD

Learning Objectives
Upon completion of this presentation, participants will be able to:
1) Discuss clinical spectrum of pediatric intracranial arterial aneurysms (IAAs).
2) Explain role of diagnostic imaging in evaluation of pediatric IAAs.
3) Summarize current approaches to management of pediatric IAAs.

Presentation Summary
In the first two decades of life, the annual incidence of hemorrhagic stroke due to aneurysmal disease is estimated to be in the range of 1 to 3 cases per million individuals (1, 2). This accounts for 10% to 15% of all pediatric hemorrhagic stroke (1, 2). In contrast, the estimated annual incidence of aneurysmal subarachnoid hemorrhage in adults (20 years of age) is 40 to 100 cases per million individuals (3). The relative rarity of intracranial arterial aneurysms (IAAs) in children has been attributed to the cumulative damage model of IAA pathogenesis. In children, modifiable vascular risk factors such as smoking generally are absent and the duration of exposure to hemodynamic wear and tear is very brief. Consequently, unusual or severe forms of vessel wall damage such as trauma and infection play a greater role. Also in children with IAA, major comorbidities frequently amplify hemodynamic wear and tear, or compromise the intrinsic tensile strength of vascular tissues. A meaningful understanding of aneurysmal disease in childhood is possible through analysis of clinical vascular phenotypes, and by comparison to adult phenotypes for context. Classification of clinical vascular phenotypes first demands recognition of fundamentally different pathogenetic IAA subtypes: traumatic, infectious, neoplastic, autoimmune (vasculitis), vasculopathic (related to an intrinsic defect in vessel wall biology), idiopathic (no identifiable cause), and those related to exaggerated hemodynamic stress. Further differentiation of clinical vascular phenotypes by age and family history reveals important aspects of intracranial aneurysmal disease in childhood. This overview will critically examine each of the clinical vascular phenotypes seen during the first two decades of life, and contrast them with the more common vascular phenotype seen in adults. Clinical vascular phenotypes will be based on patient specific (sex, age, family history, lesion multiplicity, frequency of posthemorrhagic vasospasm and rate of de novo lesion formation) and lesion specific traits (size, location, morphology, mode of clinical presentation, growth rate and rupture potential) derived from our research as well as from the literature (4, 5). The role of different diagnostic imaging modalities in the evaluation of children with suspected IAA disease also will be discussed. In addition, evolving acute and long-term management strategies will be presented.

References

Pediatric Cerebral Venous Thrombosis: Imaging Spectrum and Diagnostic Challenges

James L. Leach, MD

Learning Objectives
Upon completion of this presentation, participants will be able to:
1) Analyze the appearance of pediatric cerebral sinovenous thrombosis and parenchymal sequelae on neuroimaging examinations.
2) Explain the pathophysiology of pediatric cerebral sinovenous thrombosis and its relationship to the variable imaging findings in this condition.
PRESENTATION SUMMARY

Cerebral sinovenous thrombosis (CSVT, thrombosis of the cerebral veins and/or dural sinuses) is a serious neurologic disease with clinical and brain parenchymal findings that are potentially reversible with prompt diagnosis and therapy. Cerebral sinovenous thrombosis is an uncommon disorder with an estimated annual incidence of between 2 - 7 cases/1,000,000 in the general population (1). Unlike arterial stroke, CSVT most often affects young adults and children. Clinical presentation of CSVT is variable, can be subtle, and varies with age of presentation. Parenchymal changes may be secondary to vasogenic edema, cytotoxic edema, or intracranial hemorrhage with a primary underlying mechanism of increased venous pressure (2). Imaging plays a critical role in diagnosis. Multiple modalities are useful including: Head Ultrasound, CT, CT venography, MR imaging, and MR venographic techniques. This presentation will review the imaging manifestations and pathophysiology of CSVT in children and demonstrate common pitfalls and challenges in imaging diagnosis. Relative utility of the range of diagnostic imaging modalities is described.

REFERENCES


Tuesday Afternoon

5:00 PM – 6:30 PM
Ballroom B

(29) (ASHNR) The Face: Anatomy, Function and Pathology

(289) Facial Paresis & Paralysis: Imaging Approach to the Facial Nerve
— C. Douglas Phillips, MD

(290) Imaging the Trigeminal Nerve: From Skin to Brainstem
— Timothy L. Larson, MD

(291) Facial Pain and Sinusitis: Anatomy, Inflammation and Functional Endoscopic Sinonasal Surgery
— Richard H. Wiggins, III, MD

Moderator: Richard H. Wiggins, III, MD

Facial Paresis & Paralysis: Imaging Approach to the Facial Nerve
C. Douglas Phillips, MD

LEARNING OBJECTIVES

Upon completion of this presentation, participants will be able to:
1) Discuss the location-specific approach to facial nerve paresis.
2) Identify the appropriate imaging study for evaluation of each segment.
3) Differentiate common pathology for each segment of the facial nerve.

PRESENTATION SUMMARY

This presentation will discuss the anatomic segments of the facial nerve, beginning with the facial nerve nuclei and motor contribution to the facial nerve from the motor cortex, and then follow the course of the facial nerve to the extracranial segment. An imaging approach to pathology of each segment will be presented, with expected clinical symptomatology, and appropriate choice of an imaging study for each segment.

Imaging the Trigeminal Nerve: From Skin to Brainstem
Timothy L. Larson, MD

LEARNING OBJECTIVES

Upon completion of this presentation, participants will be able to:
1) Detect pathology involving the trigeminal nerve based on a understanding of the nerves anatomic distribution.
2) Recommend a succinct differential diagnosis for pathology involving the nerve based on the segment of the trigeminal nerve involved.
3) Identify key connections between CN5 and CN7 that might lead to disease involving both.

PRESENTATION SUMMARY

Detecting pathology involving the trigeminal nerve (CN5) requires a detailed understanding of the nerves anatomical distribution. The normal anatomy of CN5 will be covered in detail to include the associated skull base and facial foramina. Imaging suggestion to optimize visualization of the nerve will be illustrated. Pathology resulting in CN5 symptoms will be discussed based on a segmental approach (brainstem, cisternal segment, Meckel cave, cavernous sinus, peripheral branches, etc.). Succinct differential diagnosis will be offered based on the segment involved. Finally, important pathways for perineural spread will be described with an emphasis on connections between the trigeminal and facial nerves.
The sinonasal polyposis pattern can cause obstruction at the sphenoethmoidal recess, with inflammatory changes seen in the middle meatus region. In this pattern, the ethmoid and frontal sinuses are clear, while the maxillary sinus is partially or completely opacified. Infundibular lesions include mucosal thickening, polyps, debris and diseased Haller’s cells. The nasofrontal duct pattern similarly causes opacification of the frontal sinus, while the ethmoid and maxillary sinuses are clear. This is usually secondary to a focal lesion at the nasofrontal duct orifice at the ostiomeatal unit. These lesions would include polyps, mucosal thickening, debris and diseased agger nasi cells. The ostiomeatal unit pattern is the most described pattern of paranasal inflammatory disease, secondary to a lesion in the middle meatus region. This has been described as secondary to chronic inflammation of the middle and anterior ethmoid air cells, with following secondary infection of the maxillary and frontal sinuses. There is usually opacification of the middle meatus region of the lateral wall of the nose in addition to ipsilateral acute or chronic maxillary, frontal and ethmoid disease. The sphenoethmoidal recess pattern occurs with obstruction at the sphenoethmoidal recess, with inflammatory changes seen in the sphenoid, and occasionally the ipsilateral posterior ethmoid sinuses. The sinonasal polyposis pattern can cause a combination of the patterns previously described, with multiple inflammatory polyps filling the bilateral sinuses and nasal vault. CT findings in these cases include nondependent soft tissue polypoid masses within the nasal vault, an enlarged maxillary infundibulum, expansile changes to the ethmoid air cells, and attenuation of the ethmoid trabeculae and nasal septum. The sporadic pattern demonstrates inflammatory changes randomly through the paranasal sinuses without relationship to the drainage patterns. This is most commonly seen with chronic and mild changes throughout the paranasal sinuses without air-fluid levels or focal sinus opacification. Postoperative changes, mucoceles and mucous retention cysts are included in this pattern group.
the diagnosis of intracranial diseases. Emphasis will be on the specific use of DWI as a problem-solving tool to make the correct diagnosis and to narrow down the differential diagnosis. A brief discussion on the basic physics and imaging protocol of DWI will be presented. Several distinct clinical entities of the brain with characteristic DWI abnormality will be covered including pyogenic abscess, epidermoid, diffuse axonal injury, herpes encephalitis, post-ictal changes, and toxic leukoencephalopathy. Potential pitfalls and limitations of DWI will be discussed.

REFERENCES:

Diffusion in the Spine: Techniques and Applications
Karl Olaf Lovblad, MD, PhD

LEARNING OBJECTIVES
Upon completion of this presentation, participants will be able to:
1) Identify basics of spinal diffusion MR imaging.
2) Discuss applications of spinal diffusion MR imaging.
3) Cite insights into limitations of spinal diffusion MR imaging.
4) Define future potential applications of spinal diffusion MRI.

PRESENTATION SUMMARY
Diffusion-weighted MR imaging (DWI) allows to detect and quantify alterations in tissue water content and has been applied with great success to the investigation of brain disease. Its main application has been cerebral ischemia. Its application to spinal pathologies has been restricted by a number of inherent limitations. Indeed, the spine susceptibility and pulsation artifacts represent an important problem that needs to be resolved, especially when echo-planar imaging (EPI) is used; when using EPI sequences, the adjunct use of parallel imaging techniques can help. Other imaging strategies such as line scan imaging or turbo-spin-echo imaging (HASTE) techniques have been used as well. When these inherent limitations have been resolved, it is possible to obtain diffusion images at various b values, with both DWI imaging sets with ADC maps as well as diffusion tensor images (DTI) with measures of fractional anisotropy. This allows application of the method to spinal cord ischemia as well as in the brain. As in the brain, in the acute phase of ischemia we observe a hyperintensity on the DWI sets and a decrease in the ADC. Spinal DTI should additionally allow us to better investigate patients with intramedullary processes, as well as diseases of the emerging nerve roots: in the spine itself we can thus measure reductions or increases in fractional anisotropy and perform reconstructions of the intraspinal tracts (tractography) which could help in the planning of spinal interventions. The use of 3T units can improve the signal to noise ratio needed for spinal diffusion imaging but will at the same time increase artifacts in the spine, making the gain relative. In conclusion, diffusion imaging now can be applied to the spinal cord with applications close to those in the brain with a few limitations still.

Neuroradiology in the 21st Century
Colin Studholme, PhD

Dr Studholme received his PhD in Medical Physics and Bio Physics in 1997 from the University of London. He earned his Postdoctorate in 1998-2000 at the Department of Radiology, Yale University Medical School, New Haven, CT, USA. Dr Studholme's current position is as an Associate Professor In Residence, Department of Radiology and Biomedical Imaging, University of California, San Francisco, CA.

LEARNING OBJECTIVES
Upon completion of this presentation, participants will be able to:
1) Review Spatial Transformations of DTI data.
2) Identify interpolation of DTI values.

PRESENTATION SUMMARY
This talk will review developments in computational approaches to diffusion tensor imaging (DTI) data processing and analysis. It will focus in particular on the problem of registering and spatially transforming DTI data for analysis with other modalities and for multisubject imaging studies.

Tuesday Afternoon
5:00 PM - 6:00 PM
Room 11

(31) ELC Lecture: Teaching Files Online and In-House

(295) Teaching Files Online and In-House — Adam E. Flanders, MD
**LEARNING OBJECTIVES**

Upon completion of this presentation, participants will be able to:

1. Differentiate between the various neoplasms of the pediatric posterior fossa.
2. State the acute presentation of several metabolic diseases presenting in childhood.
3. Analyze the differences between encephaloclastic and genetic congenital malformations.
4. Identify the differences between encephaloclastic and genetic congenital malformations.

**PRESENTATION SUMMARY**

A series of cases will be presented to test the knowledge of the attendees on a variety of clinical topics in imaging of the pediatric brain. Cases exemplifying normal and abnormal development, neoplasms, epilepsy, infectious disease, metabolic-based conditions (both inborn enzymatic deficiencies and acquired metabolic derangements), and complications of therapy will be presented, with audience participation and subsequent review.

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**Wednesday Morning**

**7:40 AM – 8:40 AM**

**Hall A**

(32) Maintenance of Certification (MOC) – Pediatric Brain & Head and Neck

Audience Response Plus (AR+)*

*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.

(296) Pediatric Brain

— Blaise V. Jones, MD

(297) Head & Neck

— Robert W. Dalley, MD

Moderator: Blaise V. Jones, MD

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**Pediatric Brain**

*Blaise V. Jones, MD*

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**Post-Therapeutic Brain: Effects of Surgically Based Therapies**

**Susan Chang, MD**

**Dr. Susan Chang is the Director of the Division of Neuro-Oncology at the University of California, San Francisco and the current President of the Society of Neuro-Oncology. Her training includes a residency in Internal Medicine and fellowships in Medical Oncology and Neuro-Oncology. In addition to developing novel and effective therapeutic strategies for adult patients with primary brain tumors, Dr. Chang’s research goals also include the evaluation of novel**
imaging techniques that may influence treatment selection for patients and assess response to therapy. Dr. Chang also trains students in the conduct of clinical trials and in the analysis and interpretation of clinical trial data.

**LEARNING OBJECTIVES**
Upon completion of this presentation, participants will be able to:
1. Review surgically based treatments for brain tumors.
2. Discuss the radiographic effects of surgically based therapies for brain tumors.

**PRESENTATION SUMMARY**
The two major objectives of this presentation are to review surgically-based treatments for brain tumors with a focus on malignant glioma and to discuss their radiographic effects. Surgical intervention of a glioma has several goals: 1) Provide a histologic diagnosis and also tissue samples for molecular and cytogenetic analysis; 2) Relieve mass effect and potentially improve symptoms and neurologic function; 3) Maximal safe removal of the tumor to improve survival (1). Radiation therapy and chemotherapy are standard treatments followed by maximal resection of a malignant glioma, however these tumors inevitably progress. There are several limitations to the use of radiation therapy at the time of progression, such as tolerance of surrounding brain, and in addition, resistance mechanisms and systemic side effects also limit chemotherapy use. There is a great advantage to the evaluation of surgically-based therapies for malignant glioma: tumors tend to recur locally, treatment is delivered directly to the tumor site and systemic effects are minimized. Several strategies include placement of chemotherapy impregnated biodegradable wafers, direct interstitial delivery either by injections or via convection-enhanced approaches using a pressure gradient, as well as surgical devices to deliver thermotherapy or radiotherapy (2-3). It is important to note that current efficacy evaluation of therapeutic modalities in malignant glioma rely either on duration of patient survival, or more commonly, on the durability of tumor control. The assessment of radiographic control has been the major response assessment utilized in early phase clinical trials. In 1990, Macdonald et al published an objective radiologically-based assessment based primarily on computed tomography (CT) and two-dimensional World Health Organization (WHO) oncologic response criteria using enhancing tumor area (the product of the maximal cross-sectional enhancing diameter) as the primary tumor measure (4). More recent experience has highlighted limitations to Macdonald’s criteria. It is well accepted that contrast enhancement which is used as a surrogate of “tumor burden” is nonspecific and can be seen in nontumor-related disease states such as postbrain tumor therapies such as surgical interventions (5). It is critical that prior treatment approaches be a part of the information provided to neuroradiologists when assessing serial MR imaging changes in patients with malignant glioma to assess for the status of the tumor. In this presentation we will review the central nervous system effects of surgically-based therapies.

**REFERENCES**
3. Rainov NG, Gorbatyuk K, Heidecke V. Clinical trials with intracerebral convection-enhanced delivery of targeted toxins in malignant glioma.

**Post-Therapeutic Brain: Radiation, Gamma Knife, Chemotherapy**

*Jason K. Rockhill, MD, PhD*

Dr. Rockhill completed medical and graduate training at the University of Illinois in Urbana, Illinois from where he received his MD and PhD in Biochemistry; then returned to his home state and completed his residency at the University of Washington in Radiation Oncology. He stayed on to take a position as Assistant Professor in both Radiation Oncology and Neurological Surgery.

**LEARNING OBJECTIVES**
Upon completion of this presentation, participants will be able to:
1. Identify the time course and characteristics for post radiation imaging changes from conventional fractionated radiotherapy and single fraction radiosurgery.
2. Compare how those changes may be modified through the use of concurrent or adjuvant chemotherapy or biological therapy.

**PRESENTATION SUMMARY**
Radiation and chemotherapy play a significant role in the treatment of many brain tumors both primary and secondary. The radiation effects on post-treatment imaging must take into account the dose, the dose distribution, and the dose per fraction. Furthermore, chemotherapy and biologic modifiers can alter the expected imaging changes both in terms of extent and time course. Since future therapeutic intervention is dependent on determining tumor progression versus treatment effect, this is one of the most significant challenges facing those who treat brain tumors.

**Post-Therapeutic Brain: DWI, PWI & MRS Recurrent Tumor vs. Therapeutic Effects**

*Marco Essig, MD*

**LEARNING OBJECTIVES**
Upon completion of this presentation, participants will be able to:
1. Identify the different aspects of therapy induced MRI findings.
2. Differentiate therapy induced changes from tumor recurrence by the use of modern MRI techniques.
2. Identify technical aspects of functional MRI techniques in brain tumor imaging.
PRESENTATION SUMMARY
In the past few years a number of advanced, nonenhanced and contrast-enhanced MR imaging techniques have been developed that provide new insights into the pathophysiology of brain tumors, mainly gliomas. These techniques include MR spectroscopy, perfusion MR imaging, dynamic contrast-enhanced MR imaging and diffusion tensor MR imaging. In the presentation we will analyze the application of those techniques in brain tumor assessment with focus on the posttherapeutic brain. Proton MR spectroscopy or spectroscopic imaging (CSI) is becoming a common clinical tool because it can add to the diagnostic accuracy of MR imaging and in the differential diagnostics of intracerebral tumors. The method provides thresholds for the metabolite ratios for the differentiation of tumor recurrence and therapy-induced tissue changes. Perfusion-weighted imaging in brain tumors has benefits for three major fields: Differential diagnosis, biopsy planning, and treatment monitoring. Since tumor specification is limited and sometimes conventional MR imaging cannot discriminate the tumor types and gradings, new methods like perfusion MR imaging play a more and more important role. The results of the available studies in literature, all with relatively limited patient numbers, indicate that DSC MR imaging proved to be useful in the posttherapeutic workup of gliomas, lymphomas and metastatic disease. The typical patterns of tumor recurrence and therapy-induced effects will be presented. Dynamic contrast-enhanced MR imaging (DCE MRI) is the acquisition of serial images before, during and after the administration of extracellular low molecular-weighted MR contrast media. The resulting signal intensity measurements of the tumor reflect a composite of tumor perfusion, vessel permeability, and the extravascular-extracellular space. In contrast to conventional (static postcontrast T1-weighted) enhanced MR imaging, which simply presents a snapshot of enhancement at one time point, DCE MR imaging permits a fuller depiction of the wash-in and wash-out contrast kinetics within tumors, and this provides insight into the nature of the bulk tissue properties on its microvascular level. With the strong demand in drug development the identification of biomarkers that can assess tumor microvascular properties noninvasive dynamic MR imaging is the method of choice to assess tumor response and to identify atypical tumor response findings. Diffusion-weighted MR imaging is used routinely in the assessment of cerebral infarction and infectious diseases. Both diffusion-weighted and diffusion tensor imaging also play an important role in the diagnostic work up and monitoring of patients with cerebral tumors. The method enables to present the infiltration pathways of tumors and the posttherapeutic changes.

Wednesday Morning
10:45 AM – 11:00 AM
Hall A

(34) ASNR Presidential Address

— Robert D. Zimmerman, MD, FACR,
ASNR President

Wednesday Morning
11:00 AM – 11:10 AM
Hall A

(35) ASNR Award Announcements

- Gold Medal Award
- Cornelius G. Dyke Memorial Award
- Honorary Member Award
- NER Foundation Outstanding Contributions in Research Award
- 2008 Outstanding Presentation Awards
- NER Foundation Scholar Award in Neuroradiology Research
- NER Foundation/Boston Scientific Fellowship in Cerebrovascular Disease Research Award
- Bayer Healthcare Pharmaceuticals/NER Foundation Fellowship in Basic Science Research Award
LEARNING OBJECTIVES
Upon completion of this presentation, participants will be able to:
1) Discuss the basic terminology and principles of imaging genetics
2) Define how neuroimaging is being employed to study the effects of genes affecting the central nervous system.

PRESENTATION SUMMARY
The advent of new “omics” technologies (genomics, proteomics and metabolomics) has ushered in a new era of biomedical discovery that is already impacting every field of medicine. With the rapid growth of the older population worldwide, there is great interest in applying these technologies, not only to diagnose and prevent disease, but also to enhance brain longevity and mental wellness. Nearly two-thirds of the approximately 30,000 genes in the human genome are related to brain function and up to half of the variance in age-related changes in cognition, brain volume and neuronal function appears to be genetically determined. Selected examples will be used to illustrate how neuroimaging is being employed to study the effects of genes, and how neurogenetics may, in turn, impact future neuroradiology research and practice.

Material from this lecture has been adapted from Petrella JR, Mattay VS, Doraiswamy PM, Radiology 2008; 246 (1):20-32.
Functional Imaging Techniques - Considerations for the Aging Population

Carolyn Cidis Meltzer, MD, FACR

LEARNING OBJECTIVES

Upon completion of this presentation, participants will be able to:

1. Better understand the role of functional molecular imaging techniques, particularly positron emission tomography (PET), in normal aging and dementia.
2. Critically evaluate the current state of evidence of new methods, including amyloid imaging.
3. Assess the current and potential future role of the neuroradiologist in evaluating normal aging and early dementia syndromes.

PRESENTATION SUMMARY

Developments in molecular and functional imaging coupled with the imperative caused by the aging of the population has created fertile ground for improved understanding of both normal aging and neurodegenerative processes. The public health and financial impact of Alzheimer’s disease (AD) in our aging society is enormous and increasing, making the imperative of early diagnostic and prognostic tools increasingly important. Reliable imaging biomarkers of normal aging and dementia, coupled with novel therapeutic agents, are needed to substantially alter the course of AD and enhance quality of late life.

REFERENCES


Imaging in Aging - A Clinical Perspective

Charles DiCarli, MD

LEARNING OBJECTIVES

Upon completion of this presentation, participants will be able to:

1. Specify changes in clinical brain images associated with advancing age and dementia.
2. Identify the utility of certain MRI sequences in the clinical assessment of dementia risk.
3. Explain how these sequences can be interpreted clinically to increase knowledge about subject risk for dementia.

PRESENTATION SUMMARY

Human brain aging is associated with a variety of structural changes that can be identified with MR imaging. Structural brain changes also accompany most degenerative disorders of aging. Degenerative research previously has emphasized quantitative neuroimaging approaches in order to understand the biology of brain aging and dementia. Results from research studies, however, are sufficiently robust as to be clinically relevant. In this presentation, I will quantitate structural brain changes associated with aging and dementia as a background for presenting newer information on the clinical relevance of these findings that emphasize the role of the radiologist in recognizing specific brain changes of diagnostic and prognostic significance to the older individual potentially suffering from a cognitive disorder.
Radiologic Evaluation of CSF Leaks

Patricia A. Hudgins, MD

LEARNING OBJECTIVES
Upon completion of this presentation, participants will be able to:
1) Review the risk factors, presenting signs, and potential complications of CSF leak.
2) Choose the appropriate and most accurate, efficient and cost-effective imaging examination to diagnose the site of leak.
3) Analyze the leak site, and identify associated complications so that surgical planning is facilitated.

PRESENTATION SUMMARY
A skull base defect increases risk for subsequent cerebrospinal fluid (CSF) leak and the associated complications of low-pressure headache, CSF oto or rhinorrhea, meningoencephalocele development, and ascending meningitis. Prior skull base or sinus surgery, closed head injury, congenital head and neck malformations, skull base neoplasms, and obesity are among risk factors for CSF leak. This comprehensive presentation will discuss the spectrum of CSF leak, including common presenting symptoms, prior risk factors, medical work up, role of imaging in detection and surgical repair planning, and the current demographics that have led to increased incidence.

Imaging Evaluation of Pediatric Hearing Loss

Caroline D. Robson, MB, ChB

LEARNING OBJECTIVES
Upon completion of this presentation, participants will be able to:
1) Distinguish the imaging appearance of the more frequently encountered temporal bone abnormalities associated with hearing loss.
2) Detect certain specific diagnoses that have characteristic imaging findings.
3) Cite certain genetic etiologies of hearing loss.

PRESENTATION SUMMARY
Pediatric hearing loss (HL) can be congenital or acquired. Approximately 50% of congenital HL is genetic and the rest are due to causes such as congenital infection, fetal ototoxic exposure and trauma. CT. CT is used to assess the anatomy of the temporal bone. MR Imaging. MR imaging is used to document fluid within the membranous labyrinth and to identify the cochlear and vestibular nerves. Abnormalities that can be seen with CT and MR imaging will be reviewed. Congenital Infections. Congenital CMV infection is a common cause of HL and has characteristic imaging findings such as intracranial calcifications, ventriculomegaly, polymicrogyria, parenchymal destruction, delayed myelination, white matter lesions and anterior temporal lobe cysts. Branchio-Oto-Renal Syndrome BORS. BORS is characterized by HL, branchial cleft anomalies, malformed auricles and kidneys. Characteristic CT findings are tapered basal turn of the cochlea and hypoplasia of middle and apical turns. Additional findings include hypoplasia of the middle ear cavity, ossicular malformations, EVA, anomalies of the semicircular canals (SCC), and cochlear nerve hypoplasia. Waardenburg Syndrome. Waardenburg syndrome (WS) is characterized by SNHL and pigmentary defects of the hair, skin and iris. CT sometimes shows absence of the posterior SCC, underdevelopment of the vestibule, EVA, narrowing of the internal auditory canal porus, and abnormalities of the modiolus. Pendred Syndrome and the EVA Syndrome. Pendred syndrome (PS) is characterized by severe SNHL and goiter. Pendred syndrome and isolated EVA are associated with SLC26A4 gene mutations. Imaging of the temporal bones commonly reveals incomplete cochlear partition and EVA. CHARGE Syndrome. (Coloboma, Heart disease, Atresia choanae, Retarded growth and development and/or CNS anomalies, Genital hypoplasia and Ear anomalies). CT demonstrates absence or hypoplasia of the SCC and vestibules, stenosis of the cochlear nerve apertures, hypoplasia of the apical cochlear turn, and abnormalities of the ossicles. X-linked Progressive Hearing Loss with Perilymphatic Gusher (XLMLH). XLMLH affects males and is characterized by profound MHL and congenital fixation of the stapes with perilymphatic otorrhea on attempted stapedectomy. CT reveals marked dilatation of the lateral internal auditory meati with a lack of internal cochlear septation/modiolus. Treacher Collins Syndrome. Treacher Collins syndrome (TCS) manifests as maxillary and mandibular hypoplasia, cleft lip/palate, and colobomas. Temporal bone abnormalities include atresia/stenosis of the external auditory canal and middle ear cavity and contents, flattening of the cochlea and malformation of the vestibule and SCC. Oculo-auriculo-vertebral Spectrum. Oculo-auriculo-vertebral spectrum (OAVS) have unilateral or bilateral abnormalities of first and
second pharyngeal arch derivatives, with asymmetric maxillary and/or mandibular hypoplasia. Oculo-auriculo-vertebral spectrum includes hemifacial microsomia (HFM) and Goldenhar syndrome (GS). CT reveals unilateral or bilateral stenosis or atresia of the external auditory meatus, hypoplasia or atresia of the middle ear space, ossicular malformation, and atresia or stenosis of the oval window.

Robin Sequence. Robin sequence is characterized by cleft palate, glossoptosis and feeding issues. Hearing loss is variable and usually conductive, often due to middle ear effusion. Ear malformations include abnormal stapes, small or dehiscent facial nerve, anomalies of the cochlea and SCC, and small internal auditory canals. Nonsyndromic Deafness. Congenital nonsyndromic hearing impairment is usually sensorineural. More than half of genetic cases of profound deafness are linked to a defect in GJB2 gene that encodes for Connexin 26. Abnormalities of the cochlea and EVA have been observed in a variable number of patients with Connexin 26 mutations.

SELECTED READINGS

ENT Symptoms Related to Craniovertebral Junction Pathology

Wendy R. K. Smoker, MS, MD, FACR

LEARNING OBJECTIVES
Upon completion of this presentation, participants will be able to:
1) Describe normal anatomic structures and perform basic CVJ craniometry.
2) Identify various congenital osseous anomalies.
3) Describe the differences between basilar invagination and basilar impression/cranial settling.

PRESENTATION SUMMARY
Basilar invagination refers to an abnormally high location of the cervical spine relative to the skull base. Although symptoms of basilar invagination are many, including headache, neck pain, brainstem dysfunction, and myelopathy, there are a host of ENT-related symptoms that are associated with pathology in this region that often prompt referral from an otolaryngologist rather than a neurologist or neurosurgeon. These include vertigo, tinnitus, nystagmus, decreased hearing, Horner syndrome, sleep apnea, hemifacial spasm, and multiple lower cranial nerve deficits (decreased gag and soft palate paralysis, tongue atrophy, etc.). The presence of basilar invagination is identified easily on sagittal MR studies but it may be difficult to identify the precise CVJ abnormality on these studies, even with careful analysis of the axial and coronal images, due to the lack of osseous definition. CT simplifies this analysis but requires both sagittal and coronal reconstructed images as complete assessment from axial images alone is often impossible. Even with all of the available imaging information, the complexity of some CVJ anomalies presents a definite diagnostic challenge unless a systematic approach is employed. Basilar invagination is caused by CONGENITAL anomalies that decrease skull base height. These can be considered most easily as due to one of two groups of pathologies, isolated or in combination: 1) Occipital bone anomalies; or 2) Nonsegmentation anomalies. Occipital bone anomalies include jugular tubercle hypoplasia, occipital condyle hypoplasia, and/or basioccipital hypoplasia. Isolated or combined nonsegmentation anomalies in this region are not uncommon and include atlanto-occipital and atlanto-axial-occipital assimilations. Other, less common, nonsegmentation anomalies include os-atlas-occipital and occipital sclerotome-axis nonsegmentation. The term basilar impression should be reserved for ACQUIRED CVJ pathology produced by softening and remodeling of the skull base, essentially identical in appearance to basilar invagination, from various systemic conditions (Paget’s disease, osteogenesis imperfecta...). Both differ from cranial settling, an uncommon sequelae of rheumatoid arthritis. In this condition, the abnormality is at C1-2, due to destruction of the transverse atlantal ligament by panus, such that the skull AND C1 “settle down” on C2 (and the remainder of the cervical spine) as opposed to basilar invagination and basilar impression in which the ligament is intact and the C1 ring “travels” with C2.

REFERENCES
**Parenchymal Injuries in Abuse: CT and MRI**

*Marguerite M. Care, MD*

**LEARNING OBJECTIVES**

Upon completion of this presentation, participants will be able to:

1) Analyze parenchymal insults that occur in patients suffering abusive head injury.
2) Discuss the roles of CT and MR imaging in the clinical care and workup of these young patients.
3) Explain the significance of the parenchymal injuries in both the morbidity and mortality and potential help in timing of insults.
4) Describe the importance of a multidisciplinary approach in the workup of suspected abuse cases.

**PRESENTATION SUMMARY**

Child physical abuse is a common and serious health risk to young children and infants. Since abusive head injury is a primary cause of morbidity and mortality in this young population, the radiologist must be able to recognize and suspect cases of physical abuse. While subdural hemorrhage is a commonly discussed imaging finding, the parenchymal insults are often the most devastating and may go unrecognized on initial imaging. This presentation will emphasize the types and patterns of parenchymal injuries seen in abusive head injury and the clinical role and importance of both CT and MR imaging. The radiologist and neuroradiologist can play a key role in the multidisciplinary approach needed in the work up and diagnosis of these patients. Having familiarity with the imaging findings will provide necessary input to help our clinical and legal colleagues make or exclude a diagnosis of abuse.

**REFERENCES**


**Challenges in the Interpretation of Pediatric Non-Accidental Trauma Cases: Look Alikes and Appropriate Radiology Reports**

*Marvin D. Nelson, Jr., MD*

**LEARNING OBJECTIVES**

Upon completion of this presentation, participants will be able to:

1) Demonstrate that imaging studies do not reveal intent of traumatic injuries.
2) Propose that anything can mimic non-accidental injury.
3) Recommend that imaging is only one part of the determination of NAI.

**PRESENTATION SUMMARY**

*Mimics of Nonaccidental Head Injury in Children.* This presentation will illustrate that many disease processes may mimic nonaccidental injury (NAI) to a child's brain and that imaging does not reveal the intent of injuries to the head. The determination of NAI is a composite of the evaluation of the historical account of the injury, physical examination of the child, imaging studies, and social services evaluation of the child's environment. The written radiology report is very important in both what it says and what it should not say.

**Expert Testimony Involving Neuroradiology in Child Abuse Cases**

*Brian Holmgren*

Mr. Holmgren is an Assistant District Attorney General with the Davidson County District Attorney Generals Office in Nashville, Tennessee where he is team leader of the child abuse unit. Previously he served as an Assistant District Attorney in Kenosha County, Wisconsin for ten years where he directed their sensitive crimes unit. As a prosecutor, Mr. Holmgren has tried more than 250 jury trials and has handled hundreds of child abuse cases. Between 1995 and 1999 Mr. Holmgren was a Senior Attorney with APRI’s National Center for Prosecution of Child Abuse where he lectured on child abuse topics and acted as a consultant to the media, law enforcement, prosecutors and child abuse professionals.
throughout the country concerning issues of child maltreatment. Mr. Holmgren has previously served on the Board of Directors of the American Professional Society on the Abuse of Children and currently serves on the International Advisory Board for the National Center on Shaken Baby Syndrome. Mr. Holmgren received his undergraduate degree from the University of Chicago in 1981, and his law degree from Vanderbilt University in 1985.

**LEARNING OBJECTIVES**
Upon completion of this presentation, participants will be able to:
1) Review requirements for admissibility of expert testimony under the different legal standards.
2) Examine effective ways to present medical testimony involving neuroradiology.
3) Identify common challenges to the medical diagnosis of abusive head trauma and approaches to confronting these challenges.
4) Examine additional sources of non-medical data that may inform the medical opinion involving neuroradiology findings.

**PRESENTATION SUMMARY**
Trials involving abusive head trauma necessitate the presentation of complex medical issues through a variety of expert witnesses. Expert testimony involving neuroradiology is a common component in this process. This workshop will examine the key issues surrounding such testimony. Participants will be provided an overview of the legal standards for admissibility of expert testimony including the two key standards under the *Frye* and *Daubert* holdings. Particular attention will be focused on the importance of supporting proposed expert testimony through applicable scientific research and common legal challenges involving these issues. Differences between legal standards and practices in juvenile and family court proceedings versus criminal proceedings and pretrial hearings will also be discussed. The presentation will examine a number of key factors involved with effective courtroom testimony including the use of demonstrative aids, simplification of medical terminology and concepts, incorporation of medical research findings, and debunking alternative theories of causation. Emphasis will be placed on the need to incorporate the history, scene investigation and reenactments into the medical diagnosis and expert opinion.

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**Wednesday Afternoon**

**1:15 PM – 2:45 PM**

**Ballroom B**

(41) General Session: The Resurgence of CT

(312) Multi-Slice Multi-Detector CT Technology: What does a Neuroradiologist Need to Know?
— Donna M. Stevens, MS

(313) Adjusting Neuroradiology Protocols to the New CT Technology
— Max Wintermark, MD

(314) CTA & CT Perfusion: An Evidence Based Medicine Approach
— Pina Sanelli, MD, MPH

Moderator: Max Wintermark, MD

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**Multi-Slice, Multi-Detector CT Technology: What does a Neuroradiologist Need to Know?**
Donna M. Stevens, MS

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**Adjusting Neuroradiology Protocols to the New CT Technology**
Max Wintermark, MD

**LEARNING OBJECTIVES**
Upon completion of this presentation, participants will be able to:
1) Review the concepts of multislice CT technology.
2) Specify the rationale for the selection of the CT parameters.
3) Identify how to optimize neuro CT protocols using multislice CT technology.

**PRESENTATION SUMMARY**
CT technology has evolved quickly over the past few years, with the introduction of larger-coverage multidetector-row CT scanners. This has important repercussions in terms of neuroradiology CT protocols, and good understanding of CT technology is required in order to optimize image quality, and at the same time maintain the radiation dose to the
patient as low as possible, according to the ALARA principle. In this presentation, we will review the concepts guiding the selection of optimal acquisition parameters and pitch, as well as the available injection techniques. Obtaining high image quality while limiting radiation dose can be achieved by applying simple rules of thumb such as "acquire thin and review thick". We also will review new techniques developed by CT manufacturers to decrease radiation dose, such as dose modulation, that should be used systematically for all neuroradiology CT protocols. We also will discuss the impact on protocolling of the recently introduced 320-slice, whole-brain-coverage CT scanners.

CTA & CT Perfusion: An Evidence Based Medicine Approach

Pina Sanelli, MD, MPH

Wednesday Afternoon

3:15 PM – 4:45 PM

Hall A

(42a) Interventional: Thrombolysis/Stroke, Arteriovenous Malformations/Fistulae

(Scientific Papers 315 – 325)

See also Parallel Sessions
(42b) Pediatric: Neoplasms & New Techniques
(42c) Spine: New Techniques & Miscellaneous
(42d) Head & Neck: Pharynx, Larynx and Neck

Moderators: Steven W. Hetts, MD
Walter S. Lesley, MD

Paper 315 Starting at 3:15 PM, Ending at 3:23 PM

Endovascular Therapy of Acute Stroke with Penumbra Thrombectomy Device Compared to Intraarterial Thrombolysis Alone: Results in a Single Center

Alfke, K. · Tietke, M. · Rohr, A. · Börsch, K. · Zimmermann, P. · Stingele, R. · Jansen, O.

University Hospital Schleswig-Holstein
Kiel, GERMANY

PURPOSE
In acute stroke early recanalization of occluded arteries correlates with improved clinical outcome. Mechanical thrombectomy devices might have the potential to improve recanalization results in endovascular treatment of ischemic stroke and these devices are used more frequently in many centers. We assessed the hypothesis that the use of the Penumbra System as a new mechanical device for clot removal improves the results of endovascular treatment of acute stroke patients in our center. We compared to patients treated in our center with an optimized protocol of intraarterial thrombolysis. This protocol includes the combination of intraarterial rtPA with mechanical clot irritation by microcatheter and, if not contraindicated, the use of thrombocyte Gp IIb/IIIa inhibitor.

MATERIALS & METHODS
Patients for this retrospective analysis were treated at our center between 2004 and 2008. Patients for the two study groups were matched by age, gender and occluded target vessel. Images of baseline CT scan, DSA and follow-up CT (48 hours) were analyzed by three neuroradiologists in consensus. Occlusion of the target vessel at baseline and results of recanalization were rated according to the TICI-score. Hemorrhages in follow-up CT were rated according to ECASS-criteria.

RESULTS
For 38 of 50 patients treated with the Penumbra System match partners were found in a group of 70 patients treated with intraarterial thrombolysis. Seventy-six patients were matched, 38 for each group. Baseline characteristics like TICI-score of target vessel, early signs of ischemia in baseline-CT or quality of collaterals were equal. In the Penumbra group 33 patients (86%) received rtPA and 23 patients (60%) received thrombocyte Gp IIb/IIIa inhibitor for combined mechanical and thrombolytic treatment. There was no significant difference for the number of patients receiving this aggregation inhibitor iv prior to endovascular treatment. In the Penumbra group the mean dose of rtPA was significantly lower (22.5 mg vs 31.6 mg, p=0.019). In follow-up CT the rate of hemorrhagic transformation, parenchymal hematoma or SAH did not differ significantly (Chi-square test, p=0.444), but there was a tendency to lower rates of space occupying hemorrhage (6 vs 10) or SAH (7 vs 10) in the Penumbra group. Treatment was very effective in both groups. Over all 52 of 63 (82%) target vessels with TICI scores of 0 or 1 at baseline improved in score. Recanalization results, quantified as the number of steps in the TICI score between baseline and end of treatment, were not significantly different between groups (Mann-Whitney U test, p=0.232), but there was a tendency to better results in the Penumbra group (mean improvement in TICI-steps 2.32 vs 1.95). There were two procedure-related adverse events with vessel perforation/dissection in each group.

CONCLUSION
In our center the Penumbra system often is used in combination with intraarterial thrombolysis. Recanalization rate is high. Mechanical thrombectomy resulted in a tendency to better recanalization results despite a significantly lower dose of rtPA. Further evaluation in larger trials is necessary.

KEY WORDS: Mechanical thrombectomy, penumbra system, intraarterial thrombolysis
Conclusions

Perfusion CT parameters calculated by a novel quantitative, yet simple method are superior to ASPECTS-based assessment both in interrater reproducibility and correlation with early neurologic outcome in our cohort of ischemic stroke patients undergoing intraarterial thrombolysis.

Key words: Intraarterial thrombolysis, perfusion CT imaging, interrater agreement

Paper 317 Starting at 3:31 PM, Ending at 3:39 PM

Novel Swine Stroke Model for Evaluation of Mechanical Thrombectomy Devices

Kan, I. · Yuki, I. · Vinuela, F. A. · Kim, R. H. · Vinters, H. V. · Vinuela, F.

University of California Los Angeles
Los Angeles, CA

Purpose

Mechanical thrombectomy is a promising endovascular treatment modality for acute stroke patients. Although several animal models currently are used to evaluate new thrombectomy devices, the experimental thrombi used in those models, which are mainly composed of erythrocyte, are not necessarily consistent with the thromboemboli recovered from stroke patients. We developed a novel swine stroke model by utilizing a unique experimental thrombus which simulates histological characteristics of the thromboemboli recovered from stroke patients.

Materials & Methods

Each experimental thrombus was made from a clot that is spontaneous sedimentation of whole blood of swine. To obtain radiopacity, 2g of barium sulfate was mixed during the preparation. An experimental thrombus was excised manually from the original clot by a scalpel so that the thrombus included both fibrin-rich layer and erythrocyte-rich layer. The prepared thrombi were injected into the target vessels of swine via a 6F guiding catheter. A total of 12 cranial arteries in two swine were embolized under fluoroscopy, and angiographic evaluation was performed. Histological evaluations were performed by comparing the prepared thrombi with a conventional experimental clot (erythrocyte-rich clot) and a thromboembolus recovered from a stroke patient.

Results

Postprocedural angiograms showed that four internal maxillary arteries, four ascending pharyngeal arteries and four lingual arteries were embolized successfully with each injected experimental thrombus. Sufficient radiopacity of each injected thrombus also was confirmed. Histological examination revealed that created thrombi showed similar layer pattern including both erythrocyte-rich layer and fibrin-rich layer to that of thromboemboli recovered from stroke patients.
CONCLUSION
Twelve cranial arteries in swine are embolized successfully with experimental thrombus that reproduces typical histologic characteristics of thromboemboli recovered from stroke patients. This animal model can be beneficial for evaluation of mechanical thrombectomy devices for stroke treatment.

KEY WORDS: Stroke model, thrombectomy, histology

CONCLUSION
Emergency CRTAE may be feasible, safe, and effective in recanalization of probable embolic carotid occlusion and improving neurologic symptoms. Emergency CRTAE can decrease 3-month mortality and improve 3-month clinical outcome.

KEY WORDS: Embolic stroke, carotid occlusion, clot removal

RESULTS
Between 2004 and 2008, 22 patients had CRT for probable embolic carotid occlusion. Average time to CRT was 2.9 hours. Median NIHSS score changed from 18 on admission to 6.5 on day 7 (p=0.079). Complete recanalization (CR) was achieved in 12 of 22 patients (%), and their median NIHSS score improved from 17 on admission to 4 on day 7 (p<0.005). In 10 patients without CR, median NIHSS score changed from 18.5 on admission to 13 on the 7 day (n.s.). Neither procedural complications nor hemorrhagic transformation occurred. In the CR and no CR groups, 3-month mortality rate was 8.3% (1/12) and 60.0 % (6/10), respectively (p<0.05), and favorable clinical outcome of mRS (0-2) was 66.7% (8/12) and 20.0% (2/10) (p<0.05). Logistic regression analysis demonstrated that CR was a significant predictor for favorable 3-month mRS (OR: 0.125, 95%CI: 0.018-0.887, p<0.05).

CONCLUSION
Emergency CRTAE may be feasible, safe, and effective in recanalization of probable embolic carotid occlusion and improving neurologic symptoms. Emergency CRTAE can decrease 3-month mortality and improve 3-month clinical outcome.

KEY WORDS: Embolic stroke, carotid occlusion, clot removal

MATERIALS & METHODS
A retrospective review of our interventional neuroradiology and stroke databases over a 3-year period from August 2005 to July 2008 was performed so as to identify patients who had undergone Fogarty balloon thromboembolectomy for treatment of dural venous thrombosis. Angiography, pre and postprocedural imaging studies, as well as chart review was performed by two experienced neurointerventionalists in an effort to determine clinical presentation, indication for local interventional treatment, the affected dural sinuses, dose of thrombolytic (if any), use of any adjunctive mechanical devices, procedural efficacy and complications, and clinical outcomes.
Results
We identified 26 procedures in 22 patients (mean age 39 years, 71% female). Seventy-three percent of cases had intravenous heparin running prior to procedure. Clinical presentations included headache (84%), seizure (36%), mental status change (27%), and focal neurologic deficit (50%). Indications for local interventional therapy included intracranial hemorrhage or infarction (81%), clot progression or sinus reocclusion (23%), and neurologic decline despite medical therapy (12%). Adjunctive mechanical treatments were performed in 23% of cases, including the use of other balloons, suction thromboembolec tomy, and continuous thrombolytic drip infusion. Complete recanalization of the affected sinuses occurred in 81% of cases; partial recanalization in the other 19%. There were four procedural complications (sinus perforation) which were clinically significant in two patients (9%). Clinical outcomes were improved (59%), stable (4%), worsened (12%) and death (25%).

Conclusion
For high-risk patients, with complications of DVST or worsening despite anticoagulation, Fogarty balloon thromboembolectomy offers an alternative that was helpful in a majority of patients.

Key Words: Dural sinus, thromboembolec tomy, fogarty balloon

Paper 320 Starting at 3:55 PM, Ending at 4:03 PM
New Approach to Carotid Stenting from High Surgical Risk Patients to Low Stenting Risk Patients

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Purpose
Carotid artery stenting, compared with carotid endarterectomy, is emerging as an effective and less invasive method of revascularization for extracranial carotid artery stenosis. For carotid stenting to reach its full potential, an acceptable risk of periprocedural complications, particularly in low-risk patients, must be ensured. This presentation provides special emphasis on the process of risk stratification pertaining to clinical, anatomical, and procedural considerations necessary to optimize procedural safety and patient outcomes.

Materials & Methods
In between June 2003 and up to October 2007, 704 patients (764 arteries) underwent CAS performed using coaxial system with 6F - 90 cm sheath, protection device placement, predilatation, placement of the stent, stent dilatation and retrieval of the protection device. There were 142 patients (153 vessels) over 80 years old. Patients were stratified not by high surgical risk, but by high stenting risk taking in consideration patient’s age, cerebral reserve and anatomical conditions - vessel tortuosity and calcifications.

Results
Overall complication rate was 2.5% (minor stroke 1.3%, major stroke 1.3%, all death 0.4%). There was no statistical difference for age, gender and symptomatic status.

Conclusion
Key to avoid complications is to recognize situations where complications can be expected. The results using algorithm when patients undergoing CAS are selected not whether the patient is high or low risk for CEA, but instead if the patients is high or low risk for CAS, are encouraging.

Key Words: Carotid stenting

Paper 321 Starting at 4:03 PM, Ending at 4:11 PM
Technique, Results and Short-Term Follow Up of 18 Patients Undergoing Transarterial Onyx Embolization of Dural Arteriovenous Fistulae

Hurley, M. C. · Dabus, G. · Shaibani, A. · Eddleman, C. S. · Russell, E. J. · Batjer, H. H. · Bendok, B. R.
Northwestern Memorial Hospital
Chicago, IL

Purpose
To describe the immediate and short-term follow-up results in 18 patients who underwent transarterial embolization of their dAVFs with ethylene vinyl alcohol copolymer (Onyx).

Materials & Methods
With IRB approval, we reviewed the medical records and imaging of all patients who underwent transarterial Onyx embolization of a dAVF over a 2-year period by three operators in a single institution. We recorded patient demographics, clinical presentation, dAVF location, grade and anatomy, Onyx type, route of embolization, number of pedicles and sessions, angiographic result, complications, immediate and 3-6 month clinical outcome.

Results
Eighteen patients (M:F 2:1; mean age 52.7 years) underwent embolization of 27 arterial feeders over 22 sessions. Fifteen patients had high-grade lesions with cortical venous drainage and of these 11 were Cognard grade 3 or 4. Aggressive presenting symptoms included 3 with hemorrhage, 1 with amnesia, 1 with intermittent confusion and 1 with seizures. The three patients with low-grade lesions were treated due to intolerable headache or tinnitus. In one patient, treatment was combined with coiling of the distal transverse sinus and in another, coils were used to ligate scalp branches before injecting an occipital feeder. In the remaining cases, Onyx embolization was the sole endovascular therapy. The approach to the fistula was via the middle meningeal artery for 19 Onyx injections - with the remainder including the posterior meningeal, ascending pharyngeal, deep cervical, occipital and superficial temporal arteries. The mean fluoroscopy time was 57.9 minutes. Ten patients had a documented complete obliteration of arteriovenous shunting on immediate angiography with resolution of symptoms, although one of these patients experienced transient severe headaches related to acute thrombosis of a large varix. In six patients there was a partial fistula obliteration and five of them experienced amelioration of symptoms but one suffered a repeat intracranial hemorrhage several hours after the
procedure which required surgical evacuation. In two patients, the fistula was not penetrated and both went on to open surgical treatment. At a mean follow-up interval of 4.5 months, the 10 endovascular “cures” remained symptom free and of the five remaining partially treated lesions, all were low-grade residual fistulae, three were comfortable with their mild symptoms and two patients with troublesome tinnitus underwent radiotherapy.

**CONCLUSION**
Transarterial Onyx embolization can achieve a cure of high-grade intracranial dAVFs in a majority of patients. Though uncommon, complications can be severe and include intracranial hemorrhage.

**KEY WORDS:** dAVF, Onyx, embolization

**Paper 322 Starting at 4:11 PM, Ending at 4:19 PM**

**Multidisciplinary Treatment of Intracranial Dural Arteriovenous Fistulas: Evolution of Treatment in the Onyx Era**

Biswas, A. · Natarajan, S. K. · Sekhar, L. N. · Britz, G. W. · Kim, L. J. · Hallam, D. K. · Ramnathan, D. · Ghodke, B.

University of Washington
Seattle, WA

**PURPOSE**
We retrospectively reviewed our consecutive series of patients who underwent multidisciplinary treatment for intracranial dural arteriovenous fistulas (DAVFs) since the availability of Onyx as an embolic agent. We present our current algorithm for the treatment of DAVFs, with Onyx, the role of endovascular transvenous approach, surgery and radiosurgery.

**MATERIALS & METHODS**
Thirty-two patients with DAVFs were treated over a 3 years between November 2005 and November 2008 by endovascular embolization (transarterial with Onyx®), Transvenous coil embolization), surgery and or radiosurgery. Treatment strategies were based on the location and/or complexity of the fistula and the patient’s clinical status. The patient AVF characteristics, obliteration rates, complications and outcomes were analyzed and correlated with the treatment modality.

**RESULTS**
Most common presentation was hemorrhage (n= 12), headaches (n=12), tinnitus (n=5), seizures (n=1), orbital symptoms (n=7). Twenty-nine patients were treated by endovascular embolization. (Transarterial with Onyx in 23 and transvenous with GDC in 9). Five patients (after incomplete/failed embolization - 4) had surgical excision of the fistula. Four patients were treated with gamma knife radiosurgery (primary - 1). The location of the fistula was transverse sigmoid-9, tentorial-11, parasagittal/ falci-ne-2, anterio r fossa dura-1, indirect carotid cavernous fistula-7 and middle fossa dura -2. The distribution of patients according to Borden classification was I-8, II-12, and III-12. Complete obliteration of the fistula was achieved in 26/32 (81%) patients after multimodal treatment. All surgical cases had complete obliteration. In high risk group with CVR, 20/23(87%) patients were cured. Endovascular complications include: stuck micro catheter tip with fracture of tip- 3, catheter rupture-1, cranial nerve V, VII palsy -1. Surgical complications included cognitive deficits - 1 and seizures in another. At last follow up (1-30 months), 24 patients had modified Rankin score (mRS) 0-2, five patients had mRS 3-5 and three patients were dead. Two patients died in the same admission due to initial insult of hemorrhage and one died after an accidental fall and consequent subdural hematoma.

**CONCLUSION**
Multidisciplinary treatment of DAVFs has high success rates for cure. Transarterial embolization with Onyx has become the primary treatment for intracranial DAVFs with high safety profile and efficacy. Transvenous coil embolization is still preferred in DAVFs with supply from arterial branches supplying cranial nerves, predominant ICA feeders and potential EC-IC collateral anastomosis. Incompletely treated DAVFs were treated with surgery and partially treated type I fistulas were subjected to radiosurgery.

**KEY WORDS:** Intracranial dural arteriovenous fistula, embolization, Onyx

**Paper 323 Starting at 4:19 PM, Ending at 4:27 PM**

**Spinal Epidural Arteriovenous Fistula: Angiographic Features and Clinical Manifestations**

Lim, S. · Choi, I. · David, C.

1Ewha Womans University Hospital, Seoul, REPUBLIC OF KOREA, 2Lahey Clinic Medical Center, Boston, MA

**PURPOSE**
Spinal epidural arteriovenous fistulas (AVFs) are rare vascular malformations in the epidural space, are fed by dural or epidural branches, and drain primarily into epidural venous
plexuses sometimes reflux to perimedullary vein. We retrospectively analyzed the angiographic features and clinical manifestations of spinal epidural AVFs.

**MATERIALS & METHODS**

From 1992 to 2008, 17 patients (4 female, 13 male; mean age, 65.2 years) of spinal epidural AVFs were evaluated.

**RESULTS**

Nine patients (53%) had previous surgery at the lesion sites. Clinical manifestations were progressive weakness of lower extremities (16/17, 94%), bladder and/or bowel dysfunction (6/17, 35%), sensory changes of lower extremities (4/17, 24%) and back pain (1/17, 6%). Feeders (L1-S1 and iliolumbar arteries) were single (12/17, 71%) or multiple (5/17, 29%). Endovascular treatment was attempted in 14 patients and among them 12 patients (71%) achieved complete occlusion with a mixture of n-butylcyanoacrylate and lipiodol and partial occlusion was performed in two patients. Neurologic symptoms of 14 patient with endovascular treatment were improved in 13 patients.

**CONCLUSION**

Our results shows spinal epidural AVFs can be related with previous surgery and patients who had neurologic symptoms can be treated by endovascular embolization with glue.

**KEY WORDS:** Arteriovenous shunt, spine, epidural

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**Paper 324 Starting at 4:27 PM, Ending at 4:35 PM**

**Staged Embolization of Cobb Syndrome**

Huang, L. · Zhang, X. L.

Huashan Hospital, Fudan University
Shanghai, CHINA

**PURPOSE**

There are a few reports regarding the treatment of Cobb syndrome. Our aim of this retrospective study was to describe the clinical and angiographic results of endovascular therapy for Cobb syndrome.

**MATERIALS & METHODS**

The clinical and angiography features of four patients with Cobb syndrome during a 6-year period were reviewed. There were three female and one male patients with a mean onset age of 23 years (range 16-28 years). All patients were treated two times with an endovascular approach alone. Three patients were treated with transarterial embolization by mainly using N-butyl-2-cyanoacrylate (NBCA) and polypyrrol alcohol (PVA), and one patient was embolized mainly with coils targeting the venous pouch. The clinical outcome was assessed using modified Aminoff-Logue scale (ALS) for myelopathy and the modified Rankin scale (MRS) for general quality of life.

**RESULTS**

Anatomical cure was achieved in two patients and clinical cure was two. Endovascular treatment resulted in a significant improvement in ALS(-86.7%) and MRS (-66.7%), and none of the patients had severe treatment-related complications and mortality both after the treatment and during the follow up (mean 18 months; range 2-31 months).

**CONCLUSION**

We conclude that endovascular treatment of Cobb syndrome resulted in a good and lasting clinical outcome, but more than one time endovascular treatment were required to achieve complete anatomical cure. Though case number was limited, endovascular treatment was a safe and effective method for Cobb syndrome and was not associated with significant complications and mortality.

**KEY WORDS:** Angiomatosis, spine, embolization

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**Paper 325 Starting at 4:35 PM, Ending at 4:43 PM**

**Head and Neck Vascular Management Diagnosis and Ethanol Endovascular Management**

Yakes, W. F.

Vascular Malformation Center
Englewood, CO

**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.
MR and PET Imaging Correlations in Children with Newly Diagnosed Brainstem Gliomas: A Report from the Pediatric Brain Tumor Consortium


‘Children’s Hospital, Boston, MA, ‘St. Jude Children’s Research Hospital, Memphis, TN, ‘Seattle Children’s Hospital, Seattle, WA, ‘University of California San Francisco, San Francisco, CA

PURPOSE
We report a retrospective analysis of MR and PET imaging findings in children with newly diagnosed diffuse intrinsic brainstem gliomas (BSG) to investigate the association of imaging variables with progression free survival (PFS) and overall survival (OS), and to study the associations among MR and PET variables of interest.

MATERIALS & METHODS
Two multiinstitutional clinical trials of children with newly diagnosed BSG tested combinations of RT with molecular targeted agents (PBTC-007: Phase I/II study of gefitinib; PBTC-014: Phase I study of tipifarnib). Prospectively required brain MR scans (including T2*perfusion and diffusion) were done pretherapy, after every second course during year one and every third course thereafter until off study. FDG PET scans were obtained pretreatment and following the fourth course. PET variables assessed included pretreatment and on therapy FDG uptake, uniformity (the percentage of tumor with FDG uptake), comparisons of mean and maximum uptake compared to white and gray matter respectively, and correlation with MR contrast enhancement. PET scans and MR scans were matched within a window of 14 days. Cox Proportional Hazard Models were used to investigate associations of MR and PET imaging variables with PFS or OS.

RESULTS
Twenty-nine patients [9 M/20 F; median age = 7.3 years (range 3.4-18.7 years)] had both pretherapy PET and MR scans. Using a window of 14 days, 54 individual PET scans were matched with MR scans. Greater pretherapy uniformity was associated with poorer PFS and OS. At baseline, as FDG uptake increased within the tumors, perfusion values increased and diffusion ratio values decreased within the tumors. Both pretreatment MR tumor volume (on FLAIR sequences) and uniformity are associated with PFS and OS individually and jointly in a multivariable Cox model, where patients with higher tumor volume at baseline or higher FDG update in tumor seem to have earlier progression. On treatment measurements of PET variables did not differ significantly from their pretreatment counterparts and did not provide any more evidence of association with PFS or OS beyond the association of pretreatment measurements. On treatment measurements of MR variables showed patients who had at least a 25% drop in tumor volume and tumor diffusion values during RT had longer PFS and OS.

CONCLUSION
As the percentage of tumor with FDG uptake increases at baseline, there is an association with poorer PFS and OS. This association remains significant when pretreatment MR
tumor volume also is considered in a multivariable model. When correlating with MR variables, as FDG uptake increased, perfusion values increased and diffusion values decreased, reflecting increased cellularity within the tumors. Patients with at least a 25% drop in tumor volume and diffusion values during RT had longer PFS and OS. Validation of such results requires analysis across BSG protocols ongoing in PBTC.

**Key Words:** Pediatrics, brain tumors, MR and PET

**Paper 327 Starting at 3:23 PM, Ending at 3:31 PM**

**Hemorrhagic Lesions in Patients with Diffuse Brainstem Glioma Treated with Radiation and Antiangiogenic Therapy: Assessment by 2D Gradient-Echo Imaging and 3D Susceptibility-Weighted Imaging**

Löbel, U. · Sedlacik, J. · Kocak, M. · Broniszer, A. · Hillenbrand, C. M. · Patay, Z.

St. Jude Children’s Research Hospital
Memphis, TN

**Purpose**

2D gradient-echo (2D-GRE) and 3D susceptibility-weighted imaging (3D-SWI) are robust MR imaging techniques, which enhance visualization of magnetically susceptible substances (e.g., hemorrhage and calcification) in biological specimens. The recent introduction of angiogenesis inhibitors into treatment protocols for pediatric brain tumors has raised concerns about the potential of increased risk of intratumoral hemorrhages, which is an exclusionary criterion for continued antiangiogenic treatment. The aim of this study was to determine the incidence rate and clinical significance of intratumoral hemorrhages in children with diffuse pontine gliomas (DPG) during the course of combined conformal radiation (cRT) and anti-VEGF treatment using two different MR imaging techniques, conventional 2D-GRE and the novel 3D-SWI.

**Materials & Methods**

Seventeen children (9F/8M, age: 3-17 years) with DPG were recruited from an IRB-approved phase I clinical study of vandetanib administered simultaneously with cRT. All patients had baseline MR scans and up to eight follow ups on 1.5/3 T platforms over periods ranging between 10-280 days, providing 92 examinations for analysis. 2D-GRE and 3D-SWI images were randomized and scored independently by SWI images were randomized and scored independently by 3D-SWI than on 2D-GRE in 40(R1)/42(R2) cases. Lesions were only 9.67%/5.22% of lesions larger than 0.5cm on 2D-GRE/SWI, respectively. More lesions were identified on 3D-SWI than on 2D-GRE in 40(R1)/42(R2) cases. Lesions were missed or misinterpreted more frequently on 2D-GRE (R1: 35/R2:36 cases) as with 3D-SWI (R1: 7/R2: 2 cases). No significant neurologic event was recorded in our patients regardless of the number and size of intratumoral hemorrhages.

**Conclusion**

Petechial hemorrhages are common in patients with DBG and their number increases during combined cRT/anti-VEGF treatment. Hematomas (>0.5cm) are rare, likely explaining the lack of significant adverse neurologic correlates in our study. Phase images facilitate the differentiation of blood from calcium with both 2D-GRE and 3D-SWI techniques, but SWI is more accurate in differentiating hemorrhages not only from calcifications but also from intratumoral vessels, necrotic areas, or pulsation artifacts. Occasionally, clusters of punctuate hemorrhages may appear confluent on 2D-GRE images, but the inherently higher spatial resolution of 3D-SWI allows more accurate and confident identification of individual lesions, which explains the higher number of lesions detected by 3D-SWI. 3D-SWI also helps differentiating hematomas from petechial hemorrhages, which has significant clinical implications. We predict that 3D-SWI will soon replace 2D-GRE as the new gold standard in the MR imaging evaluation of intraparenchymal hemorrhages. Our work also contributes to a better appreciation of the incidence and significance of intratumoral hemorrhages in DPG during cRT/anti-VEGF treatment, which may ultimately help reduce the number of patients who need to be excluded from novel therapeutic protocols using antiangiogenic drugs for concerns of therapy-induced hemorrhagic complications.

**Key Words:** Brainstem glioma, gradient-echo imaging, susceptibility-weighted imaging

**Paper 328 Starting at 3:31 PM, Ending at 3:39 PM**

**Serial Perfusion and Diffusion MR Imaging in Pediatric Diffuse Intrinsic Brainstem Glioma**

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1Lucille Packard Children’s Hospital at Stanford, Stanford, CA, 2Childrens Hospital Los Angeles, Los Angeles, CA, 3Rudi Schulte Research Institute, Santa Barbara, CA

**Purpose**

Diffuse intrinsic brain stem gliomas (DIBSG) have a poor prognosis. Clinical tools are needed to monitor physiologic tumor behavior and guide early intervention or response to therapy. The goal of this study was to assess and correlate hemodynamic and cellular properties of pediatric DIBSG using dynamic susceptibility contrast-enhanced (DSC) perfusion MR imaging (pMRI) and diffusion tensor imaging (DTI).

**Materials & Methods**

A total of 34 DSC pMRI and 33 DTI studies of 13 DIBSG patients (ages 4-15 years) were reviewed. These studies were performed at baseline, after completion of radiation therapy and initial chemotherapy, and thereafter at regularly scheduled follow-up MR imaging. A 1.5T magnet was used. Gradient-echo EPI perfusion was used. Dynamic susceptibility contrast-enhanced pMRI and DTI were analyzed using...
software provided by the manufacturer. Relative CBV was normalized to rCBV values obtained from cerebellum unaffected by tumor.

**RESULTS**

Diffuse intrinsic brain stem gliomas at baseline demonstrated hypoperfusion (rCBV $68\pm 29\%$ of control tissue) and hypocellularity {mean ADC $1.32\pm 0.23$ vs. $0.72\pm 0.02 \text{ mm}^2/\text{s}$ [mid pons in controls (n=8)], Fig. 1}. Over the disease course, rCBV increased significantly at a rate of $4\%$/month ($r=0.6$, $p<0.001$, linear correlation, Fig. 2A). Mean ADC values decreased significantly during disease course ($r^2=0.3$, $p<0.01$, Fig. 2B). No correlation was observed between rCBV and ADC values at baseline and survival times.

**CONCLUSION**

Relative hypoperfusion (low rCBV) and hypocellularity (high ADC) were observed in pediatric DIBSG at baseline consistent with low-grade lesions. Despite therapy, a progressive increase of rCBV and decrease of ADC were observed over the disease course. These changes are consistent with hemodynamic and cellular changes observed with malignant degeneration of gliomas in adult population. With new therapeutic trials that aim to prevent/delay malignant degeneration, DSC pMRI and DWI may be, in the absence of any other quantitative measures, essential tools for the evaluation of response to treatment.

**KEY WORDS:** Diffusion tensor imaging, diffuse intrinsic brain stem gliomas

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**Paper 329 Starting at 3:39 PM, Ending at 3:47 PM**

**Assessment of Treatment Response in Pediatric Diffuse Intrinsic Brain Stem Glioma by Serial In Vivo MR Spectroscopy**

Panigrahy, A.¹ · Bluml, S.¹,² · Dhall, G.¹ · Finlay, J.¹ · Nelson, M. D.¹

¹Childrens Hospital Los Angeles, Los Angeles, CA, ²Rudi Schulte Research Institute, Santa Barbara, CA

**PURPOSE**

Diffuse intrinsic brain stem gliomas (DIBSG) are inoperable and highly resistant to chemotherapy/radiation therapy. Conventional MR imaging is of limited value to assess disease progression or response to therapy. Serial MR spectra acquired from these tumors show that these tumors transition from low-grade to high-grade. We compared metabolic changes in subjects that were treated using a novel therapy that included radiation therapy (RT) and concomitant aggressive chemotherapy versus previous patients with standard treatment. Our hypotheses were that metabolic degeneration is observed to a lesser extent in the first group and that the lack of metabolic progression correlates with significant longer survival.

**MATERIALS & METHODS**

Twenty-six prospective MRS studies were performed in five subjects prior to and following a novel therapy that consisted of RT and daily carboplatin and etoposide followed by temozolomide, irinotecan and bevacizumab (Group A). Data were compared with changes observed in seven subjects (22 studies) that were treated with standard therapy (Group B). Individual therapies in group B varied in their details but did not include aggressive chemotherapy concomitant with RT and the use of the VGEF inhibitor bevacizumab at follow up. All spectra were acquired using a single-voxel PRESS sequence (repetition time TR=1.5s, echo time TE = 35 ms). LCModel software (S. Provencher Inc.) was used for processing and absolute concentrations of metabolites and metabolite concentration ratios were determined.

**RESULTS**

Time to progression (death) in Group A was $9.7\pm 2.8$ (14.0±3.5) months and was significantly longer than in Group B ($6.7\pm 2.2$ (9.8±1.9), $p<0.05$). There were no significant differences in metabolite levels at baseline for the two groups. In Group B, changes in tumor metabolism consistent with progression were observed within 6 months of diagnosis and at further follow-up studies. This metabolic progression was not observed in group A (Figure, Table).
### Table
Comparison of changes of creatine to choline (Cr/Cho) and N-acetyl-aspartate to choline (NAA/Cho) levels relative to baseline (*p<0.01, **p<0.001, ***p<0.0001)

<table>
<thead>
<tr>
<th></th>
<th>Post RT - less than 6 months after diagnosis</th>
<th>6-12 months after diagnosis</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Group A</strong></td>
<td>Group A</td>
<td>Group B</td>
</tr>
<tr>
<td>Cr/Cho</td>
<td>129±26%</td>
<td>63±17%***</td>
</tr>
<tr>
<td>NAA/Cho</td>
<td>87±32%</td>
<td>63±27%</td>
</tr>
<tr>
<td><strong>Group B</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cr/Cho</td>
<td>132±40%</td>
<td>63±11%**</td>
</tr>
<tr>
<td>NAA/Cho</td>
<td>146±74%</td>
<td>47±29%*</td>
</tr>
</tbody>
</table>

### CONCLUSION
MR spectroscopy provides early noninvasive detection of significant metabolic differences between DIBSG patients treated with two separate therapeutic regimens. MR spectroscopy shows a lack of metabolic degeneration correlated with long event-free and overall survival. MR spectroscopy could serve as an early surrogate for the effectiveness of therapy and speed up clinical trials significantly.

**KEY WORDS:** MRS, DIBSG

### Paper 330 Starting at 3:47 PM, Ending at 3:55 PM
Quantitative Comparison of Hemodynamic Parameters in Hemorrhagic versus Nonhemorrhagic Areas of Diffuse Brainstem Gliomas Treated by Combined Conformal Radiation and Antiangiogenic Therapy Using Dynamic Susceptibility-Weighted Contrast-Enhanced Perfusion MR Imaging

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Memphis, TN

**PURPOSE**
In a previous study we have shown that intratumoral petechial hemorrhages (ITH) are common in diffuse pontine gliomas (DPG) treated with combined conformal radiation (cRT) and antiangiogenic (anti-VEGF) therapy. The exact pathomechanism of increased vessel wall fragility resulting in microhemorrhages within the tumor (occasionally in surrounding tissue) is yet poorly understood. We hypothesized that the steep increase of ITH observed in a subset of the patients may indicate transformation from lower towards higher tumor grade and hence carry a poor prognosis. Since dynamic susceptibility-weighted (DSC) contrast-enhanced perfusion MR imaging has proved to be a reliable biomarker of tumor grade/outcome in gliomas, we used this technique to determine whether or not areas of petechial hemorrhages in DPGs are associated with perfusion alterations consistent with a change in tumor biology and possible poor outcome, or related to other factors without prognostic value.

**MATERIALS & METHODS**
From a subset of 17 children (9F/8M, age:3-17years) with DPG treated on an institutional IRB-approved phase I clinical study of vandetanib administered simultaneously with cRT, we identified five patients who presented with an obvious increase in hemorrhagic lesions starting at 150-200 days postinitiation of treatment. Of each patient four MR imaging studies, including at least one exam preceding and one following the time point when increase of hemorrhages was first noted, were analyzed. Regions of interest (ROIs) encompassing the hemorrhagic foci within the tumor (TU+) and other tumor areas without detectable hemorrhagic lesions (TU-) were drawn on susceptibility-weighted images and manually transferred to CBF/CBV parametric maps generated using DSC perfusion data (acquired with standard sequence and injection parameters). Relative values (rCBF/rCBV) were calculated with respect to normal cerebellar white matter and compared for TU+ and TU-.

**RESULTS**
At the time of first increase of hemorrhagic lesions within tumor tissue rCBF/rCBV were higher in TU+ (mean rCBF/rCBV=1.4/1.95) as compared to TU- (mean rCBF/rCBV=1.17/1.23) in two patients. In another two patients rCBF was lower in TU+ (mean rCBF/TU+/TU- =1.22/1.67) with similar values for rCBV. For patient five, rCBF did not differ markedly between the two regions, but rCBV was higher for TU+ (rCBV/TU+/TU-=1.68/1.23). The increase in the number of hemorrhagic lesions always was accompanied by a subsequent decrease in rCBF, while rCBV either decreased or increased.

**CONCLUSION**
The lack of evidence for consistent and significant increase of rCBV (and rCBF) in tumor areas characterized by an increased number of petechial hemorrhages as compared to nonhemorrhagic tumor areas suggests that intratumoral hemorrhagic “diathesis” does not necessarily indicate a change in tumor biology, notably malignant transformation. It is therefore conceivable that vessel wall fragility is either secondary to cRT or anti-VEGF therapy (or a synergistic effect of the two) or alternatively, it is inherent to the natural course of intratumoral histopathologic changes. We believe that the phenomenon is worthy of further investigations, perhaps using other MR-based vascular imaging tools, such as T1-weighted permeability imaging.

**KEY WORDS:** Hemorrhagic lesions, brainstem glioma, DSC perfusion imaging
**Paper 331 Starting at 3:55 PM, Ending at 4:03 PM**

**Pineal Tumor Growth and Cysts in Children with Retinoblastoma: Sorting the Benign from the Aborted Trilateral Retinoblastoma**

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Memphis, TN

**PURPOSE**

Approximately 10% of children with genetic retinoblastoma (Rb) will develop an asynchronous trilateral retinoblastoma (TRb). The prognosis of TRb is dismal requiring surveillance screening with MR imaging. Recently, the rare occurrence of pineal cysts was described in children with bilateral Rb. We sought to understand the association between new retinal disease, changes in pineal size, and the development TRb and pineal cysts.

**MATERIALS & METHODS**

In this IRB-approved retrospective study, we reviewed serial MR imaging examinations performed at diagnosis, and every 6 months until 5 years of age corresponding to 37 patients with Rb, and correlated the findings with new intraocular tumor formation (IOTF). Examinations under anesthesia typically were performed every 3-6 weeks during the first year, and at less frequent intervals thereafter. The median age at diagnosis was 4.5 months (3-36 months), 35/37 had bilateral disease, and the median follow-up time was 2.7 years (0.07–4.96 years). All but one patient were treated with systemic Vincristine and Carboplatin +/- Etoposide for 6-8 cycles. All patients received intensive focal treatments, and those with disease progression received enucleation and/or external beam irradiation. Statistical analysis was performed using the Exact Wilcoxon-Mann-Whitney Test, and Fisher’s exact test.

**RESULTS**

There was a significant increase in pineal gland size in the seven patients with bilateral Rb who developed new ocular tumor(s) compared with those who did not (p=.0073), although none of these patients developed classic TRb. Pineal gland size increase occurred during systemic treatment, was outside the normal range for age, (Figure), and was associated in eventual cyst development in five of seven patients. Intraocular tumor formation was associated with age at diagnosis (<6 mo, p=.0042). One patient developed TRb which was successfully resected and treated. Overall, pineal cysts developed in 15 of 37 patients. While cystic pineal glands were larger than noncystic glands (p< .001) there were no differences in pineal gland size changes between those with or without cysts.

**CONCLUSION**

Children with bilateral retinoblastoma show changes in pineal gland size and structure during the first months after diagnosis, which are characterized by progressive size increase, with eventual development of a cyst in 40% of the cases. Pineal gland size increase and cyst formation appear to be more significant in younger children with new tumor formation, suggesting that pineal and retinal development share common developmental cues involved in oncogenesis. Whether these changes represent a forme fruste of TRb induced by the use of systemic chemotherapy remains to be investigated.

**KEY WORDS:** Retinoblastoma, pineal cysts, trilateral retinoblastoma

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**Paper 332 Starting at 4:03 PM, Ending at 4:11 PM**

**Longitudinal Diffusion Tensor Findings in Children with Diffuse Brainstem Glioma Treated with Radiation and Antiangiogenic Therapy**

Helton, K. J. · Tran, H. · Scoggins, 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 (1.5T and 3T) on an IRB-approved therapeutic protocol. MRI exams occurred at baseline, during RT (weeks 1, 3 and 6), and bimonthly thereafter until taken off the study. Conventional MRI (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: (I) relapse within the brainstem (n=3), (II) relapse from leptomeningeal (LM) disease (n=2), (III) 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 II, 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 III, 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 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

Paper 333 Starting at 4:11 PM, Ending at 4:19 PM
Diffusion Tensor Imaging Reveals Abnormal White Matter and Gray Matter Maturation in Preterm Newborns with Periventricular Hemorrhagic Infarction

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University of California San Francisco
San Francisco, CA

PURPOSE
Periventricular hemorrhagic infarct (PVHI), formerly called Grade 4 intraventricular hemorrhage, results from occlusion of an intraventricular vein draining surrounding white matter (1). Diffusion tensor imaging can characterize microstructural changes in white matter (WM) and gray matter (GM) of the developing brain (2-4) and has been shown to detect microstructural injury, even in normal-appearing neonatal WM (5). However, there have been no reports of abnormal microstructural maturation in GM with DTI. Furthermore, there have been no prior DTI studies of PVHI.

MATERIALS & METHODS
Ten preterm neonates with imaging findings of PVHI, and 10 age-matched preterm healthy neonates without imaging evidence of brain injury and normal neurologic outcome at 1 year of age were prospectively enrolled. We compared DTI parameters of directionally averaged diffusion coefficient (Dav), fractional anisotropy (FA), and the maximum, intermediate, and minimum eigenvalues (λ1, λ2 and λ3 respectively) in GM and WM regions between the two groups.

RESULTS
Compared to normal controls, the PVHI group showed significantly higher FA values in the frontal (P = 0.004) and temporal (P = 0.043) cortical regions, while occipital cortex showed a trend towards higher value (P = 0.065). No significant differences were seen in the Dav values in the cortical and deep GM regions. Across serial examinations with correction for repeated measures, PVHI patients showed statistically significant increases in λ1 in temporal (P = 0.003) cortex, while frontal (P = 0.13) and occipital (P = 0.083) cortex showed a trend towards higher values. The PVHI group had significantly lower FA values in normal-appearing low centrum semiovale (LCS, P <0.001), high centrum semiovale (HCS, P = 0.008), and splenium (P = 0.002). Periventricular hemorrhagic infarct patients showed statistically significant increases in Dav in the normal-appearing LCS (P = 0.005), and splenium (P = 0.003), while HCS (P = 0.123) showed a trend towards higher Dav values. Diffusion tensor imaging in PVHI reveals abnormal microstructural maturation of gray matter and white matter in regions that appear normal on conventional MR imaging. Late-maturing white matter (high and low centrum semiovale) and cortical (frontal, occipital, and temporal cortex) regions are more affected compared to earlier maturing regions such as the posterior limb of the internal capsule or the pre and postcentral cortex.

CONCLUSION
The increased cortical FA and decreased WM FA in the affected regions, as well as the pattern of alteration of the diffusion tensor eigenvalues, suggest delayed development as the etiology of the observed microstructural changes of gray matter and white matter in PVHI.

REFERENCES

Acknowledgments: This study was supported NCRR UL RR024131-01, a component of the NIH Roadmap for Medical Research, NINDS NS35902 and NS046432, the “Overseas Associateship Award” to A.G. from the Department of Biotechnology, India, and the NINDS Neurological Sciences Academic Development Award (NS01692) to H.C.G.

KEY WORDS: PVHI, DTI, neonatal
Applications of Cine MR Imaging Techniques in Central Nervous System Pathology in Children

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PURPOSE
To determine the feasibility and applications of real-time cine-MR imaging in the functional evaluation of various pathologic entities causing alteration of cerebrospinal fluid (CSF) flow.

MATERIALS & METHODS
Real-time MR techniques, such as cine and CSF flow imaging were applied in 10 cases of supratentorial hydrocephalus, including four cases which were imaged at the obstructive phase and following third ventricle ventriculostomy; three cases of arachnoid cyst fenestration; two cases of unexplained headache; and two cases of suspected tethered cord. True FISP cine and cine phase contrast with low velocity encoding parameters sequences were utilized for assessment of the target structures, with the acquisition plane depending on the particular CSF flow being evaluated.

RESULTS
Real-time cine-MR imaging techniques were equally feasible in evaluation of normal and impaired CSF flow at the craniocervical junction; through the foramen of Monro and Sylvian aqueduct. Valuable depiction of a CSF jet through the endoscopically created openings in the 3rd ventricle floor and fenestrated wall of arachnoid cyst was demonstrated. Decreased motion of the distal lumbar nerve roots was demonstrated in cases of tethered spinal cord.

CONCLUSION
Cine-MR imaging methods are technically feasible and appear to be valuable tools in assessment of intracranial CSF flow dynamics and evaluation of effectiveness of endoscopic neurosurgical procedures performed to change route of flow of CSF.

KEY WORDS: Cine, MRI, CSF flow

Impact of Introducing Cine Clips in Neonatal Head Ultrasound Protocols

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PURPOSE
To determine the impact of introducing cine clips on the efficiency of daily workload for neonatal head ultrasound studies.

MATERIALS & METHODS
We retrospectively reviewed the neonatal head ultrasound exams that were performed before and after the introduction of cine clips into the routine protocols. Cases performed for 1 month were used to measure the average scan time. The studied data include 36 studies that were performed using the static image protocol and 97 studies that were performed using the cine clips protocol. The results were compared to determine time savings, impact on work efficiency and the average storage space required for the studies. Subjective survey responses to the protocol change among sonographers and sonologists were recorded.

RESULTS
Average scan time using the old static image protocol was 6.5 minutes per patient. After introducing the new cine clip protocol, the average scan time reduced to 3.4 minutes. Survey responses from sonographers included the following: decrease in repetitive stress disorders, less resistance to portable examinations, less repeat studies. Among sonologists, the following changes were recorded: easier distinction between artifact and true findings; less rescans to confirm sonographer findings, easier communication with clinicians, more confidence in diagnosis.

CONCLUSION
Introduction of cine clips to the routine scanning protocol result in significant time savings, more confidence in diagnosis, less rescans times, less repetitive stress disorders among sonographers, and better communication between sonologists and clinicians. These results have led to the application of the new protocol to other types of ultrasound examinations.

KEY WORDS: Cineclip, neonatal, head

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

PURPOSE
Radiation dose in CT is an important concern for public health, especially for pediatric patients. Various dose reduction methods have been investigated. The objective of this work was to determine the minimum clinically acceptable radiation dose for pediatric CT of the head and sinuses using a novel low-dose simulation tool.

MATERIALS & METHODS
A novel low-dose software tool was developed that can accurately simulate the noise characteristics and spatial-frequency content of reduced-dose patient images. The tool modifies the raw CT dataset with consideration for the effects of the bowtie filter and automatic tube current modulation prior to reconstruction of the clinical images. The accuracy of the tool was validated using four different phantom sizes and two reduced-dose scan settings. The noise level and local noise power spectrum of the simulated reduced -dose images were compared to those of phantom images acquired at matching dose levels. Raw data from 30 pediatric exams from two 64-slice CT scanners (Sensation 64, Siemens) was collected and trans-
ferred to an external workstation. The exams included 10 sinuses, 11 routine sequential heads, and 9 routine spiral heads. Automatic tube current modulation was used in the sinus and routine spiral head exams. Patient ages ranged from 4 weeks to 16 years, with 25 patients under 6 years old. Five different noise levels were inserted into each dataset, resulting in unique raw datasets simulating 50%, 60%, 70%, 80%, and 90% of the original dose level. All 150 new raw datasets were transferred back into the scanner. All datasets, including the originals at 100% dose, were reconstructed using soft tissue and bone kernels, yielding a total of 12 images per case. The radiologists indicated which of the 12 images showed acceptable image quality in each set, thereby allowing the lowest acceptable dose to be determined.

RESULTS
The acceptable dose reductions relative to current clinical pediatric techniques with soft-tissue reconstructions were as follows: 50% for sinus exams, 20% for routine sequential heads, and 20% for routine spiral heads. For bone reconstructions, 50% dose reduction was acceptable for all exams. Based on the results from soft-tissue reconstruction, the average CTDIvol for patients under 6 years old was reduced from 32.9 mGy to 16.4 mGy for sinuses, from 32.7 mGy to 26.2 mGy for routine sequential heads, and from 29.3 mGy to 23.4 mGy for routine spiral heads.

CONCLUSION
A novel noise insertion tool to simulate reduced-dose exams from existing patient exams was developed and validated. The tool was used to determine the lowest acceptable dose level for pediatric head and sinuses CTs. Dose reductions of 50% for sinuses and 20% for routine heads were realized while maintaining clinically acceptable image quality.

KEY WORDS: CT, dose reduction, brain and sinus

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**Paper 337 Starting at 3:15 PM, Ending at 3:23 PM**

**Imaging Fast Retrograde Axonal Transport**

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**PURPOSE**
Currently, there is no imaging technology that can adequately assess the anatomy and function of peripheral nerve tissue in intact organisms in vivo. We have designed a fluorescent probe that exhibits rapid and specific nerve transport after intramuscular injections.

**MATERIALS & METHODS**
Our probe is based on a neurotrophic protein which utilizes retrograde axonal transport, a vital maintenance pathway in peripheral nerves. We have labeled our protein with fluorescent tags, and did immuno- and bio-assays to assess that it retained biological activity. In vivo imaging of the compound was undertaken in mice using a fluorescent imager. Tissues were excised for histological analysis.

**RESULTS**
We were able to label the protein successfully with retention of biological activity. In vivo imaging experiments demonstrated retrograde axonal transport along the sciatic nerves and into the spinal cord. Histological studies confirmed imaging findings. After intramuscular injection of fluorescently labeled protein, transport occurs along nerve and to spinal cord at time intervals shown.

**CONCLUSION**
We demonstrate that retrograde axonal transport can be imaged using a novel molecular imaging tracer. This technology has significant potential for future human use in the assessment of diseases affecting nerves.

**KEY WORDS:** Neurography, imaging, transport

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**Paper 338 Starting at 3:23 PM, Ending at 3:31 PM**

**Sub-Minute Fat-Water Separated Dual-Echo Automated Spine Survey Iterative Scan Technique**

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**PURPOSE**
To develop and prospectively test an automated sub-minute 3-D dual-echo MR imaging technique to produce fat-water separated, color-encoded images of the entire spine with labeled vertebral and disks.
**MATERIALS & METHODS**

The study protocol was HIPAA-compliant and institutional review board-approved with informed consent. Twenty-one subjects (15 female, 6 males; mean age, 41.0 ± 17.8; range 13-78 years) including six normal volunteers were scanned at 3T with an investigational dual-echo fast spoiled gradient two-point Dixon technique (1) (TR = 4.77 - 5.44 msec, TE1 = 1.36 - 1.52 msec, TE2 = 2.6 msec, flip angle = 12, BW = +/- 167 khz, 336 x 284 matrix, zero interpolation, and slice thickness = 4 mm with 2mm overlap or 3mm with 1.5 mm overlap, 32 slices respectively providing 6.2 or 4.8 cm left to right coverage) utilizing two contiguous 21-22 sec breath-hold 35 cm field of view 3-D sagittal acquisitions with coverage from skull-base to the sacrum. In 12 subjects the technique was performed pre and postintravenous contrast administration, seven had noncontrast sequencing only and two received only postcontrast spine imaging. Calculated water, fat, and color-encoded apparent fat signal percentage and water plus fat maps with vertebral and disk labeling were auto-generated. Images were evaluated for homogeneity of fat-water separation and auto-labeling was compared to neuroradiologist assignments. To determine potential throughput, two volunteers were alternately scanned in a 1-hour time slot.

**RESULTS**

Fourteen alternating subject scan sessions were achieved in 58 minutes. In all cases, fat-water separation was homogenous over the entire 70 cm FOV; in two lower stations fat/water assignments were reversed. All auto-labeled non-contrast spine surveys were concordant with neuroradiologist assignments. Pathology, to include spinal metastasis, could be appreciated readily on both noncontrast and contrast exams (Fig 1). Color-encoded images (not illustrated) facilitated review and afforded qualitative assessment of fatty marrow distribution throughout the spine.

Figure. Sixty-one-year-old with metastatic breast cancer. Midline sagittal ASSIST DE images from left to right: precontrast auto-labeled water; nonlabeled water and fat; postcontrast water and fat calculated images. Solitary L2 metastasis (arrow) replaces fat and enhances with contrast. Incidental Modic type II degenerative changes anterior inferior endplate T8 (arrowhead).

**CONCLUSION**

Rapid automated fat-water decomposition spine screening is a promising technique. Further investigation is warranted.
branch whereas in three others, the catheter angiogram was inconclusive. Both TRICKS and catheter angiography were normal in one patient. Detailed data will be presented.

CONCLUSION
Time-resolved (dynamic) contrast-enhanced MR angiography by using the TRICKS sequence is useful in identifying the approximate location of feeding vessels in suspected spinal vascular malformations and can thereby aid in planning further selective catheter angiography thus limiting morbidity and radiation exposure.

KEY WORDS: MR angiography, TRICKS, spine

Paper 340 Starting at 3:39 PM, Ending at 3:47 PM
Spare a Minute or Two? Multiparametric MR Imaging Spine Screen

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PURPOSE
Design and test a multi-breath-hold MR imaging protocol to screen entire spine with less than 2 minutes total acquisition time and provide multiparametric contrast.

MATERIALS & METHODS
Eighteen ambulatory volunteers (11 males, 7 females, ages 21 - 61 years, mean 40 +/- 13) were imaged consecutively on 11/25/2008 at 3T, using an 8-channel spine-array coil and auto-prescribed investigational sequences as follows: upper followed by lower station; 35 cm FOV, sagittal 3D fast spoiled-gradient dual-echo 2-point Dixon sequencing (TR ~ 5 msec, TE1 ~ 1.4 msec, TE2 ~ 2.6 msec, flip angle=12, BW = +/- 167khz, 336 x 284 matrix, zero interpolation, 32 slices, thickness = 4mm with 2mm overlap, 21 sec) and sagittal 2D FSE (TR ~ 3100 msec, TE ~ 100 msec , ETL =35, 416 x 256 matrix, 9 slices, thickness = 4mm with 1mm spacing, 25 sec), and finally similar lower station coronal 3D fast spoiled-gradient dual-echo sequencing with exception of 40 rather than 32 slices acquired (26 sec). All five sequences (total acquisition time = 1:58 sec) were performed with computer-prompted breath-holding. Examinations subsequently reviewed to evaluate adequacy of breath-holding, fat/water separation, tissue contrast and spatial coverage; and identify pathology.

RESULTS
All 18 subjects were scanned sequentially within a 2:30 minute block (average throughput = 8:20 sec/subject). Sagittal coverage was deemed adequate in all but one subject exhibiting marked lumbar levoscoliosis (100 degrees) related to multiple segmentation anomalies, best appreciated on her coronal 3D sequence. Ten subjects adequately performed the five sequential breath-holds. The other eight had difficulty with ≥1 breath-hold, evidenced by motion degradation, most commonly in the final sequence. In all cases, the 3D dual-echo sequences provided good fat/water separation and T1 contrast, while the FSE sequences provided complementary T2 contrast. Twelve subjects displayed varying degrees of degenerative disk disease. One subject had a solitary block vertebra (T11-T12). Incidental vertebral hemangiomas were appreciated and well characterized in several patients (Figure). Two presumptive liver hemangiomas and one subcutaneous lipoma also were identified.

CONCLUSION
Rapid automated multiparametric total spine screening with sequential breath-holds is a promising technique, providing both good image contrast and throughput.

KEY WORDS: MRI, spine, automated

Figure: Thirty-year-old male. Sagittal 70 cm composites (A = water, B = fat, C= T2 FSE) and coronal 35 cm lower station (D = water, E = fat). Note L5-S1 disk protrusion (lower arrow A), large C-7 (upper arrows A) and smaller L-2 hemangiomas (arrows D,E).
Feasibility of enrollment in prospective, blinded, randomized vertebroplasty trials has not been demonstrated previously. Referring physician and patient bias that vertebroplasty is of proved efficacy might limit enrollment. We present our experience in success of patient enrollment in the recently completed investigational vertebroplasty efficacy and safety trial (INVEST), a prospective, randomized, blinded trial comparing vertebroplasty to a “control intervention,” in which a vertebroplasty is simulated but no cement infused.

MATERIALS & METHODS
At 12 US and 7 international sites a total of 2101 patients were screened for enrollment in the INVEST trial, of which 425 (20%) were eligible for enrollment. The overall enrollment rate of eligible patients was calculated 131/425 (31%). Enrollment rates for eligible patients were calculated for domestic versus international sites, as well as for sites enrolling two or more patients versus sites enrolling zero or one patient. Enrollment rates for domestic sites enrolling two or more patients also was calculated.

RESULTS
Among 425 eligible patients in the entire trial, 131 (31%) agreed to be randomized. Among 289 eligible, domestic patients, 44 (15%) agreed to be randomized. Among 136 eligible, international patients, 87 (64%) agreed to be randomized. Among the 10 centers that enrolled two or more patients, 128 (44%) of 290 eligible patients agreed to be randomized, while among the nine centers with zero or one patient enrolled, two (1%) of 134 eligible patients agreed to be randomized. Among the three domestic centers enrolling two or more patients, 42 (27%) of 155 eligible patients agreed to be randomized.

CONCLUSION
Enrollment of patients into blinded, placebo controlled vertebroplasty trials is feasible, especially in international centers. Selected United States centers also are capable of enrolling these patients.

KEY WORDS: Vertebroplasty, recruitment
Materials & Methods
Institutional review board approval was waived for this study. This ongoing survey study consists of questionnaires sent to 186 American academic radiology training programs on November 15, 2008. All participants were informed of the study purpose. The survey included questions about departmental demographics, performance of spinal pain injections by radiologists and nonradiologists in the surveyed institutions, number of injections performed by radiologists, types of image guidance utilized, trainee exposure to spinal injections, the role of midlevel providers in spinal injection performance, and patient follow-up protocols.

Results
While data collection is ongoing, at this time 12% (22/186) of questionnaires have been returned. Of these responders, spinal pain injections are performed by radiologists in 55% (12/22) of the departments. Within radiology departments, neuroradiologists perform the most injections, followed by musculoskeletal radiologists, followed by vascular and interventional radiologists. Five departments perform less than 10% of the total number of spinal injections performed at their institution, with two departments stating they performed 10-25%, four departments performing 26-50%, and one department performing greater than 75% of the total institutional spinal injection volume. In all 22 of the respondents, nonradiologists perform some portion of their institution’s total spinal injection volume; including anesthesiologists, physiatrists, orthopedic surgeons and neurosurgeons. With regard to image guidance, 100% (12/12) of the radiologists perform injections primarily utilizing conventional fluoroscopy for guidance, with 58% (7/12) utilizing CT fluoroscopy or conventional CT guidance less frequently. Conventional fluoroscopy is used by 82% (18/22) of nonradiologists performing spinal injections, with less than 10% utilizing CT or CT fluoroscopy guidance. Spinal injections without image guidance are being performed by nonradiologists at 27% (6/22) of respondent institutions. The mode follow-up time by radiologists is 24 hours (range 24 hours to 14 days), most often by phone. The reported average number of total injections performed by each radiology department is 450 per year, with a daily average of two injections. In departments that perform spinal injections, radiology residents are exposed to spinal pain injections in 75% (8/12) of training programs, and reportedly become proficient in 50% (6/12) of the programs. In those same departments, radiology fellows are exposed to and reportedly become proficient in spinal injection performance in 92% (11/12).

Conclusion
Slightly more than half of the radiology departments perform spinal pain injections, most commonly in the neuroradiology division. The total number of injections and percentage of total institutional volume performed by radiologists varies among academic centers. A majority of these spinal pain management injections are performed via conventional fluoroscopic guidance. Nonradiologists from multiple specialties perform a significant portion of spinal pain injections at many institutions, mostly utilizing fluoroscopic guidance. Half of residents and nearly all fellows in sections who perform spinal injections become proficient with injection techniques. Radiology residencies and fellowships may need to include spinal pain injection training in their curriculum in order to meet future referral demands.

Key Words: Pain management, spinal injections, survey

Paper 344 Starting at 4:11 PM, Ending at 4:19 PM
Low-Risk Lumbar Skin Stigma: The Role of Ultrasound Screening

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Purpose
Since midline skin lesions in the neonates may be associated with tethered cord syndrome (TCS), it was important to classify the more “benign” lesions in order to obviate the need for a routine ultrasound in these common cases.

Materials & Methods
In this prospective study, 254 infants, under 6 months of age, with suspicious dorsal midline skin stigma underwent high-resolution ultrasound. All were examined by neurosurgical evaluation, and 50 had MR imaging examinations. Ultrasound and MR imaging findings were analyzed for correlation. We also evaluated the association between low-risk skin lesions of simple dimples (113 cases) and deviated gluteal folds (44 cases) and their respective imaging findings.

Results
Analysis of US and MR imaging results for a cohort of 50 neonates showed a very high level of concordance. The low risk group of simple dimples and deviated gluteal fold constituted 157 US, 96% of highly quality, providing clear visualization of spinal components. None had clinically significant pathologic findings.

Conclusion
Ultrasound reliability as a screening tool is reaffirmed. Low-risk lesions, simple dimples, and deviated gluteal folds may be absolved from US screening. We further propose a simplified diagnostic classification system for midline skin stigmata.

Key Words: Tethered cord syndrome, lumbar skin stigmata, simple dimple

Paper 345 Starting at 4:19 PM, Ending at 4:27 PM
Effect of Tonsilar Position on Cerebrospinal Fluid Flow in the Spinal Subarachnoid Space Studied with Computational Fluid Dynamics

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Purpose
Phase contrast MR (PC MR) has demonstrated changes in cyclic CSF flow in the foramen magnum due to abnormal tonsillar position in the Chiari I malformation. Phase contrast MR has not demonstrated the effect of tonsil position on CSF pressures. The goal of this study was to develop an idealized 3D
computational model of the subarachnoid space, and then use
this model to study the detailed spatio-temporal effects of
anatomical variations on CSF pressures and velocities.

**MATERIALS & METHODS**

A geometric model ("normal") was created with a computer-
assisted design program. The model contained a central
structure for the brain and spinal cord axis, and a second sur-
rounding structure for the peripheral borders of the sub-
arachnoid space. Model dimensions were adjusted to
approximate those in a 3D atlas of a normal human posterior-
or fossa and cervical spinal anatomy. A second model
("Chiari I") was created in which the tonsils were changed in
position to occupy the upper cervical spinal canal. Cerebrospinal fluid velocities and pressures during cranio-
caudal and caudo-cranial flow were calculated with compu-
tational fluid dynamics (CFD) software. Cine and static flow
images were created. Simulated flow was compared to pub-
lished phase contrast MR measurements of CSF flow in
healthy human subjects.

**RESULTS**

The dimension of the subarachnoid space in axial and sagi-
tal projections of the two models approximated those in axial
and sagittal MR images of a normal subject and a Chiari I
patient. Flow velocities varied with the time in the cycle and
location in space. Velocities were greater in the Chiari I
model than in the normal model. Flow velocities had spatial
variations that resembled those in normal human subjects
and Chiari I patients. Pressure varied uniformly along the
long axis of the model during cranio-caudal and caudo-cra-
nial flow in both models. Maximal pressure gradients were
larger in the Chiari I model compared to the normal model.

**CONCLUSION**

In models approximating the anatomy of the human sub-
arachnoidal space, CSF velocities and pressures can be studied
in spatio-temporal detail with mathematical models.

**KEY WORDS:** Chiari I malformation, CSF flow imaging, MR

**Paper 346 Starting at 4:27 PM, Ending at 4:35 PM**

**Comparison of MERGE and Axial T2-Weighted FSE
Sequences in the Detection of Demyelinating Lesions in
the Cervical Spinal Cord**

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Vertinsky, A.

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**PURPOSE**

Cervical spine MR imaging is important in work up of
demyelinating disease, particularly in suspected multiple
sclerosis (MS), as spinal cord lesions fulfill criteria for dis-
semination of disease in space and increase diagnostic speci-
ficity. While T2-weighted fast spin echo (FSE) sequence is
typically applied, newer sequences such as multiple-echo
recombined gradient-echo (MERGE) have reduced pulsation
artifact and demonstrate excellent gray-white matter resolu-
tion, maximizing lesion detection. Here we evaluate the abil-
ity of MERGE to detect demyelinating lesions in the cervi-
cal cord and compare it with axial T2-weighted FSE.

**MATERIALS & METHODS**

A retrospective analysis of cervical spine MR images was
performed in 29 subjects with known demyelinating lesions
and 29 normal controls. All cases had at least MERGE (an
axial sequence), axial T2-weighted FSE, and sagittal T2-
weighted FSE sequence acquisitions. An experienced neuro-
radiologist reviewed MERGE and axial T2-weighted FSE
images independently in a randomized blinded fashion for
presence and location of cord lesions. The rater also assigned
a degree of confidence (1=low to 5=high) to each lesion, and
a degree of artifact to each sequence (1=marked to 5=none).
The reference standard involved nonblinded review of each
case, with lesions defined as being present if detected on two
or more of all available sequences. In review of each case,
MERGE and T2-weighted FSE also were compared for
overall lesion conspicuity.

**RESULTS**

Ninety-nine lesions were assessed. Eighty-five true positive
and 19 false positive lesions were seen on MERGE(mean
confidence 4.85+/-.049). While only 58 true positives were
identified on T2-weighted FSE(mean confidence 4.62+/-
0.64), it had a lower rate of only 11 false positives. In the
normal controls, 18 false positives were recorded with MERGE,
misclassifying seven subjects, as compared to six false
positives and five misclassified subjects with T2-
weighted FSE. Mean artifact scores were similar for both
sequences(MERGE 3.82+/-.105, T2-weighted FSE 3.79+/-
0.74). Subjectively, lesions were better visualized in 21 cases
on MERGE, four cases on T2-weighted FSE, and equally
demonstrated in four cases.

**CONCLUSION**

Multiple-echo recombined gradient-echo and T2-weighted
FSE sequences are complementary in the identification of
demyelinating lesions. Multiple-echo recombined gradient-
echo demonstrates greater sensitivity for cord lesions, inde-
pendently identifying 86% of true lesions, but with a higher
false positive rate. While T2-weighted FSE failed to identify
41% of cord lesions, it has greater specificity and is corre-
lated more easily with sagittal T2-weighted FSE. Although
MERGE is susceptible to motion artifact, artifact scores
were similar overall and lesion conspicuity was greater on
MERGE (Figure).

**KEY WORDS:** Demyelination, spinal cord, MRI
**Paper 347 Starting at 4:35 PM, Ending at 4:43 PM**

**Diffusion-Weighted MR Imaging and Spinal Infections: Preliminary Results in Diagnosis and Monitoring Treatment Response**

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**PURPOSE**

Conventional spine MR imaging is limited in diagnosing and monitoring patients with spinal infections. There is often a delay before pertinent imaging findings are demonstrated and findings may be difficult to differentiate from degenerative, neoplastic and postoperative changes. Techniques that allow accurate and early detection of spinal abscesses therefore would be valuable. Diffusion-weighted imaging (DWI) has been useful in evaluation of cerebral infections but has not been utilized for commonly evaluation of spine infection. We sought here to evaluate the usefulness of DWI in diagnosing and monitoring treatment effects of spinal infections.

**MATERIALS & METHODS**

Fourteen patients with suspected spinal infection underwent MR imaging of the spine with DWI. (Philips 1.5 T Gyroscan Intera, the Netherlands): DWI was performed in three directions (single-shot echo-planar: TR 2 x pulse-pulse interval; TE 15 msec; FOV 22; 256x144; 5.0/0.5 mm; B-value 400 sec/mm²). Apparent diffusion coefficient (ADC) maps were obtained and regions of interest (ROI) were drawn and analyzed for mean ADC values using software available on the scanner. Studies were read by two blinded neuroradiologists. Correlation was made with microbiologic specimens obtained via image-guided or surgical biopsies. Concurrent antibiotic therapy also was noted.

**RESULTS**

Twelve of 14 patients had microbiologic specimens obtained. Nine patients had evidence of spinal infection confirmed by microbiology. Five patients had reduced diffusion on DWI, verified on ADC maps (an additional patient did not have a microbiologic specimen but was on antibiotic therapy at time of study); average ADC value was: 0.611 x 10⁻³mm²/sec. One of these patients had a 1-week follow-up DWI after antibiotic therapy which demonstrated normalization of ADC within the area of infection. The remaining 4 patients with infection demonstrated increased diffusion, average ADC 1.997 x 10⁻³mm²/sec. One patient had atypical infection mycobacterium tuberculosis; three of the four had paraspinal soft tissue infections. Of the three patients with negative microbiologic specimens, 3/3 showed increased diffusion on DWI, average ADC 1.616 x 10⁻³mm²/sec; none were on antibiotic (pathology revealed multiple myeloma, hematoma and seroma respectively).

**CONCLUSION**

Diffusion-weighted imaging is a sensitive technique for evaluating spinal infections and is most sensitive evaluating epidural collections and those of typical pyogenic etiology. Our preliminary data suggests that diffusion-weighted images show reduced diffusion regardless of antibiotic use. Diffusion-weighted imaging may be a less sensitive measure of infection in postoperative paraspinal soft tissue infections. Diffusion-weighted imaging is another tool to help guide in diagnosing and monitoring therapy in spine infection.

**KEY WORDS:** Spine, infection, diffusion

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**Paper 348 Starting at 3:15 PM, Ending at 3:23 PM**

**Nasopharyngeal Carcinoma: Pretreatment Evaluation of Distant Sites Status with 3.0 T Whole-Body MR Imaging and Integrated FDG PET/CT**

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**PURPOSE**

Patients with nasopharyngeal carcinoma (NPC) have a high risk of having distant metastases. We prospectively evaluate the efficacy of whole-body MR imaging and integrated fluorine-18-deoxyglucose positron emission tomography (PET)/computed tomography (CT), and their side-by-side visual correlation for assessment of distant sites status of primary NPC patients.

**MATERIALS & METHODS**

Institutional review board approved this study; informed consent was obtained. A total of 150 patients NPC (111 men, 39 women; mean age, 48 years) prospectively underwent both 3.0 T whole-body MR imaging and PET/CT before treatment to detect distant malignancy. Their respective findings were reviewed independently and then compared with each other. The diagnosis was based on biopsy or imaging follow up for 12 months. We analyzed differences in sensitivity and specificity among whole-body MR imaging, FDG
PET/CT, and their visual correlation using the McNemar test. The receiver-operating characteristic (ROC) analysis was used to compare their diagnostic capabilities.

RESULTS
Eighteen (12%) of our 150 patients had distant malignancy, including 15 patients had distant metastases and three had distant synchronous second primary tumors. Diagnostic yields of whole-body MR imaging and PET/CT were 9.3% and 8.7%, respectively. Whole-body MR imaging was more sensitive than PET/CT in detecting malignancies in the lung, liver and adrenal gland but was less sensitive in detecting malignancies in the bone and colon. The false positive rates of whole-body MR imaging and PET/CT were 12.5% and 18.8% respectively. Whole-body MR imaging had more false positive results in the liver whereas PET/CT had more false positive results in the bone and distant nodes. On a patient-based analysis, there were no significant differences between whole-body MR imaging and PET/CT with respect to the sensitivity (77.8% vs. 72.2%, P = 1) and specificity (98.5% vs. 97.7%, P = 1). The ROC analysis revealed whole-body MR imaging had similar diagnostic capability with PET/CT for distant malignancy detection (0.905 vs. 0.878, P = 0.669). Visual correlation of whole-body MR imaging and PET/CT improved the sensitivity and specificity up to 88.9% and 99.2%, respectively, but its diagnostic capacity was still not significantly different from those of whole-body MR imaging alone (0.935 vs. 0.905, P = 0.447) and PET/CT alone (0.935 vs. 0.878, P = 0.255).

CONCLUSION
For detection of distant malignancies in untreated NPC, whole-body MR imaging provided similar diagnostic accuracy with PET/CT and can be employed as a first-line imaging modality. Side-by-side visual correlation of whole-body MR imaging and PET/CT was not significantly better than either modality alone.

KEY WORDS: Nasopharyngeal carcinoma, whole-body MRI, PET/CT

MATERIALS & METHODS
Initial staging MR studies from 50 consecutive pretreatment NPC patients were identified. The nasopharyngeal/ parapharyngeal tissues were separated into right/left sides and assessed separately. Three head and neck neuroradiologists independently reviewed each side in a randomized blinded fashion for the presence of PPE based on the AJCC staging definition. PPE’s relationship to 1) presence of pharyngobasilar fascia attenuation or disruption; and 2) tumor extension beyond a previously described “line” joining the medial pterygoid plate and the lateral ICA was evaluated. In addition, we also examined the relationship of the AJCC PPE definition to tumor involvement of six structures adjacent to the PBF [1. levator veli palatini (LvP); 2. tensor veli palatini (TvP); 3. neurovascular bundle (NVB); 4. pre- pharyngeal parapharyngeal fat (PsF); 5. prevertebral musculature (PvM); and 6. pterygoid process marrow signal change (PtM)]. Data were compared using the Kappa statistic and McNemar’s Test.

RESULTS
Tumor was present in 83/100 sides, with PPE present in 47 (57%). There was good inter and intraobserver agreement for PPE. In normal sides, the PBF was always detected. Attenuation or disruption of the PBF was a very good proxy for PPE (sensitivity 99%, specificity 94%, kappa 0.95, p<0.001). In contrast, the “line” was a poor proxy for PPE (sensitivity 41%, specificity 100%, kappa 0.4, p<0.001), systematically undercalling disease extension (McNemar’s p<0.001). In this series, PPE was always present when any of the six anatomical structures was involved. However, no individual structure was involved in all cases (Table). Of note, isolated prevertebral involvement, which is not clearly addressed in the staging definition, occurred in three cases.

Table: Relationship of PPE cases (n=47) to tumor involvement of six structures adjacent to the PBF

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CONCLUSION
Although the staging definition of PPE has limitations, it can be assessed reliably on MR imaging by different readers. Attenuation or disruption of the pharyngobasilar fascia is a very good surrogate for PPE. The “line,” however, is a poor proxy for PPE. While all of the six evaluated anatomical structures were highly specific, none had adequate sensitivity when evaluated in isolation. Future versions of the staging may be improved by incorporating more specific reference to standard radiologic spaces and landmarks.

KEY WORDS: Nasopharyngeal carcinoma, staging, parapharyngeal
Posttreatment FDG-PET in Head and Neck Cancer Predicts Tumor Recurrence

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PURPOSE
To investigate the prognostic value of FDG-PET standardized uptake values (SUV) prior to and following radiotherapy in patients with head and neck squamous cell carcinomas (HNCa).

MATERIALS & METHODS
A retrospective nested-cohort study was performed on patients with HNCa who underwent curative-intent intensity modulated radiation therapy (IMRT) between August 2004 and September 2008 and received pretreatment FDG-PET studies. Patients treated with adjuvant postoperative irradiation were excluded. Outcome was measured as locoregional or distant tumor recurrence (failure). A radiologist measured the maximum SUV (SUVmax) for the primary tumor and nodal metastases on both the pretreatment and the posttreatment FDG-PET. Chi-square test and multivariate logistic regression analyses were used to find parameters associated with treatment failure.

RESULTS
Ninety-nine of 324 patients met the study criteria. The median follow-up time for 91 surviving patients was 18 months (range 2-49). Twenty (20%) patients had tumor recurrence after treatment: 8 (8%) locoregional only, 5 (5%) distant only, and 7 (7%) both locoregional and distant. Forty-nine patients had a second FDG-PET study at a median time of 2 months (range 2-49). Twenty (20%) patients had tumor recurrence: 8 (8%) locoregional only, 5 (5%) distant only, and 7 (7%) both locoregional and distant. Twenty-two patients underwent routine contrast-enhanced computerized tomography (CECT) and pretreatment FDG-PET. Tumor response was determined according to radiologic (RECIST) criteria. The median follow-up time for posttreatment FDG-PET was 18 months (range 1-13) following radiotherapy. There was no association between treatment failure and the following variables: age, sex, primary tumor site, tumor stage, concurrent chemotherapy and neck dissection (Table). Four factors were found to be significant on univariate analysis: postradiotherapy SUVmax in the primary tumor, postradiotherapy SUVmax in the nodal metastasis, reduction in SUVmax of primary tumor, and reduction in SUVmax of nodal metastasis (Table). However, on multivariate analysis only postradiotherapy SUVmax in the nodal metastasis was an independent predictor of treatment failure (p-value = 0.028).

CONCLUSION
Posttreatment SUVmax in the lymph node was found to be an independent predictor of locoregional and distant failure. Surprisingly, pretreatment SUVmax was not found to be prognostic. Although our study was limited by low proportion of failure and short follow-up duration, these results suggest an additional role of posttreatment FDG-PET in providing prognostic information for HNCa. This study should be extended by a future prospective study with a dedicated follow-up time for posttreatment FDG-PET.

KEY WORDS: FDG-PET, head and neck carcinoma, prognosis

Table. Characteristics of Head and Neck SCCa With and Without Tumor Recurrence

<table>
<thead>
<tr>
<th>Univariate analysis</th>
<th>Multivariate analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>No Failure (n=79)</td>
<td>Failure (n=20)</td>
</tr>
<tr>
<td>Age, years</td>
<td>59 (57, 62)</td>
</tr>
<tr>
<td>Male</td>
<td>63 (80%)</td>
</tr>
<tr>
<td>SITE</td>
<td>N0-1</td>
</tr>
<tr>
<td>Nasopharynx</td>
<td>4 (6%)</td>
</tr>
<tr>
<td>Oropharynx and oral cavity</td>
<td>54 (68%)</td>
</tr>
<tr>
<td>Larynx and Hypopharynx</td>
<td>16 (20%)</td>
</tr>
<tr>
<td>Unknown or other</td>
<td>5 (6%)</td>
</tr>
<tr>
<td>STAGE</td>
<td>T1-2</td>
</tr>
<tr>
<td>T1-2</td>
<td>39 (49%)</td>
</tr>
<tr>
<td>T3-4</td>
<td>40 (51%)</td>
</tr>
<tr>
<td>N0-1</td>
<td>28 (35%)</td>
</tr>
<tr>
<td>N2-3</td>
<td>51 (64%)</td>
</tr>
<tr>
<td>TREATMENT</td>
<td>Primary</td>
</tr>
<tr>
<td>Chemotherapy</td>
<td>69 (87%)</td>
</tr>
<tr>
<td>Post-IMRT Nodal Dissection</td>
<td>34 (43%)</td>
</tr>
<tr>
<td>Node Pre-IMRT SUVmax</td>
<td>15.8 (13.6, 17.9)</td>
</tr>
<tr>
<td>Node Post-IMRT SUVmax</td>
<td>4.7 (3.9, 5.5)</td>
</tr>
<tr>
<td>Node Primary SUVmax</td>
<td>0.87 (0.81, 0.92)</td>
</tr>
<tr>
<td>Node Node SUVmax</td>
<td>13.9 (11.5, 16.3)</td>
</tr>
<tr>
<td>Node Post-IMRT SUVmax</td>
<td>2.7 (2.3, 3.0)</td>
</tr>
<tr>
<td>Node Reducetion SUVmax§</td>
<td>0.87 (0.82, 0.92)</td>
</tr>
</tbody>
</table>

SUVmax = Maximum standardized uptake value; Primary = primary tumor; Node = nodal metastasis with greatest SUVmax
*Proportion, n (%).
§ Proportion reduction of SUVmax comparing post-IMRT PET to pre-IMRT PET

Paper 351 Starting at 3:39 PM, Ending at 3:47 PM

Response to Induction Chemotherapy and Progression-Free Survival in Oropharyngeal Carcinoma Assessed by Perfusion CT: Comparison with Tumor Volume Measurements

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1Karl Eberhards University Hospital, Tübingen, GERMANY 2Medical University of South Carolina, Charleston, SC, 3JWG University Hospital, Frankfurt, GERMANY

PURPOSE
To assess whether pretreatment dynamic perfusion CT (PCT) and/or tumor volume measurements may predict response to induction chemotherapy and midterm progression-free survival (PFS) in advanced oropharynx squamous cell carcinoma (SCCA).

MATERIALS & METHODS
Twenty-two patients underwent routine contrast-enhanced CT (CECT) and pretreatment PCT. Tumor response was determined according to radiologic (RECIST) criteria. The PCT parameters, tumor volume, radiologic response, and...
progression-free survival (PFS) were analyzed using Cox-proportional hazards model, receiver operating characteristic (ROC), and Kaplan-Meier analysis.

RESULTS
The baseline blood flow (BF), blood volume (BV), and permeability surface area product (PS) were significantly higher while mean transit time (MTT) was significantly lower in the responders than in the nonresponders \((p<0.002)\). Blood volume showed 100% sensitivity, MTT and PS had the highest specificity (100%) and BF showed 84% sensitivity and 67% specificity for prediction of tumor response after induction chemotherapy. The pretreatment tumor volume was correlated with PFS in the pooled patients group \((r=-0.5, p<0.0001)\) while postinduction tumor volume was significantly correlated with PFS in the responders and nonresponders \((r=-0.3 \text{ to } -0.68, p<0.006)\). Pretreatment tumor volume \((p=0.0001)\) and BF \((p=0.001)\) were significant predictors for PFS.

CONCLUSION
Pretreatment PCT parameters may predict response after induction chemotherapy. Tumor volume and BF values may predict PFS in patients with advanced oropharynx SCCA.

KEY WORDS: Perfusion CT, squamous cell carcinoma

Paper 352 Starting at 3:47 PM, Ending at 3:55 PM
Asymmetric Mineralization of the Arytenoid Cartilage in Patients Without Laryngeal Cancer

Zan, E. · Aygun, N. · Yousem, D. M.
The Johns Hopkins Medical Institution Baltimore, MD

PURPOSE
Neoplastic invasion of the laryngeal cartilages in the setting of laryngeal cancer translates to a higher T stage and is an important consideration for planning of the surgical and nonsurgical treatment (1). Cartilage involvement presents as sclerotic or lytic lesions of the cartilages on CT scans which usually is judged by comparison to the same cartilage on the contralateral side. The overall accuracy of CT for cartilage invasion is about 80% (2). Asymmetric mineralization of the cartilages is seen on CT scans in individuals without laryngeal cancer and may be contributing factor to CT’s inaccuracy. We sought to determine the frequency of asymmetric mineralization of the arytenoid cartilages in individuals without laryngeal cancer.

MATERIALS & METHODS
We retrospectively evaluated 972 consecutive trauma patients who had cervical spine CT scans in our ED. Three hundred eighteen patients were excluded who were younger than 18 years old or whose arytenoids could not be reliably seen due to artifacts. Six hundred fifty patients \((424 \text{ male}, 226 \text{ female})\) were assessed; mean age was 44.2 years \((\text{range 18-97})\). The calcification of the arytenoid cartilages was scored as grade 0: no calcification, grade 1: calcification involving less than 1/3 of the cartilage, grade 2: calcification involving 1/3-2/3 of the cartilage, grade 3: calcification involving greater than 2/3 of the cartilage. The right and left arytenoid cartilages were scored separately and were compared for asymmetry in different age groups and genders.

RESULTS
There were 173 patients in group 1 (18-29 years), 210 in group 2 (30-39 years), 130 in group 3 (40-49 years), 113 in group 4 (50-59 years) and 130 in group 5 (>60 years). The overall frequency of asymmetric arytenoid cartilage mineralization was 7.38%. When compared based on gender the overall asymmetry was 8.4% in female and 6.8% in male patients. The rate of asymmetry in arytenoid calcification by different age and gender groups is depicted in the following table.

<table>
<thead>
<tr>
<th>Gender</th>
<th>Group 1</th>
<th>Group 2</th>
<th>Group 3</th>
<th>Group 4</th>
<th>Group 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>10.8%</td>
<td>9.5%</td>
<td>6%</td>
<td>4%</td>
<td>1.4%</td>
</tr>
<tr>
<td>Female</td>
<td>5.6%</td>
<td>8.1%</td>
<td>8.7%</td>
<td>16.2%</td>
<td>5.6%</td>
</tr>
</tbody>
</table>

CONCLUSION
Asymmetric mineralization of the arytenoid cartilages is seen at a 7.38% overall in the general population of trauma patients. This should be taken into account when evaluating CT scans of laryngeal cancer patients for arytenoid cartilage invasion to avoid false positive reads.

REFERENCES

KEY WORDS: Asymmetric arytenoid calcification, laryngeal cancer

Paper 353 Starting at 3:55 PM, Ending at 4:03 PM
Imaging Findings of Laryngeal Lymphoma

Siddiqui, N. · Branstetter, B. F. · Hamilton, B. · Ginsberg, L. · Glastonbury, C. · Harnsberger, R. · Barnes, L. · Myers, E. N. 1
1University of Pittsburgh, Pittsburgh, PA, 2Oregon Health Sciences University, Portland, OR, 3MD Anderson Cancer Institute, Galveston, TX, 4San Francisco VA Medical Center, San Francisco, CA, 5University of Utah, Salt Lake City, UT

PURPOSE
Lymphoma of the larynx is a rare tumor accounting for less than 1% of laryngeal tumors. Fewer than 100 cases are reported in the literature, with the largest imaging review involving four patients. The purpose of our study was to delineate the features of laryngeal lymphoma using CT, PET and MR imaging, and to identify features that could distinguish laryngeal lymphoma from the far more common squamous cell carcinoma.

MATERIALS & METHODS
Multiinstitutional retrospective imaging and chart review revealed 19 patients with histopathologically proved laryngeal lymphoma. CT, PET and MR images were reviewed by
a dedicated Head & Neck radiologist with focus on the site of origin, margins, nodal extension, metabolic activity, signal intensity, and enhancement pattern of the tumor.

**RESULTS**

Patients ranged in age from 30 to 90 years with a mean of 61 years at the time of initial diagnosis. A 2:1 female preponderance was found. Laryngeal lymphoma was located in the supraglottis [19/19 (100%)], also extended into the glottis [12/19 (63%)], and subglottis [6/19 (32%)]; and was submucosal [10/19 (53%)], mucosal [7/19 (37%)], or within both locations [2/4 (10%)]. Involvement of the false cords [14/19 (74%)], aryepiglottic folds [10/19 (53%)], epiglottis [8/19 (42%)], paraglottis [6/19 (32%)], true cords [9/19 (47%)], anterior commissure [8/19 (42%)], and laryngeal cartilage [2/19 (11%)] was noted. The tumor sometimes extended beyond the larynx into the hypopharynx [11/19 (58%)], strap muscles [2/19 (11%)], tongue base [1/19 (5%)], and the oropharynx [3/19 (16%)]. Cervical lymphadenopathy was seen in 4/19 (21%). Lymphoma was usually FDG-avid [4/4 (100%)] and enhanced uniformly with iodinated contrast [10/13 (77%)]. No necrosis or calcifications were seen on CT imaging. MR imaging demonstrated intermediate T1-weighted and T2-weighted signal, along with homogenous enhancement after contrast administration.

**CONCLUSION**

Although laryngeal lymphoma is rare, there are some distinctive imaging features that should raise the possibility of this diagnosis. Large, uniformly enhancing tumors without central necrosis are uncharacteristic of squamous cell carcinoma, but are characteristic of lymphoma. Although some squamous cell carcinomas are submucosal, this finding is more characteristic of lymphoma. Like squamous cell carcinoma, lymphoma may show evidence of cervical adenopathy and extension into the subglottis, oropharynx, strap muscles, and laryngeal cartilages.

**KEY WORDS:** Lymphoma, larynx

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**Paper 354 Starting at 4:03 PM, Ending at 4:11 PM**

**Value of Needle-Washout Thyroglobulin Measurement for the Diagnosis of Postoperative Recurrence: Is It Necessary to Be Combined with Ultrasounds-Guided Fine Needle Aspiration Cytology in Thyroid Cancer Follow Up?**

Lee, Y.¹ · Seo, H.¹ · Suh, S.² · Lee, J.¹ · Kim, N.¹ · Seo, J.¹

¹Ansan Hospital Korea University College of Medicine, Ansan, REPUBLIC OF KOREA, ²Guro Hospital Korea University College of Medicine, Seoul, REPUBLIC OF KOREA

**PURPOSE**

To determine the role of needle-washout thyroglobulin (Tg) measurement combined with ultrasound (US)-guided fine needle aspiration cytology (FNA-C) in total-thyroidectomized patients for the diagnosis of recurrence.

**MATERIALS & METHODS**

Ultrasound-guided FNAs were done for suspicious lesions in neck in 38 patients (male: female=8:30, mean age: 44 years) who underwent total thyroidectomy (mean duration: 28.6 months), to obtain specimen for FNA-C and FNA-Tg. Their cytologic results were classified into three: insufficient sampling, benign and malignant. Ig/ml was used as cut-off value for FNA-Tg. We also compared their sonographic findings including location, multiplicity, size, shape, margin, echogenicity; and calcification. After initial US-guided FNA, surgical resection or US follow up at least 1 year was later made in all patients to confirm the diagnosis.

**RESULTS**

Of 38 lesions (mean size: 0.84 cm, range: 0.3- 3.5 cm), 19 (11 lateral; 8 central) were confirmed as recurrent tumors, and 19 (17 lateral; 2 central) were nonrecurrent lesions. Sensitivity and specificity of FNA-Tg were 100% (19/19), and 89.5% (17/19). Sensitivity and specificity of FNA-C were 100% (10/10), and 90.9% (9/10). Of 17 lesions classified as insufficient sampling by FNA-C, FNA-Tg results of 9 recurrent and 8 nonrecurrent lesions were concordant with final diagnosis. There was no statistical difference in sonographic findings between two groups.

**CONCLUSION**

Fine needle aspiration-Tg should be combined with FNA-C to confirm the possibility of recurrence in patient with thyroidectomy, especially when small size or an inconclusive sonographic finding.

**KEY WORDS:** Thyroid cancer
blinded protocol. Data acquisition consisted of two phases. In the initial phase, each reader independently reviewed each exam for suspicion of metastatic lymphadenopathy by laterality and nodal level. One reader reviewed the exams on two separate occasions, separated by at least 1 month. Inter and intraobserver agreement was examined using both the Kappa statistic and the intraclass correlation coefficient. The second phase of the study sought to provide objective criteria to determine abnormal contrast enhancement/density within suspicious LN. Prior to the independent assessment of specific suspicious LN, all discordant cases in the initial phase were reviewed and reconciled in a consensus conference. Criteria for subsequent assessment of individual suspicious LN included: 1) subjective assessment of abnormal contrast enhancement/density, and 2) formal Hounsfield Unit (HU) measurement of suspicious LN (sLN) along with a nonsuspicious normal density reference LN (nLN), and the sternocleidomastoid muscle (SCM). Differences in HU were evaluated using Student’s t-test for paired data. The Area Under (AUC) the Receiver Operator Characteristic (ROC) curve was used to determine the density in HU that best differentiated subjectively normal from abnormally enhancing/dense LNs.

RESULTS
There was good inter and intraobserver agreement for identification of neck side and nodal levels. There were 32 subjectively enhancing lymph nodes in 11 patients. Enhancement was notably different for sLNs compared to the normal matched reference node and to the SCM (mean difference: 59 HU with nLN, and 61 HU SCM; p<0.001). In this series, the median HU for suspicious LN was 130 HU (IQR: 109 to 147 HU) compared to 62 HU for nLN (IQR: 55 to 76 HU) and 70 HU for SCM (IQR: 60 to 73 HU). A density of >88 HU best discriminated subjectively normal from abnormal nodes (Sensitivity 97%, Specificity 92%, AUC 0.99).

CONCLUSION
At our institution, preoperative imaging with CECT is employed almost universally for PTC. Using strict criteria on CECT for the identification of suspected metastatic LN, high inter and intraobserver agreement can be achieved. Contrast-enhanced CT is a potentially valuable preoperative imaging tool to guide appropriate concomitant LN dissection at the time of definitive surgery.

KEY WORDS: Thyroid cancer, lymph nodes, CT

Paper 356 Starting at 4:19 PM, Ending at 4:27 PM
Thyroid Cancer Risks During CT Perfusion Studies of the Neck

Spampinato, M. · Sterzik, A. · Rumboldt, Z. · Cianfoni, A. · Huda, W.
Medical University of South Carolina
Charleston, SC

PURPOSE
To assess the thyroid cancer risk from the radiation received by patients undergoing CT perfusion examinations of the neck.

MATERIALS & METHODS
CT perfusion studies are performed on a GE LightSpeed 16 scanner at 80 kV and 200 mAs. A total of 50 scans, each taking 1 second, are performed over a time interval of 50 seconds. Thyroid doses were obtained using a spreadsheet developed using Monte Carlo dose calculations (ImPACT), and thyroid doses were converted into risks of cancer incidence using data provided in the BEIR VII report. Doses were computed assuming that the x-ray beam was centered on the thyroid gland, which would maximize the absorbed dose to the thyroid gland.

RESULTS
Males account for 60% of the patient population, whose average age is 50 years. Our CT perfusion protocol has a CTDIvol of 12.7 mGy per scan, and the highest possible total thyroid dose from 50 scans is estimated at 0.45 Gy. The thyroid cancer risk for a 50-year-old female receiving this maximum dose is 1.8 per 10,000, and the corresponding risk for males is approximately a factor of four.lower. CT scans of the neck that do not directly irradiate the thyroid gland reduce radiation doses, and the corresponding risks, by at least 80%.

CONCLUSION
Average thyroid cancer risks in neck perfusion CT studies are well below 0.01%.

KEY WORDS: Radiation dose, CT perfusion, thyroid

Paper 357 Starting at 4:27 PM, Ending at 4:35 PM
Assessment of Hyperfunctioning Parathyroid Adenomas Using Multiphase Multidetector CT

Vu, T. H. · Ahmed, S. · Perrier, N. D. · Guha-Thakurta, N. · Kumar, A. J. · Hamberg, L. M. · Hunter, G. J.
1The University of Texas M.D. Anderson Cancer Center, Houston, TX, 1Massachusetts General Hospital and the Harvard Medical School, Boston, MA

PURPOSE
To characterize the baseline and postcontrast enhancement pattern of hyperfunctioning parathyroid adenomas versus thyroid gland using multiphasic multidetector computed tomography (MDCT).

MATERIALS & METHODS
The multiphase MDCT images of 22 pathologically proved hyperfunctioning parathyroid adenomas were analyzed retrospectively. Unenhanced MDCT was followed by enhanced MDCT at 25, 55 and 85 seconds. Region of interest were drawn and recorded over the parathyroid adenomas and thyroid glands at each scan interval.

RESULTS
The mean nonenhanced CT density of parathyroid adenomas was 33 HU +/- 12 (mean +/- standard deviation) compared to 91 HU +/- 19.0 for thyroid tissue (P<.01). Peak enhancement occurred at 25 seconds and the CT density of parathyroid adenomas and thyroid glands were 188 HU +/- 53 and 201 HU +/- 32, respectively (P>.05). At 55 seconds, mean attenuation of parathyroid adenomas (121 HU +/-27) was significantly lower than the thyroid glands (157 HU +/- 23)
(p<.001). At 85 seconds, mean attenuation of parathyroid adenomas (101 HU +/-25) was significantly lower than the thyroid glands (141 HU +/- 23) (p<.001). The relative percentage increase in enhancement of parathyroid adenomas (559 % +/- 401) at 25 seconds was greater than thyroid glands (175% +/- 203 (P<.0001). The relative percentage decrease in enhancement of parathyroid adenomas (30% +/- 33 and 38% +/- 40) at 55 and 85 seconds was greater than thyroid glands (20% +/- 12 and 28% +/- 12) (P=.002).

CONCLUSION
Hyperfunctioning parathyroid adenomas exhibit a wash-in and wash-out pattern of contrast enhancement, which is greater than that of thyroid tissue. The nonenhanced and early arterial enhancement phases are more robust than the delayed postcontrast phases in differentiating parathyroid adenomas from thyroid tissue.

KEY WORDS: Parathyroid, adenomas, multiphase MDCT

Paper 358 Starting at 4:35 PM, Ending at 4:40 PM
Emergent CT-Guided Percutaneous Drainage of Bilateral Laryngoceles

McDermott, M. · Branstetter, B. F. · Mehta, A. · Ferris, R.
University of Pittsburgh
Pittsburgh, PA

PURPOSE
Laryngoceles are dilated laryngeal saccules that may remain within the cartilaginous boundaries of the larynx or extend through the thyroid membrane. Patients with laryngoceles can present with hoarseness, cough, or a foreign body sensation, but also may be completely asymptomatic with the laryngocele as an incidental radiologic finding. If a laryngocele becomes very large, or if bilateral laryngoceles are present, the patient’s presentation may include airway obstruction. We present a patient whose bilateral laryngoceles reduced his airway to 1mm on CT, and who was urgently treated with emergent CT-guided percutaneous drainage to avoid complete airway obstruction from attempted intubation.

CASE REPORT
Our patient was a 65-year-old male with a history of a supracricoid laryngectomy with epiglottopexy for treatment of a T2N0 SCC of the supraglottis. He presented 2 years after his surgery with a high-pitched voice, progressive sleep apnea, and the inability to complete an entire sentence in a single breath. He was noted to have biphasic stridor that worsened when he was supine. Contrast-enhanced neck CT showed symmetric cystic masses on the lateral aspects of the remaining larynx that reduced the size of the glottic airway to 1mm. Due to the risk of complete airway closure during any attempted intubation, we decided to perform urgent CT-guided percutaneous drainage of the laryngoceles in preparation for definitive surgical treatment.

IMAGING FINDINGS
An otolaryngologist was present during the procedure in case emergent cricothyroidotomy was required. Under CT fluoroscopic guidance, progressively larger needles were inserted from an anterolateral approach into the left-sided laryngocele. Once the needle caliper reached 14G, 15cc of yellow, stringy mucus could be extracted from the cyst. A similar amount of material then was extracted from the right-sided cyst. After aspiration of the first cyst, the patient’s stridor resolved. At the completion of the procedure, the patient’s voice returned to normal. The patient was discharged that evening and underwent routine resection of the laryngoceles 1 month later.

SUMMARY
We report a case of acquired bilateral laryngoceles that presented with a dramatic airway obstruction on imaging and was treated successfully with emergent CT-guided drainage.

KEY WORDS: Laryngocele, CT fluoroscopy, drainage

Paper 359 Starting at 4:40 PM, Ending at 4:45 PM
Osteoblastoma of the Hyoid Bone

Rivera-Serrano, C. · Branstetter, B. F. · Johnson, J. T.
University of Pittsburgh
Pittsburgh, PA

PURPOSE
Solid primary tumors of the hyoid bone are exceedingly rare. Reported cases have included plasmacytoma, osteosarcoma, giant cell tumor, aneurysmal bone cyst, osteoma, and chondrosarcoma. Osteoblastoma is a rare bone tumor first described in 1956. This disease accounts for <1% of all bone tumors and most commonly involves the spine and sacrum of young individuals. Locations in the head and neck include the jaw and the temporal bone, but osteoblastomas of the larynx are extremely rare. We present the first proved case of an osteoblastoma of the hyoid bone.

CASE REPORT
A 51-year-old man presented with a 3-week history of palpable mass in the left neck. Thirty years ago, he had received external beam radiation to his neck for treatment of a fibrosarcoma, and had been disease-free since that time. His voice was unchanged. Physical examination revealed a hard, non-tender, 3cm left neck mass at the level of the hyoid bone. The mass was freely mobile with no associated skin changes, and moved with swallowing.
**IMAGING FINDINGS**

CT revealed a well defined heterogeneously enhancing spherical mass with chondroid calcifications that expanded the left hyoid bone and caused extrinsic compression of the hypopharynx. The preferred radiographic diagnosis was low-grade chondrosarcoma of the hyoid bone. The patient underwent resection of the left hyoid bone, with a pathologic diagnosis of primary osteoblastoma of the hyoid bone. Focal tumor invasion into the surrounding soft tissues was noted, as well as a small secondary aneurysmal bone cyst.

**SUMMARY**

To our knowledge, this is the first report of an osteoblastoma of the hyoid bone. The radiographic appearance is similar to that of low-grade chondrosarcoma, with well defined expansion of the bone and central chondroid matrix.

**KEY WORDS:** Hyoid bone, osteoblastoma, CT

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**Wednesday Afternoon**

**4:45 PM – 6:15 PM**

**Ballroom A**

(44) (ASHNR) Imaging the Acute Head and Neck

(361) Temporal Bone Trauma: What the Radiologist Needs to Know  
— Deborah R. Shatzkes, MD

(362) Infections of the Head and Neck  
— Christine M. Glastonbury, MBBS

(363) Imaging the Acute Post-Treatment Head and Neck Cancer Patient  
— Lawrence E. Ginsberg, MD

Moderator: Lawrence E. Ginsberg, MD

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**Wednesday Afternoon**

**3:30 PM – 5:00 PM**

Room 11

(43) ELC Workshop: Photoshop for Scientific Presentations and Exhibits

(360) Photoshop for Scientific Presentations and Exhibits  
— Steven G. Imbesi, MD

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**Temporal Bone Trauma: What the Radiologist Needs to Know**

*Deborah K. Shatzkes, MD*

**LEARNING OBJECTIVES**

Upon completion of this presentation, participants will be able to:
1) Specify the imaging clues that point to temporal bone trauma.
2) Review the various mimics of temporal bone fracture.
3) Discuss the currently utilized classification schemes for temporal bone fracture.
4) Analyze the imaging findings and clinical features of temporal bone trauma.

**PRESENTATION SUMMARY**

Temporal bone fractures occur in almost a fifth of closed head injuries, and are a significant cause of morbidity and mortality. As these often are picked up during initial head CT scans following trauma, it is important to recognize those imaging clues, such as air or blood in characteristic locations, which indicate the likelihood of a temporal bone fracture. Conversely, it is important to be familiar with the large number of normal anatomical features of the lateral and central skull base that may mimic fractures, including a variety of fissures, sutures and canals. Once a temporal bone fracture is diagnosed, there are several classification schemes available, each with particular benefits. The most frequently used are the longitudinal/transverse/mixed and the otic capsule sparing/violating schemes, the latter currently favored.
because of its strong correlation with clinical outcomes. The clinical sequelae of temporal bone trauma are numerous and include facial palsy, hearing loss, vertigo and brain injury. Familiarity with the imaging features that predict the occurrence of these clinical syndromes will help the radiologist generate a report that is useful to our clinical colleagues.

REFERENCES

Infections of the Head and Neck
Christine M. Glastonbury, MBBS

LEARNING OBJECTIVES
Upon completion of this presentation, participants will be able to:
1) Recognize the causes and appearances of sinonasal and deep neck infections.
2) Review the merits and pitfalls of different imaging modalities for the evaluation of primary infections and their complications.
3) Discuss the radiologist’s role in detecting H&N neck infections and monitoring treatment response.

PRESENTATION SUMMARY
Imaging has a crucial role in the evaluation of patients with head and neck infections. Neck infections may involve the superficial facial tissues, the nodal chains, deep neck spaces, sinonasal cavities, or mastoid air cells. Tonsillitis in children and dental disease in adults are responsible for most deep neck infections. These infections can be complicated by the development of venous thrombosis or compromise of the airway. While sinonasal infections are common, spread of this infection to the orbits or intracranial cavity is fortunately much less frequently seen. The consequences of these complications, however, even in immunocompetent patients, can be dire. Similarly mastoiditis, although now a less common entity, can result in intracranial infection and/or dural sinus thrombophlebitis. The radiologist’s role is to determine the complete extent of any potentially drainable collections, evaluate for complications, including vascular, orbital or intracranial complications, and monitor response to surgical or medical treatment.

Imaging the Acute Post-Trauma Head and Neck Cancer Patient
Lawrence E. Ginsberg, MD

LEARNING OBJECTIVES
Upon completion of this presentation, participants will be able to:
1) Review the common treatment-related complications that can occur in the head and neck cancer patient.
2) Describe the imaging features specific to head and neck therapy.
3) Discuss the imaging strategies and considerations in imaging the treated head and neck cancer patient.

PRESENTATION SUMMARY
The treated head and neck cancer patient faces a host of challenges. In the immediate postoperative period, depending on the location and nature of the surgery, potential acute complications include infection, flap necrosis, and wound dehiscence. Following nonsurgical therapy, head and neck patients face various types of infection as well as potential complications of radiotherapy, including loss of airway. In the follow-up period, patients treated for head and neck cancer may present with emergencies pertaining either to complications of their therapy, or tumor recurrence; in some cases, these occur together. This presentation will focus on the role of imaging in diagnosing and distinguishing among the various conditions that may arise acutely in the treated head and neck cancer patient.
LEARNING OBJECTIVES
Upon completion of this presentation, participants will be able to:
1) Review the concepts underlying perfusion imaging.
2) Specify the different definitions of the ischemic penumbra.
3) Define the role of recanalization, reperfusion and collateral flow in stroke patients.

PRESENTATION SUMMARY
Prior to development of an effective method of limiting the size of a cerebral infarct, the ischemic penumbra was of more theoretical than practical interest. However, with the approval of recombinant tissue plasminogen activator (rTPA) by the Federal Drug Administration for treatment of acute cerebral infarction, the ischemic penumbra has assumed great importance as an indicator of the amount of brain tissue that is potentially salvageable. In the past decade, various operational definitions of the ischemic penumbra have been proposed. On MR imaging, the ischemic penumbra has assumed great importance in the salvage of brain tissue. It is defined as the area of perfusion-weighted (PWI)-diffusion-weighted Imaging (DWI) mismatch on initial MR imaging. In MR imaging terms, the penumbra is the region that has a lesion of markedly reduced cerebral blood volume (CBV) to represent the region of infarcted tissue. In addition, the same investigators consider the region having prolonged mean transit time (MTT) and reduced cerebral blood flow (CBF) to represent the ischemic penumbra, or tissue. More complex definitions have been proposed, both for CT and MR imaging. However, a number of unresolved issues about the definition, validation and use of the ischemic penumbra concept remain, as reflected by the multiple definitions mentioned above. First, no single hemodynamic parameter (or combination of parameters) is widely accepted as being most valuable. Also, there is no agreement on the highest predictive value for subsequent infarct if no treatment is provided. Thus, various studies have used different hemodynamic parameters, such as MTT, CBV and CBF. This paper will review systematically these issues related to perfusion imaging and penumbra definition.
phy (PET) and Xenon CT. Following this, the use of indicators that are confined to the cerebral vasculature will be examined, with examples from MR imaging dynamic susceptibility contrast (DSC) and CT perfusion. The strengths and weaknesses of the various techniques will be explained, with particular attention to the interaction of systematic errors with cerebral pathologies. It will be demonstrated that there is no method that fulfills the ideal criteria, and that the “best” method will depend on a number of factors, including pathology, operating environment, and patient acceptance.

Hyper-Polarized Flow and Angiography

J. Stefan Petersson, PhD

Dr Petersson has been working as a research scientist and project leader within Nycomed, then within Amersham Healthcare, and lately within GE Healthcare. The main focus has been the development of MR contrast media. He is still with GE Healthcare and works within the area of advanced MR imaging applications. The title of Dr Petersson’s thesis is “k-space models in MRI using the concept of partitions”. He has written and participated as a co-author in more than 80 papers and conference abstracts where more than 50 are in the field of hyper-polarized imaging. Dr Petersson holds 37 international patents within MRI, where 27 are in the field of applications and methods using hyper-polarized imaging agents.

LEARNING OBJECTIVES

Upon completion of this presentation, participants will be able to:
1) Differentiate between “standard” clinical MR imaging using thermal equilibrium polarization and hyper polarization.
2) Describe some attractive aspects when a hyperpolarized imaging agent is used as an angiographic agent and as a perfusion agent.
3) Describe the dependence on scanner field strength and the gradient demands when a hyper polarized imaging agent is used.

PRESENTATION SUMMARY

Recent developments of hyper-polarization methods for 13C have opened a new field of in vivo applications. An injectable hyperpolarized solution may be used to visualize part of the vascular system, to map physiologic parameters (e.g., perfusion) or probe metabolic pathways. The possible clinical applications of hyperpolarized 13C compounds may be grouped according to: 1) Vascular/angiographic imaging, 2) Perfusion mapping, 3) Interventional applications, and 4) Metabolic/molecular imaging. The presentation will focus on results from applications within the three first categories. Two 13C polarization techniques have been developed. In the first method, a hydrogen molecule, in the para-state, is introduced into the molecule in question. By performing a diabatic magnetic field cycling on this highly ordered spin system we have been able to increase the signal from the small organic molecule by several orders of magnitude. The second method is based on a Dynamic Nuclear Polarization (DNP) process. The molecule is mixed with a stable free radical, placed in low temperature environment (~ 1 K) and exposed to a moderate magnetic field (~ 4 T). The high degree of polarization of unpaired electrons, then is transferred to the 13C nucleus in the target molecules. Results from both types of hyper-polarization methods have been used to demonstrate possible vascular and interventional applications. The polarization methods will be described during the presentation. A paramagnetic contrast medium operates by altering the relaxation times of the nuclei in the surrounding tissues, but the signal from a hyper-polarized imaging agent emanates only from the injected molecules. Consequently, one important aspect of a hyper-polarized contrast molecule is the total lack of background signal. This makes a hyperpolarized substance an excellent candidate for an angiographic imaging agent. During the presentation angiograms obtained after intraarterial injections and intravenous injection will be demonstrated together with results from quantitative perfusion experiments. The outcome from in vivo imaging experiments using different animal models will be used to evaluate the future aspects of the hyper polarized techniques. The dependence on scanner magnetic field strength and gradient demands also will be discussed.

REFERENCES


Wednesday Afternoon

5:00 PM – 6:00 PM
Room 11

(47) ELC Lecture: Switching to a New PACS Vendor

— C. Douglas Phillips, MD
— Richard H. Wiggins, III, MD
Thursday Morning

7:45 AM – 8:45 AM
Hall A

(48) Maintenance of Certification (MOC) – Head and Neck and Adult Brain
Audience Response Plus (AR+)

(370) Head and Neck
— Barton F. Branstetter, IV, MD

(371) Adult Brain
— Nafi Aygun, MD

Moderator: Barton F. Branstetter, IV, MD

Thursday Morning

8:45 AM – 10:15 AM
Hall A

(49) General Session: Neuro-Ophthalmology

(372) Brainstem Anatomy for Ocular Motility and Reflex Functions
— John R. Hesselink, MD, FACR

(373) Neuroimaging of Ophthalmoplegia
— Alessandro Cianfoni, MD, FACR

(374) Ocular Imaging
— Mahmood F. Mafee, MD

Moderator: John R. Hesselink, MD, FACR

Brainstem Anatomy for Ocular Motility and Reflex Functions

John R. Hesselink, MD, FACR

LEARNING OBJECTIVES
Upon completion of this presentation, participants will be able to:
1) Describe the anatomy of the brain stem related to ocular motility.
2) Discuss the visual subsystems for keeping images focused.

Thursday Morning

7:45 AM – 8:45 AM
Hall A

(48) Maintenance of Certification (MOC) – Head and Neck and Adult Brain
Audience Response Plus (AR+)

(370) Head and Neck
— Barton F. Branstetter, IV, MD

(371) Adult Brain
— Nafi Aygun, MD

Moderator: Barton F. Branstetter, IV, MD

LEARNING OBJECTIVES
Upon completion of this presentation, participants will be able to:
1) Interpret CT and MR of frequently-encountered head and neck pathology.
2) Review pertinent anatomy in the skull base and neck.
3) Compare different pathologic entities with similar radiologic appearances in the head and neck.

PRESENTATION SUMMARY
The audience response system will be used to allow attendees to test themselves in the interpretation of both classic and confusing pathology of the head and neck. There will be an emphasis on comparing different pathologies with similar (but distinguishable) radiologic appearances.

Adult Brain

Nafi Aygun, MD

LEARNING OBJECTIVES
Upon completion of this presentation, participants will be able to:
1) Review the differential diagnosis of bilateral multifocal brain lesions.
2) Identify imaging features of CSF leaks.
3) Demonstrate the imaging features of inflammatory brain lesions.

PRESENTATION SUMMARY
Common metabolic causes of encephalopathy, inflammatory disorders of the brain and meninges, central nervous system (CNS) vasculitis and cerebrospinal fluid (CSF) leak will be reviewed using a case-based approach. The cases will be presented as unknowns and multiple choice questions will be asked with respect to imaging features and diagnostic work up.

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/2009.
on the fovea of the retina.
3) Identify the reflex functions of the eyes.
4) Cite specific neurological deficits associated with focal brain stem lesions.

PRESENTATION SUMMARY
Ocular motility and reflex functions are part of a complex system to keep images focused on the retina. This intricate control system for the extraocular and intrinsic eye muscles involves cranial nerves 2 through 8, the sympathetic system, many deep brain nuclei, and several areas of the cerebral cortex. Multiple subsystems, such as saccades, pursuit, vergence, and vestibular, are constantly making adjustments to keep the fovea of the retina in alignment with the visual target. Saccades are very rapid eye movements that constantly scan a visual field in search of targets. For example, horizontal saccades are used to read a line of text on this page. Saccades are operational continuously whether we are awake or asleep, and they cease only in a comatose state, with deep anesthesia, or death. Smooth pursuit, also called visual tracking, is used to follow an object moving across our visual field. Image blurring invokes vergence, which consists of convergence, accommodation, and pupillary constriction to bring the image back into sharp focus. If we move our head, the vestibular system automatically adjusts the extraocular muscles to maintain position of the eyes and visual focus on an object. Focal lesions of the cranial nerves or brain stem often produce specific deficits in ocular motility and/or reflex functions that can pinpoint the location of the offending lesion.

Neuroimaging of Ophthalmoplegia
Alessandro Cianfoni, MD

LEARNING OBJECTIVES
Upon completion of this presentation, participants will be able to:
1) Predict the most likely anatomical site of involvement and respective etiology in patients with ophthalmoplegia on the basis of basic clinical concepts
2) Choose the most appropriate imaging modality and protocol in the most frequent ophthalmoplegia clinical scenarios.
3) Review a gallery of neuroimaging cases of ophthalmoplegia, correlated with pathophysiology.

PRESENTATION SUMMARY
This lecture will outline the different categories of diseases encountered in patients with ophthalmoplegia, and their pathologic mechanisms, mainly classified based on the anatomical site of involvement, and on the clinical course (acute, sub-acute, chronic, progressive, painful, associated with proptosis, etc...). In general, diseases affecting ocular movement can be divided into gaze disorders, ocular motor nerve palsies, intrinsic extra-ocular muscle diseases, orbital diseases secondarily affecting the extra-ocular muscles. Ophthalmoplegia can be caused by injuries or diseases of the cerebral hemispheres, of the midbrain, pons, and cerebellum; the cranial nerves responsible for ocular movements can be affected intrinsically or extrinsically along their course in the brain stem, in the cisterns, skull base, cavernous sinuses and orbits; the extra-ocular 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 pathologic process. This presentation will cover general basic clinical concepts about ophthalmoplegia, to help understand pathophysiology of ophthalmoplegia, and to provide the radiologist with the necessary knowledge to discuss clinical cases with the referring neuro-ophthalmologist. Clinical indications to image patients with ophthalmoplegia, as well as technical consideration about the most appropriate imaging modalities and protocols will be reviewed. The main clinical scenarios will be presented, along with the rationale for the respective imaging technique, based on the expected site of involvement, and the most likely etiology. Multiple neuroimaging cases will be presented. Finally, the most advanced imaging techniques applied to the study of ocular movement control will be discussed briefly.

REFERENCES

Ocular Imaging
Mahmood F. Mafee, MD, F ACR

LEARNING OBJECTIVES
Upon completion of this presentation, participants will be able to:
1) Identify the role of CT and MR imaging in the clinical management of patients with intraocular pathology.
2) List an imaging overview with regard to differential diagnosis of Leukokoric eye.
3) Demonstrate the utility of diffusion-weighted imaging in the diagnosis of retinoblastoma and uveal melanoma.

PRESENTATION SUMMARY
MR Imaging Evaluation of the Globe. The imaging investigation of the eye has an important role in the diagnostic evaluation of diverse ocular lesions. In keeping with the purpose of this presentation, an attempt will be made to discuss the imaging characteristics of common and uncommon ocular pathology in infants, children, and adults.

LEUKOKORIA. In the evaluation of a child with leukokoria (white pupillary reflex), the major diagnostic considerations are retinoblastoma, persistent hyperplastic primary vitreous (PHPV), Coats' Disease, retinopathy of prematurity (ROP), congenital cataract, toxocariasis, chronic retinal detachment, retinal astrocytoma, choroidal hemangioma, and a variety of other nonspecific causes of leukokoria. RETINOBLASTOMA. Retinoblastoma, the most common cause of leukokoria, is the most common intraocular malignancy of infants and children. More than 90% of retinoblastomas contain calcium, which is detected easily by CT. Retinoblastomas on T1-weighted and perfusion-weighted MR images appear as areas of moderately high signal (hyperintense) compared with the signal intensity of the vitreous. On T2-weighted MR images, retinoblastomas are moderately to markedly hypointense. On post-contrast T1-
weighted MR images, retinoblastomas demonstrate moderate to marked enhancement. Postcontrast fat suppression T1-weighted MR sequences are the best to show extracocular tumor extension. Retinoblastomas show diffusion restriction on diffusion-weighted imaging pulse sequence. No tumoral enlargement of pineal gland may be seen on follow-up MR imaging in patients treated for bilateral retinoblastomas.

PHPV. Persistent hyperplastic primary vitreous (PHPV) is the second most common condition producing leukokoria in childhood and occasionally can be confused clinically with retinoblastoma. Persistent hyperplastic primary vitreous develops when the embryonic hyaloid vascular system (primary vitreous) fails to regress completely. CT and MR imaging may demonstrate enhancing retrolental mass.

MELANOMA. In adults, most primary and metastatic ocular neoplasms involve the choroid, the most common being primary malignant uveal melanoma. Melanomas appear as hyperintense lesions on T1-weighted and perfusion-weighted MR images, and become characteristically hypointense on T2-weighted MR images. Extraocular extension of uveal melanoma including vortex vein involvement can be demonstrated best on enhanced fat suppression T1-weighted pulse sequences. Melanomas show restriction on diffusion-weighted scans. UVEAL METASTASES. Uveal metastases can be confused clinically and on various imaging studies with uveal melanoma. Metastatic lesions of the uvea extend chiefly in the plane of the choroid, causing relatively little increase in its thickness. Most metastases involve the posterior half of the globe.

CHOROIDAL HEMANGIOMAS. The clinical diagnosis of choroidal hemangioma is difficult, since the tumor often is concealed by a detachment of the retina. With MR imaging, choroidal hemangiomas appear hyperintense on T2-weighted images, and demonstrate intense enhancement on enhanced scans.

SUGGESTED READING
Hypocapnic patients showed global hyperperfusion on ASL CBF maps and respiratory alkalosis on ABG. Regression analysis revealed a significant positive linear relationship between cerebral perfusion and pCO2 ($\beta$=4.02, $t=11.03$, $p<.0005$), such that rates of cerebral perfusion changed by 4.0 mL/100 g/minute for each 1 mm Hg change in pCO2.

**CONCLUSION**

With the inception of ASL as a routine perfusion imaging modality, hypercapnic associated cerebral hyperperfusion will be recognized more frequently and may provide an alternative etiology for unexplained neuropsychiatric symptoms in hospitalized patients. Similarly hypocapnia may account for a subset of patients with normal MR exams with poor ASL perfusion signal.

**KEY WORDS:** Hypercapnia, arterial spin labeling, PASL

**Paper 376 Starting at 10:53 AM, Ending at 11:01 AM**

**Repeatability of Parameters Derived from Dynamic Contrast-Enhanced MR Imaging**

Paldino, M. J. · Desjardins, A. · Friedman, H. S. · Vredenburgh, J. J. · Barb(87,454),(274,481)(87,454),(274,481)iak, D. P.

Duke University Medical Center

Durham, NC

**PURPOSE**

Dynamic contrast-enhanced MR imaging (DCE MRI) has been used to monitor microcirculatory physiology within tumors as a means of assessing early response to chemotherapy. However, the reproducibility of measurements derived from DCE MRI in patients with neoplastic disease has not been studied widely. The purpose of this study is to quantify the repeatability of parameters derived from DCE MRI in patients with recurrent glioblastoma multiforme (GBM).

**MATERIALS & METHODS**

IRB approval and informed consent were obtained for this HIPAA-compliant study. Twenty patients with recurrent GBM underwent MR imaging at two time points within a 48-hour period without interval intervention or therapy. All imaging was performed on the same 1.5 T magnet (Siemens Avanto). Dynamic contrast-enhanced MR imaging was performed after T1-mapping using multi-flip 3D FLASH imaging. Dynamic images were obtained using 3D FLASH (25 degree flip angle, TR 3.8, 16 slice volume of 5mm thick every 4.8 seconds). Whole tumor regions of interest defined by tumor-related enhancement (TRE) were selected from 1mm isotropic contrast-enhanced whole brain 3D FLASH images using a semiautomated thresholding technique. Fractional plasma volume (fPV), fractional volume of the extracellular extravascular space (v_e) and volumetric transfer constant to the extracellular extravascular space ($K_{\text{trans}}$) were extracted from dynamic images. The following statistics were calculated for each parameter: within patient standard deviation, mean coefficient of variation (CoV), route mean square (RMS) CoV, intraclass correlation coefficient (ICC), and regression coefficient. A repeatability coefficient (1) and 95% confidence limits for change (2) also were calculated.

**RESULTS**

Statistical analysis of the repeatability of fPV, v_e, and $K_{\text{trans}}$ is presented in Table 1.

**Table 1:** Repeatability of the fractional plasma volume (fPV), fractional volume of the extracellular extravascular space (v_e) and $K_{\text{trans}}$ (min^-1). Asterisk (*): $p<0.0004$.

<table>
<thead>
<tr>
<th>Statistic</th>
<th>fPV</th>
<th>v_e</th>
<th>$K_{\text{trans}}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>0.0217</td>
<td>0.3356</td>
<td>0.0446</td>
</tr>
<tr>
<td>Within subject standard deviation</td>
<td>0.0033</td>
<td>1.1163</td>
<td>0.0171</td>
</tr>
<tr>
<td>Mean CoV (%)</td>
<td>13.1978</td>
<td>57.8551</td>
<td>14.8915</td>
</tr>
<tr>
<td>Route mean square CoV (%)</td>
<td>16.4888</td>
<td>80.5232</td>
<td>20.7132</td>
</tr>
<tr>
<td>Intraclass correlation coefficient</td>
<td>0.4336</td>
<td>-0.9962</td>
<td>0.2433</td>
</tr>
<tr>
<td>Regression coefficient</td>
<td>0.8466*</td>
<td>0.0438</td>
<td>0.7885*</td>
</tr>
<tr>
<td>Repeatability coefficient</td>
<td>0.0092</td>
<td>3.0922</td>
<td>0.0475</td>
</tr>
<tr>
<td>95%CL (%)</td>
<td>45.6740</td>
<td>223.0492</td>
<td>57.3754</td>
</tr>
</tbody>
</table>

**CONCLUSION**

For an individual patient, changes after therapy greater in absolute magnitude than the repeatability coefficient or in fractional magnitude than the 95%CL are unlikely to be related to intramethod variability in the measurement of fPV, v_e, and $K_{\text{trans}}$. Although the magnitude of clinically relevant change is yet to be determined, these data provide a context with which to interpret changes in parameters derived from DCE MRI that occur after treatment.

**REFERENCES**


**KEY WORDS:** DCE MRI, repeatability, brain

**Paper 377 Starting at 11:01 AM, Ending at 11:09 AM**

**Perfusion-Weighted Imaging and Proton MR Spectroscopy in Differentiation of Oligodendroglial Subtypes**

Chaudhary, S. · Chawla, S. · Ali, N. · Wang, S. · Kapoor, G. · Timothy, G. · Melhem, E. · O’Rourke, D. · Poptani, H.

University of Pennsylvania

Philadelphia, PA

**PURPOSE**

Oligodendrogliomas with 1p and 19q loss of heterozygosity (LOH) are known to be more sensitive to chemotherapy. The current study was performed to determine whether perfusion-weighted imaging (PWI) guided analysis of multivoxel proton MR spectroscopy (H MRS) can be used to differen-
tiate oligodendrogliomas with 1p or 1p and 19q LOH from those with intact alleles.

**MATERIALS & METHODS**

Twenty-three patients diagnosed with oligodendrogliomas, based on histopathology and availability of cytogenetic profile, underwent MR imaging and two-dimensional multivoxel 1H MRS on a 3 T MR system. These patients were classified into two cytogenetic groups: 1p or 1p and 19q LOH (Group I; n=12), and 19q LOH only or intact alleles (Group II; n=11). Cerebral blood volume (CBV) maps were constructed using a Leonardo workstation and the Syngo software. Cerebral blood volume values obtained by drawing regions of interest (ROIs) in the tumor were normalized with respect to contralateral white matter to obtain relative CBV (rCBV) values. Receiver operating characteristic (ROC) analysis revealed a cut-off value of 1.5 for separating oligodendrogliomas into two regions, one with high rCBV and another with low rCBV.

Concentrations of metabolites [N-acetyl aspartate (NAA), choline (Cho), myo-inositol (mI), glutamate/glutamine (Glx) and lipid+lactate (Lip+Lac)] were computed using LC model software and normalized with respect to creatine (Cr). Voxels with maximum metabolite ratios were used to differentiate the two groups of oligodendrogliomas using a two-tailed student t test. A probability (p) value of less than 0.05 was considered significant.

**RESULTS**

Representative images from group I and group II oligodendrogliomas are shown in Figure 1. Cho/Cr from regions of high rCBV was significantly higher in group I oligodendrogliomas compared to group II. No significant differences were observed from other metabolites between the two groups. Oligodendrogliomas harboring 1p/19q deletions have been reported to have high rCBV and increased 18FDG and 201TI uptake as compared to oligodendrogliomas with intact alleles. Thus, it seems that high rCBV regions reflect a hypermetabolic state, which has been correlated with increased mitotic activity, indicating high cell proliferation and thus increased Cho.

**CONCLUSION**

Our results suggest that Cho/Cr from high rCBV regions may be helpful in distinguishing oligodendrogliomas with 1p/19q deletion from those with intact alleles and may help in identifying patients that respond to chemotherapy.

**KEY WORDS:** Perfusion, MR spectroscopy, oligodendroglial

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**Paper 378 Starting at 11:09 AM, Ending at 11:17 AM**

1H-MR Spectroscopy Chemical Shift Imaging and 11C-Methionine Positron Emission Tomography for Hotspot Detection in Diffuse Gliomas: A Correlation Study

Widhalm, G. · Krssak, M. · Minchev, G. · Wöhrer, A. · Dietrich, W. · Czech, T. · Asenbaum, S. · Knosp, E. · Hainfellner, J. · Wolfsberger, S. · Prayer, D.

Medical University of Vienna Vienna, AUSTRIA

**PURPOSE**

Positron emission tomography (PET) is a clinically useful method for preoperative detection of malignant areas (=hotspots) in diffuse gliomas. Recently, 1H-magnetic resonance spectroscopy (MRS) chemical shift imaging (CSI) using choline/creatine (Cho/Cr) and choline/N-acetylaspartate (Cho/NAA) ratios has emerged as new potential alternative. We therefore investigated usability of CSI for hotspot detection in diffuse gliomas in comparison to 11C-methionine (MET)-PET.

**MATERIALS & METHODS**

Between July 2007 and November 2008 28 consecutive patients were analyzed: 18 patients with primary diffuse gliomas and 10 with recurrences of previously operated low-grade gliomas. All patients were preoperatively examined with MET-PET and single slice CSI on 3 T MR imaging. Associations between PET (tumor/normal brain ratio) or CSI (Cho/Cr- and Cho/NAA-ratios) and histopathologic tumor subtype and WHO grade were statistically tested. Coregistration of MR imaging with CSI and MET-PET was performed and topographic overlap of CSI and PET hotspots was analyzed.

**RESULTS**

After topographic correlation of MET-PET and CSI hotspots, four of 28 patients had to be excluded: in two patients, the MET-PET hotspot was too close to the skull which did not allow reliable CSI analysis due to bone artifacts; in two patients, the CSI slice was outside of the MET-PET hotspot as CSI examinations were performed without knowledge of MET-PET results. Therefore, 24 patients (10 females, 14 males; median age: 38 years) remained for further analysis: nine astrocytomas (5 WHO II, 4 WHO III), nine oligodendrogliomas (4 WHO II, 5 WHO III) and six oligoastrocytomas (6 WHO III). MET-PET detected a pathologic hotspot (T/N ratio ≥1.5) in 14/24 patients, whereas a CSI hotspot (ratio >1.0) was present in all patients. Median CSI Cho/Cr ratio was significantly higher in gliomas grade III than grade II. CSI Cho/Cr and Cho/NAA ratios showed strong correlation. Topographic correlation of PET and CSI hotspots showed a >50% overlap in 11/14 and <50% overlap in 3/14 patients, respectively. Chemical shift imaging Cho/Cr and Cho/NAA hotspots showed a >50% overlap in 15/22, a <50% overlap in 6/22 patients and no overlap in 1/22 patients. To further increase the likelihood of tumor hotspot detection we currently are testing also the reliability of multislice CSI (multiple parallel contiguous CSI slices covering the majority of the tumor volume) and preliminary results look promising.
CONCLUSION
According to our data, CSI using Cho/Cr and Cho/NAA ratios is a promising method that is at least as sensitive for visualization of metabolically active areas (=hotspots) within diffuse gliomas as MET-PET.

KEY WORDS: Chemical shift imaging, methionine positron emission tomography, hotspot correlation

Paper 379 Starting at 11:17 AM, Ending at 11:25 AM
Hyperpolarized 1-[13C]-Ethyl Pyruvate: A New Probe for Metabolic Imaging of the Brain

Wilson, D. M. · Chen, A. · Bok, R. · Park, I. · Kurhanewicz, J. · Vigneron, D. · Nelson, S. · Hurd, R.
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San Francisco, CA

PURPOSE
The purpose of this work was development of novel neuroimaging agents using the technique of dynamic nuclear polarization (DNP). To date, DNP-NMR in vivo has focused on the metabolic imaging of 1-[13C]-pyruvate, which is converted rapidly in vivo to 1-[13C]-lactate, to a higher extent in cancerous tissues (1). Neuroimaging applications of DNP are limited, given the poor transport of small, charged molecules across the blood-brain barrier (BBB). To address this limitation, a lipophilic pyruvate analog was studied, 1-[13C]-ethyl pyruvate (EP). EP has been investigated as a therapeutic antiinflammatory drug for stroke and neurodegenerative disorders, demonstrated to attenuate kainic acid-induced cell death in the mouse hippocampus (2,3). Since hydrolysis of EP is expected in vivo, hyperpolarized 1-[13C]-EP represents a method to image 1-[13C]-pyruvate within the brain parenchyma.

MATERIALS & METHODS
Hyperpolarized 1-[13C]-EP and 1-[13C]-pyruvic acid: Solutions of 1-[13C]-EP and 1-[13C]-pyruvic acid containing 15mM trityl radical were hyperpolarized on a Hypersense instrument (Oxford Instruments) (4). Animal experiments: Male Sprague-Dawley rats (250-350g) were anesthetized with isoflurane (1-3%). Heart rate and O2 saturation were continuously monitored, with body temperature maintained at 37 °C. All experiments were performed using a 3T GE MR scanner (GE Healthcare) and a custom-built dual-tuned (H/13C) quadrature rat coil. High-resolution T2-weighted anatomical images of the rat brain were obtained in all three planes using a fast spin-echo sequence. 13C spectroscopic imaging of the brain used a double spin-echo sequence as previously described (5).

RESULTS
The left panel of the figure shows data from a hyperpolarized 1-[13C]-pyruvate study, whereas the right panel shows data from a 1-[13C]-EP study. Voxels containing brain tissue demonstrate less pyruvate signal than surrounding tissues. In contrast, ethyl pyruvate appears to be concentrated in the brain, with conversion to 1-[13C]-lactate also observed.

CONCLUSION
A polarization and dissolution method for hyperpolarized 1-[13C]-ethyl pyruvate have been developed. This new lipophilic pyruvate analog has demonstrated preferential uptake in the brain parenchyma of anesthetized rats. As DNP methods continue to evolve, hyperpolarized 1-[13C]-EP may at some point be suitable for human use as a metabolic probe for ischemic, inflammatory and neoplastic disease within the brain.

REFERENCES

KEY WORDS: Molecular imaging, metabolism, hyperpolarized

Paper 380 Starting at 11:25 AM, Ending at 11:33 AM
Withdrawn
Paper 381 Starting at 11:33 AM, Ending at 11:41 AM

**Diffusion Tensor Imaging of Neurodegenerative Cerebellar Ataxia**

Lee, P. · Muscarella, L. · Perlman, S. · Salamon, N.
University of California Los Angeles
Los Angeles, CA

**PURPOSE**
Conventional MR imaging has limited specificity in the early diagnosis of neurodegenerative cerebellar ataxic diseases such as multiple system atrophy (MSA) and spinocerebellar atrophy (SCA). The aim of this study is to confirm the neuronal degeneration in these disorders with diffusion tensor imaging (DTI) and to assess whether DTI may differentiate the different causes of cerebellar ataxias.

**MATERIALS & METHODS**
Diffusion tensor imaging was performed on 27 patients (7 with cerebellar variant of MSA, 6 with SCA, 6 with cerebellar atrophy related to antiepileptic medications, and 8 age-matched controls) using a 1.5 T scanner. The pyramidal, extrapyramidal, spinocerebellar and corticopontocerebellar pathways were studied with regions of interest including the lentiform nucleus, thalamus, internal capsule, pyramidal tract (pons), medial lemniscus, cerebellar peduncles, and transverse pontine fibers. Three-dimensional fiber tractography was performed. The fractional anisotropy (FA), linear index, planar index, spherical index, and mean diffusivity (ADC) were measured and ANOVA was used for statistical analysis.

**RESULTS**
No difference in FA and ADC values was seen in all pathways between controls and the cerebellar atrophy group. The FA and ADC values in the pyramidal tract showed no difference in the SCA group. By contrast, Fractional anisotropy was decreased and ADC increased in the pyramidal tract of the MSA-C group. Decreased FA and increased ADC were found in the transverse pontine fibers in both the MSA-C and SCA groups. Fractional anisotropy and ADC values of the middle cerebellar peduncle showed a greater difference in the MSA-C group than the SCA group compared with controls. In addition, ADC values increased in the SCA group in the putamen and not the MSA group.

**CONCLUSION**
Diffusion tensor imaging could identify white matter degeneration in patients with MSA-C and SCA. Multiple system atrophy-C more profoundly affects the middle cerebellar peduncle than SCA. Conversely, degeneration in the putamen was isolated to the SCA group. No DTI differences were found in patients with cerebellar atrophy related to antiepileptic medications compared to controls.

**KEY WORDS:** Diffusion tensor imaging, multiple system atrophy, spinocerebellar atrophy

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Paper 382 Starting at 11:41 AM, Ending at 11:49 AM

**Directional Diffusivity Detects Microstructural Abnormalities in the Corpus Callosum of Asymptomatic Subjects with Beta-Amyloid Plaques on C-11-PIB PET**

Benzinger, T. L. S. · Daniels, D. N. · D’Angelo, G. M. · Sheline, Y. I. · Snyder, A. Z. · Head, D. · Morris, J. C. · Mintun, M. A.
Washington University School of Medicine in St. Louis
Saint Louis, MO

**PURPOSE**
Positron emission tomography (PET) imaging using the β-amyloid (β)-binding compound Pittsburgh Compound B ([11C]PIB) recently has emerged as an exciting diagnostic tool for Alzheimer disease (AD). However, intermediate levels of [11C]PIB have been observed in asymptomatic individuals. MR imaging with diffusion tensor imaging (DTI) has identified loss of structural integrity in the corpus callosum (CC) mouse and human familial AD. Using directional diffusivity DTI, we investigated microstructural changes in the CC in subjects with and without AD who underwent [11C]PIB PET scans.

**MATERIALS & METHODS**
Within a prospective study of memory and aging, 32 subjects ages 50-86 (10 male) were identified who had undergone [11C]PIB PET imaging and DTI. Of these, 28 had a clinical dementia rating (CDR) of 0 and four had CDR>0. Regions of interest (ROI) were drawn on each MR image over the cerebellar, prefrontal, lateral temporal, occipital, gyrus rectus, precuneus, and striatal cortex. Binding potential values (BPs), proportional to the density of [11C]PIB-β binding sites, were calculated using the Logan graphical analysis and cerebellar cortex as a reference. Diffusion tensor imaging was performed at 1.5 with SE-EPI (7 directions, \( b_{max} = 1004.91 \) s/mm²). DTI and structural MR imaging data (MPRAGE and T2-weighted imaging) were coregistered and adjusted for motion correction. Diffusion parameters calculated were mean diffusivity (MD), radial anisotropy (RA), axial diffusivity (\( \lambda_{||} \)) and radial diffusivity (\( \lambda_{\perp} \)). Regions of interest were drawn in the genu of the CC.

**RESULTS**
Defining elevated [11C]PIB binding as mean cortical BP (MCBP) of > 0.18, 8 subjects had elevated [11C]PIB binding suggestive of AD (4 of whom had CDR>0). Thirteen subjects had intermediate [11C]PIB binding (0.10-0.18). Spearman correlation coefficients were calculated. At the genu of the CC, RA was inversely correlated with MCBP (\( p=0.039 \)) and directly correlated with both MD and \( \lambda_{||} \) (\( p=0.0022, 0.0012 \)). There was no significant correlation with \( \lambda_{\perp} \). When the four subjects who were CDR>0 were excluded from the analysis, significant correlations remained between MCBP and RA (\( p=0.0429 \)) and \( \lambda_{\perp} \) (\( p=0.0265 \)). However, MCBP remained highly correlated with age in this sample (Spearman’s correlation 0.33). In order to partially adjust for this effect, the data were limited to subjects age 66 or greater with CDR 0 (19); within this subset \( \lambda_{\perp} \) remained significantly correlated with MCBP (\( p=0.01 \)).

**CONCLUSION**
Microstructural changes in deep white matter tracts as measured by DTI have been reported with AD, preclinical famil-
ial AD, and in mouse models. Here we identify loss of RA and increased MD, specifically related to elevations in $\lambda_\perp$, to be correlated with the Aβ burden measured by $[^{11}C]$PIB. Although a larger cohort will need to be studied to fully correct for age and degree of dementia, this suggests that directional diffusivity MR may be useful for identifying patients with intermediate $[^{11}C]$PIB at risk for developing symptoms of AD or for monitoring response to therapy in patients with early AD.

**Key Words:** Alzheimer’s, DTI, PIB

**Paper 383 Starting at 11:49 AM, Ending at 11:57 AM**

**Comparison of Blood-Oxygen-Level Dependent Activation During Functional MR Imaging in Elderly Patients with Cerebral Leukoaraiosis and Age-Matched Controls**

Welker, K. M.¹ · De Jesus, R. O.² · Watson, R. E.¹ · Machulda, M. M.¹ · Jack, C. R.¹

¹Mayo Clinic, Rochester, MN, ²Virginia Commonwealth University, Richmond, VA

**Purpose**

To test the hypothesis that elderly individuals with prominent leukoaraiosis demonstrate altered blood-oxygen-level-dependent (BOLD) activation during motor and language functional MR imaging (fMRI) as compared to normal elderly controls.

**Materials & Methods**

With IRB approval, right-handed, cognitively normal individuals were selected from a registry for the study of Alzheimer disease risk. As participants, all had received FLAIR MR brain scans during the prior year. By reviewing these scans with a leukoaraiosis grading scale, 12 subjects with greater than 25 cm³ leukoaraiosis and 12 age-matched controls with less than 5 cm³ leukoaraiosis were enrolled. The average age of each group was 79 years. Average leukoaraiosis scores were 34.8 cc for subjects and 0.8 cc for controls. Each participant underwent 3.0T fMRI with two block design paradigms: right finger tapping and visual semantic decision making. The scans were processed with SPM02 and normalized to MNI coordinates. Individual brain statistical maps were derived using the general linear model. Within group t-maps were created from individual contrast images using an uncorrected p-value of .001. Intergroup analyses were performed using a random effects model and results were reviewed using an uncorrected p-value of .005 for finger tapping and p-values of .005 and .0075 for the semantic decision task.

**Results**

In controls, right finger tapping resulted in expected BOLD activation of the left sensorimotor cortex at the hand knob with additional activation in the left supplemental motor area and right cerebellum. In the leukoaraiosis group, finger tapping produced atypically diffuse activation in large confluent regions of both the left and right sensorimotor cortex and both cerebellar hemispheres. In controls, the semantic decision task generated language-related activation in the left middle and inferior frontal gyri and the posterior left inferior and middle temporal gyri. The leukoaraiosis group collectively demonstrated less activation in the left middle and inferior frontal gyri and no activation in the posterior left temporal lobe. The average correct response rate was 88% for controls and 92% for leukoaraiosis group.

**Conclusion**

Individuals with leukoaraiosis demonstrate significantly more diffuse BOLD activation when performing a finger tapping motor task compared to age-matched controls. In contrast, individuals with leukoaraiosis generate less activation in expressive and receptive language areas when performing a semantic decision task than do controls. These results suggest that leukoaraiosis exerts different pathologic effects on the cerebral motor and language systems. When performing fMRI on elderly individuals, clinical neuroradiologists and researchers should be aware that leukoaraiosis can alter scan results.

**Key Words:** Leukoaraiosis, fMRI, elderly

**Paper 384 Starting at 11:57 AM, Ending at 12:05 PM**

**Altered Finger Representations in Postcentral Gyrus of Musicians with Focal Dystonia**

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¹North Shore University Health Care Systems, Evanston, IL, ²Schwab Rehabilitation Hospital/Rehabilitation Institute of Chicago, Chicago, IL, ³Rehabilitation Institute of Chicago, Chicago, IL; ⁴Mayo College of Medicine, Rochester, MN

**Purpose**

Previous reports suggest that abnormal sensory processing may be the underlying cause of focal task-specific dystonia (1), that musicians with this condition have abnormal finger representations in somatosensory cortex (2-4), and that the abnormalities in somatosensory representations in some cases may be ameliorated by splint therapy (5). We sought to further characterize postcentral finger representations in musicians with and without dystonia, and to identify abnormalities that reflect the severity of dystonia symptoms and systematically improve with effective treatment.

**Materials & Methods**

Using functional MR imaging (fMRI), finger representations were identified from differential activation of each finger relative to others during repetitive movements. The volume of postcentral activation for each finger, its location in 3-
dimensional space, and distance to an adjacent finger representation were compared in 11 unaffected musicians and 14 dystonia patients, both before and after splint therapy. Particular attention was made to the representations of the primary dystonic finger (PDF, characterized by excessive flexion) and the primary compensatory finger (PCF, characterized by excessive extension). Abnormalities were delineated by differences in finger representations between dystonia patients and unaffected musicians. The volumes of finger representations, displacement in space, and Euclidean distance between adjacent finger representations among dystonia patients were examined for a possible correlation with symptom severity; postcentral changes following treatment were examined for a possible correlation with behavioral improvement.

**Results**

A somatotopic organization was demonstrated for individual fingers 1-4 in both groups of musicians, with the thumb (finger 1) located ventrolateral and the ring finger located dorsomedial. Before treatment, the distance of the PDF and PCF representations to the adjacent finger in dystonia patients were significantly greater than in unaffected musicians, and the representation of the PDF (but not the PCF) was displaced significantly. Due to large variability within the dystonia group, the mean volume of activation did not differ significantly between groups. Unlike the other finger representations, however, the mean volume for the postcentral PCF representation was double that observed in unaffected musicians, and the PCF volume was positively correlated with patient reports of overall symptom severity. Correlations following treatment revealed that either a decrease in postcentral PCF volume or an increase in postcentral PDF volume resulted in fewer hyperflexing (dystonic) movements of the primary dystonic finger. Overall, increases in volume for individual finger representations following treatment were correlated with decreases in their displacement; nonetheless, reduced displacement of the postcentral PDF or PCF representation was not correlated to improvement in symptoms. Following a 6-month period of therapy, increases in the distance from the PDF representation to the next finger were correlated with patient reports of overall improvement in symptoms and marginally correlated with a decrease in frequency of dystonic finger movements.

**Conclusion**

The distance between finger representations and the postcentral volume of two finger representations (the PDF and PCF) appear intimately related to dystonia symptoms; following splint therapy, reciprocal changes in the representational volume for these two fingers improve symptoms. Results suggest that splint therapy is most effective when it improves functional independence of affected fingers.

**Key Words:** Dystonia, topography, post central

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**Paper 385 Starting at 12:05 PM, Ending at 12:13 PM**

**Functional MR Imaging-Diffusion Tensor Imaging Reveals the Somatotopic Organization of Motor Corticospinal and Corticobulbar Tracts in Glioma Patients**

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1University College London Hospital, London, UNITED KINGDOM, 2University College London, London, UNITED KINGDOM, 3Menoufia University Hospital, Menoufia, EGYPT

**Purpose**

Previous studies have suggested a somatotopic arrangement of the corticospinal tract (CST) foot (F) and hand (H) fibers. However, there has been little success in mapping in vivo corticobulbar tract (CBT) lips (L) and tongue (T) fibers. Furthermore, alterations to the CST/CBT due to the vicinity of a tumor (information relevant for the preoperative assessment of patients) are poorly understood (1). Aims: to investigate 1) the somatotopic organization of the motor CST/CBT (M-CST/CBT) F/H/L/T fascicles by combining motor-task fMRI and diffusion tensor imaging tractography; 2) the influence of the vicinity of intrinsic tumors on these fascicles.

**Materials & Methods**

Data were acquired at 3T from three healthy volunteers and at 1.5T from five healthy controls and nine tumor patients. Eighty-nine percent of patients had history of seizures and 56% had focal neurologic function deficit related to the vicinity of the tumor to the left (8 patients) or right (1 patient) M-CST/CBT. MR imaging data were analyzed with SPM5 and FSL (probabilistic tractography 2-tensor model). The highest intensity peaks in the SPM{t} maps within the precentral gyrus were used as seed regions for the tractography.

**Results**

Hand-MCST was tracked in 100% of patients and 80% (1.5T), 100% (3T) of controls; feet-MCST in 89% of patients and 60% (1.5T), 67% (3T) of controls; lips- and tongue-MCBT in 78% of patients and 60% (1.5T), 100% (3T) of controls. Some degree of overlap between the fascicles was observed. All four fascicles were identified in five patients (results in the table, one example in the figure) and two (1.5T) and two (3T) controls. Table shows the percentage of each arrangement of the (F), (H), (L) and (T)-fascicles at the levels:

<table>
<thead>
<tr>
<th>Arrangement</th>
<th>Level</th>
<th>Patients (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>F/H/L/T</td>
<td>Mid-third of cerebral peduncle</td>
<td>40</td>
</tr>
<tr>
<td>F/H/LT</td>
<td>Lateral to medial</td>
<td>40</td>
</tr>
<tr>
<td>F/HLT</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>F/H/L/T</td>
<td>Posterior limb of internal capsule</td>
<td>30</td>
</tr>
<tr>
<td>F/H/LT</td>
<td>Anterior to Posterior</td>
<td>40</td>
</tr>
<tr>
<td>F/H/T</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>F/T/L/H</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>F/H/L/T</td>
<td>Cella Media</td>
<td>40</td>
</tr>
<tr>
<td>F/H/LT</td>
<td>Anterior to posterior</td>
<td>50</td>
</tr>
<tr>
<td>F/H/TL</td>
<td>10</td>
<td></td>
</tr>
</tbody>
</table>

In the remaining four patients and three (1.5T) and 1 (3T) controls, 1-3 fascicles were identified. Their relative organ-
ization was consistent with the previous findings. The tumors mainly caused tract displacement (67% of patients).

CONCLUSION

Our results confirmed M-CST/CBT-somatotopic organization with cephalo-caudal body representation from medial to lateral along the cerebral peduncle transverse axis and from anterior to posterior along the posterior limb of internal capsule/cella media long axis. Tumors close to the CST/CBT displaced the motor-fascicles without affecting their topographic organization.

REFERENCES


KEY WORDS: Corticospinal tract, fMRI, DTI

Paper 386 Starting at 12:13 PM, Ending at 12:21 PM

Increased Functional MR Imaging Activation in Primary Motor Areas after Constraint-Induced Movement Therapy in Chronic Stroke

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1Kuopio University Hospital, Kuopio, FINLAND, 2Kuopio University, Kuopio, FINLAND, 3Brain Research and Rehabilitation Center Neuron, Kuopio, FINLAND

PURPOSE

Hemiparesis is the most common deficit after cerebral stroke. Constraint-induced movement therapy (CIMT) is a neurorehabilitation method that emphasizes task-relevant repetitive training of the paretic hand. Positive effects on paralyzed hand motor control at the behavioral level have been demonstrated. In this study we evaluated cortical reorganization associated with motor recovery induced by CIMT using functional MR imaging (fMRI).

MATERIALS & METHODS

Twelve chronic stroke patients (ages 30-64, mean 47.7 years) with cortical and subcortical lesions were studied with fMRI before and after a 2-week CIMT period, which included 10 weekdays of supervised exercises. To assess the motor function of the affected hand, a structured motor function test, WMFT, was performed before and after the CIMT. Functional MRI experiment consisted of blocks of rest, right hand movement, and left hand movement in alternating order. Subjects performed simple repetitive flexion/extension movements of fingers or wrist. Functional MRI analysis was performed with SPM5. Preprocessing included motion correction, coregistration of functional images to individual anatomical T1-weighted images, normalization into stereotactic space, and spatial smoothing of images. Statistical analysis was performed on a voxel-by-voxel basis using the General Linear Model. The effect of CIMT on brain activation patterns was tested with t-statistics by contrasting posttraining activation to pret raining activation during both paretic and nonparetic hand movements in each individual subject. The quantification of activation changes in motor cortical areas (i.e., in the precentral, postcentral, premotor and SMA regions) was conducted using a region-of-interest approach. The extent of altered activation was correlated with age, time from stroke, pretherapy WMFT scores (time and function) as well as improvement in WMFT scores.

RESULTS

Constraint-induced movement therapy resulted in an improvement in voluntary hand motor control: mean total time needed to perform the WMFT decreased significantly after therapy (p=0.015), whereas the mean functionality and quality scores were higher (p=0.002). During paretic hand movement, increased fMRI activity in the precentral gyrus of the contralateral (i.e., affected) hemisphere correlated significantly with age and both pretherapy function parameters as well as with change of function score (p<0.045). Increased activation in the contralateral postcentral gyrus also correlated with both pretherapy function parameters and with changes of function parameters (p< 0.002): The larger the area of activation increase, the more substantial the functional improvement. Decrease of activation of nonparetic hand movements in premotor area correlated with both changes of function parameters: The larger the area of activation decrease the lesser the functional improvement. Individual segmented reconstruction images of the areas of increased cortical activation were created and demonstrated wide interindividual variation in response to rehabilitation.

CONCLUSION

After an intensive two-week rehabilitation period with CIMT, paretic hand movements produced an increase in activation on primary motor and sensory areas of the affected hemisphere, while nonparetic hand movements resulted in decreased activation on premotor area. The CIMT provided an increasingly difficult motor challenge to our patients, and thus created increased activation in the brain that may reflect reorganization related to motor control. Functional MRI was a feasible tool to study effects of stroke rehabilitation.

KEY WORDS: Functional MR imaging, rehabilitation, stroke
DeCREASED VISUAL FUNCTIONAL MR IMAGING CONNECTIVITY IN MULTIPLE SCLEROSIS

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Salt Lake City, UT

PURPOSE
Previous research has suggested functional connectivity differences in patients with multiple sclerosis in primary motor cortex. Visual pathway abnormalities are a prominent feature of multiple sclerosis, with visual evoked potentials comprising a core diagnostic test for multiple sclerosis. The purpose of this study is to attempt to distinguish the differences in visual functional connectivity between a group of control patients and a group of patients with clinically definite multiple sclerosis.

MATERIALS & METHODS
Thirteen patients with clinically definite multiple sclerosis and 13 control subjects were imaged using BOLD EPI technique at 3 T with high temporal resolution (TR=300 ms). A sparse visual stimulus was provided with single checkerboard flash every 20 seconds. A total of 85 8-minute sessions from the multiple sclerosis subjects and 78 sessions from the control subjects were obtained for analysis. Data were extracted using 3 mm radius circular regions of interest in bilateral pericalcarine primary visual cortex. Cross-correlation curves between time series for left and right primary visual cortex then were obtained for each session and peak correlation height was measured.

RESULTS
The cross-correlation curves for the multiple sclerosis group demonstrated a mean peak height of 0.30±0.02 s.e.m.. The cross-correlation curve for the control group demonstrated mean peak height of 0.35±0.02 s.e.m.. The difference between the two groups was significant by a t-test p-value of 0.04.

CONCLUSION
Cross-correlation curves comparing differences in bilateral V1 cortices between multiple sclerosis and control patients reveal a statistically significant decrease in functional connectivity in the multiple sclerosis group. Given prior reports of differences in functional connectivity in multiple sclerosis patients, this data suggest that incorporation of connectivity information from multiple brain regions may be used as quantitative metrics for distinguishing multiple sclerosis from control subjects. This also suggests a quantitative index that may facilitate serial measurements and treatment monitoring in multiple sclerosis.

REFERENCES

KEY WORDS: Multiple sclerosis, fMRI, functional connectivity

Thursday Morning
10:45 AM – 12:30 PM
Ballroom B

(50b) Adult Brain: Neoplasms II
(Scientific Papers 388 – 400)

See also Parallel Sessions
(50a) Adult Brain: Functional Imaging II
(50c) Adult Brain: Degenerative/Demyelinating/Metabolic Diseases I
(50d) Pediatric: Infections, Metabolic, Other & Spine
(50e) Excerpta Extraordinaire: Pediatrics

Moderators: Kelly K. Koeller, MD, FACR
TBD

Correlation of 3 T MR Spectroscopy, MR Perfusion and MR Diffusion Imaging Values with WHO Grade in Newly Diagnosed Malignant Gliomas

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1University of Washington, Seattle, WA, 2Tottori University, Yonago, JAPAN

PURPOSE
Physiologic MR imaging methods including MR spectroscopy, MR perfusion and MR diffusion imaging have been used for preoperative tumor grading in malignant gliomas. Our goal was to investigate which of these methods had the best correlation with WHO glioma grade in adult patients who underwent 3T MR physiologic imaging with two or more of these modalities prior to surgical histopathology evaluation.

MATERIALS & METHODS
All consecutive adult patients with histopathologically proved malignant glioma (WHO grades II-IV) who underwent 3T MR physiologic imaging using MR spectroscopy (MRS), dynamic susceptibility MR perfusion (DSC) and MR diffusion imaging (DWI) at our institution between October 2006 and September 2007 prior to initial surgical histopathologic evaluation were identified retrospectively. Only patients who had interpretable imaging data from at least two of these 3T MRI modalities were included. Maximum peak height choline/creatine ratio (Cho/Cr) and choline/N-acetylaspartate ratio (Cho/NAA) were measured within each lesion. Maximum intralesional regional cerebral blood volume/normal white matter ratio (rCBV ratio) and minimum intralesional apparent diffusion coefficient/normal white matter ratio (ADC ratio) were calculated. Spearman
rank correlations between each parameter and final WHO tumor grade were calculated. ROC analyses for each parameter to distinguish low-grade glioma (WHO grade II) from high-grade glioma (WHO grade III-IV) were calculated.

RESULTS
Thirteen patients with malignant glioma (4 grade II, 7 grade III, 2 grade IV) who underwent preoperative 3T MRS, DSC and/or DWI were reviewed; 10, 11 and 10 patients had interpretable MRS, DSC and DWI studies, respectively. Cho/NAA (r = 0.85) correlated best with WHO grade, followed by Cho/Cr (r = 0.74), ADC ratio (r = 0.53) and rCBV ratio (r = 0.23). ROC analyses showed that Cho/NAA was able to distinguish all low-grade from high-grade gliomas, while fitted area under the curve for Cho/Cr (Az = 0.87) and ADC ratio were comparable (Az = 0.88); all outperformed rCBV ratio (Az = 0.57).

CONCLUSION
Our initial results comparing the correlations of different physiologic 3T MRI parameters with adult WHO glioma grade suggests that MRS values, particularly Cho/NAA, may have better correlation with final WHO tumor grade than DWI and/or DSC values. Logistic regression analysis of multiparametric 3T MRS, DSC and DWI data from a larger number of patients would be most helpful to confirm these results. Analysis of an additional patient cohort of greater number will be undertaken to augment statistical power.

KEY WORDS: 3T MRI, malignant glioma, WHO grade

Paper 389 Starting at 10:53 AM, Ending at 11:01 AM
Characterization of Peritrigonal Glioblastoma Multiforme by MR Imaging and Biological Markers

Goel, G. · Santosh, V. · Ravishankar, S. · Jayakumar, P. N. · Vasudev, M. K. · Anandh, B.
National Institute of Mental Health and Neurosciences Bangalore, INDIA

PURPOSE
In our clinical practice we observed that peritrigonal gliomas show MR features of high-grade glioma. We hypothesized that a majority of the tumors in this region are glioblastomas. We also hypothesized that stem cells play a major role in their tumorigenesis and growth potential.

MATERIALS & METHODS
A neuroradiologist blinded to the grade of gliomas retrospectively evaluated MR images of 285 histopathologically proved gliomas. Eighteen peritrigonal gliomas were identified and their clinical and MR features were studied. Detailed histopathologic evaluation was done using immune-markers like p53, pTEN & EGFR. CD 133 was used as stem cell marker. Fourteen lobar glioblastomas were taken as controls.

RESULTS
Out of 18 peritrigonal gliomas on histopathologic analysis 14 were glioblastomas (GBM). CD133 expression was noted in 10 cases (71.4%) of peritrigonal GBM and eight cases (57.14%) of control GBM. The median value of CD133 positivity in peritrigonal gliomas is significantly higher than in control group. Statistically significant correlation was observed between presence and absence of cortical involvement, as manifested by cortical involvement on MR imaging, and CD133 expression.

CONCLUSION
Glioblastoma is the most common tumor amongst peritrigonal gliomas. Increased CD133 expression in peritrigonal GBM supports the hypothesis that stem cells in subependymal zone are associated with development of GBM in peritrigonal region. CD133 expression shows positive correlation with invasiveness of GBM.

KEY WORDS: Glioblastoma, stem cell markers, peritrigonal

Paper 390 Starting at 11:01 AM, Ending at 11:09 AM
Diffusion-Weighted Imaging in the Early Detection of Intraventricular Spread of Malignancy

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University of Utah Medical Center Salt Lake City, UT

PURPOSE
This paper demonstrates a new role for diffusion-weighted imaging in the early detection and treatment of intraventricular disseminated malignancy.

MATERIALS & METHODS
Retrospective review of 118 patients with intraventricular dissemination of high-grade neoplasm was performed. Axial T2, FLAIR, diffusion-weighted imaging, gradient susceptibility imaging, and axial and coronal gadolinium-enhanced imaging was reviewed. All available prior studies were reviewed chronologically. Imaging was reviewed to determine if enhancing intraventricular or subependymal lesions demonstrated associated diffusion restriction. Imaging was evaluated retrospectively for the presence of diffusion restriction prior to the development of enhancing intraventricular lesions.

RESULTS
In 118 patients with intraventricular dissemination of high-grade neoplasm (glioblastoma multiforme, anaplastic astrocytoma, anaplastic oligodendroglioma), 11 cases demonstrated subependymal diffusion restriction which preceded the development of subependymal enhancement.

Figure. Axial diffusion-weighted imaging (1.5 T, B1000, left panel) and Axial T1 postgadolinium fat saturated imaging (right panel), demonstrates punctate diffusion restriction (arrow) in left lateral ventricle prior to development of
enhancement. Upon later studies, this lesion subsequently developed significant nodular enhancement.

CONCLUSION
Intraventricular or subependymal dissemination of neoplasm often is considered a near terminal event. Intraventricular or subependymal disease can be treated with intraventricular chemotherapeutics. Highly cellular tumors have been shown to restrict diffusion. In this series, 11 patients demonstrated the presence of disease on diffusion-weighted imaging prior to the detection of enhancing subependymal or periventricular lesions. This suggests that early tumor spread can be detected on diffusion-weighted imaging prior to the development of gadolinium enhancement. Early detection may allow earlier treatment with intraventricular chemotherapeutics.

KEY WORDS: Diffusion-weighted imaging, neoplasm, intraventricular dissemination

Paper 391 Starting at 11:09 AM, Ending at 11:17 AM
Development and Validation of the Parametric Response Map as a Perfusion Imaging Biomarker for Early Treatment Response Assessment

Sundgren, P. C. · Galban, C. J. · Cheneveret, T. L. · Meyer, C. R. · Tsien, C. · Lawrence, T. S. · Hamstra, D. A. · Junck, L. · Johnson, T. D. · Ross, D. J. · Rehemtulla, A. · Ross, B. D.
University of Michigan
Ann Arbor, MI

PURPOSE
To develop and evaluate an analytical approach as an early imaging biomarker of prognostic value based on MR quantifiable hemodynamic parameters using a voxel-wise comparison of perfusion changes following therapeutic intervention of patients with grade III/IV gliomas.

MATERIALS & METHODS
Forty-four patients with grades III/IV glioma underwent MR imaging 1-2 weeks before and at week 1 during radiochemotherapy. MR scans were acquired on a 1.5T (General Electric Medical Systems, Milwaukee, WI) or a 3T (Philips Medical Systems, Andover, MA) clinical scanner. Dynamic susceptibility contrast (DSC) T2* -weighted imaging with intravenous administration of a standard dose (0.1 mL/kg) bolus of Gd-DTPA, and postcontrast T1-weighted imaging 1-2 weeks with 6mm thickness and 0mm gap. All images were registered to Gd-enhanced T1-weighted images pretherapy using an automated mutual information rigid-body algorithm. Following registration, brain tumors were contoured manually on Gd-enhanced T1-weighted images by radiologists. The absolute difference of rCBV (ΔrCBV) values of each voxel within the tumor was calculated from values pre and 1 week posttherapy. PRMrCBV was performed by thresholding ΔrCBV into three categories: ΔrCBV ≥1.2 (PRMrCBV+: red); ΔrCBV ≤1.2 (PRMrCBV: blue); and ≥1.2ΔrCBV <1.2 (PRMrCBV: green). The thresholds were empirically determined to be the 95% confidence intervals calculated from normal contralateral brain tissue. Percent difference of the mean (%CBV) pre and posttherapy also were acquired and compared with PRMrCBV results. Patient population was stratified based on the optimal cutoff of PRMrCBV+, PRMrCBV, and %CBV as assessed by ROC analysis for one year survival. Kaplan-Meier survival curves and the log-rank test were used to characterize and compare the groups in terms of overall survival. Statistical significance was assessed at P<0.05.

RESULTS
In general, patients with low survival times (< 1 year) exhibited larger volumes of decreasing rCBV when compared to patients with high survival times. Percent difference of mean rCBV was found to not correlate with patient outcome. In contrast, PRMrCBV exhibited a significant correlation with overall survival. From measures acquired from PRMrCBV, PRMrCBV produced the most significant result. Patients whose PRMrCBV was below the cutoff (6.8%) had a significantly longer median survival than patients whose PRMrCBV was above the cutoff (20.4 months and 10.2 months, respectively; P=0.009). PRMrCBV and %rCBV were found to not be predictive of 1 year and overall survival.

CONCLUSION
We have developed a novel, voxel-wise method for monitoring treatment response in glioma patients using perfusion maps, which we refer to as Parametric Response Map (PRM). This approach is made possible by measuring functional changes in blood perfusion, as assessed by rCBV maps within the tumor pre- and at 1 week follow up. PRMrCBV was found to have predictive value for survival in patients with high-grade gliomas as early as 1 week into therapy. Most notable was the volume fraction associated with decreasing rCBV, PRMrCBV, which best correlated with overall survival (P=0.009).

KEY WORDS: Brain tumor, treatment response, perfusion

Paper 392 Starting at 11:17 AM, Ending at 11:25 AM
Diffusion Tensor Imaging of Optic Radiation in Brain Tumors: Correlation with Vision Field Deficit

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1University of Pennsylvania, Philadelphia, PA, 2Tokushima University Hospital, Tokushima, JAPAN

PURPOSE
Optic radiation (OR) is the major visual pathway. Damage to it can cause significant visual field deficits. Diffusion tensor imaging (DTI) metrics including fractional anisotropy (FA) and apparent diffusion coefficient (ADC) have been reported to be abnormal in patients with brain tumors (1). The purpose of this study was to determine whether the degree of OR involvement evaluated using DTI correlate with clinical visual field deficits.

MATERIALS & METHODS
Seventeen patients (13M/4F, age 21-84 years) with pathologically proved gliomas (11 glioblastoma multiforme, 3 anaplastic astrocytomas, 1 anaplastic oligodendroglioma, 2 low grade astrocytomas) with lesions located adjacent to the OR were included. They were categorized as nine normal and eight abnormal based on clinical assessment of visual
function. All patients underwent MR examination before surgery on a 3T Siemens Tim Trio scanner. Diffusion tensor imaging was acquired with a 12-direction single-shot, spin-echo echo-planar sequence with parallel imaging using GRAPPA and acceleration factor of two. Imaging parameters were as follows: TR/TE 4900/83 ms, FOV 22x22 cm², matrix 128x128, b values 0 and 1000 s/mm², slice thickness 3 mm. The data were postprocessed off-line using DtiStudio, Version 3.0 (Johns Hopkins University, Baltimore, MD). The images were first corrected for motion and eddy-current artifacts using a 12-mode affine transformation with automated image registration (AIR) (2) and FA and ADC maps were computed, subsequently. The OR was reconstructed by placing two regions of interest (ROIs) at the occipital lobe and lateral geniculate body (LGB) based on FACT (fiber assignment by continuous tractography) (3). Unrelated fibers were removed by using “not” option. Optic radiations were manually segmented for 4 parts (loop, anterior, middle, posterior) using MRlctero. The anterior part of the OR was used as the mask for the FA and ADC measurements. Upon normalization of the FA and ADC values to the contra-lateral normal side, the data were compared across the two groups using a two-tailed, unpaired Student t-test.

RESULTS
Optic radiation was visualized in all of the patients. Patients with visual field deficits demonstrated significantly reduced FA (0.64 ± 0.13) compared to those with normal visual field (0.81 ± 0.15) (p < 0.03), whereas ADC measurements did not reach any significance (1.30 ± 0.26 vs 1.15 ± 0.27).

CONCLUSION
This preliminary study suggests that the microstructural integrity of the OR can be evaluated by DTI. Tractography-guided measurement has the potential to predict the degree of OR involvement in brain tumors.

REFERENCES

KEY WORDS: Diffusion tensor imaging, optic radiation, brain tumor

Paper 393 Starting at 11:25 AM, Ending at 11:33 AM

Comparison of 3 T MR Spectroscopy, MR Perfusion and MR Diffusion Imaging Values in Distinguishing Recurrent Malignant Glioma from Postradiation Change

Carr, R.¹ · Fink, J. R.¹ · Matussue, E.² · Haynor, D. R.¹ · Maravilla, K. R.¹
¹University of Washington, Seattle, WA, ²Tottori University, Yonago, JAPAN

PURPOSE
Recurrent malignant glioma is often indistinguishable from postradiation changes by anatomical contrast-enhanced MR imaging alone. MR spectroscopy, MR perfusion, and MR diffusion imaging each may improve diagnostic accuracy in making this important distinction. Our goal was to compare the diagnostic accuracies of these physiologic 3T MR imaging methods in distinguishing recurrent adult malignant glioma from postradiation changes using ROC analysis and logistic regression analysis.

MATERIALS & METHODS
All consecutive adult patients with histopathologically proved glioma who underwent 3 T MR physiologic imaging using MR spectroscopy (MRS), dynamic susceptibility MR perfusion (DSC) and MR diffusion imaging (DWI) at our institution between October 2006 and September 2007 for suspicion of malignant glioma recurrence were identified. Only patients who had interpretable imaging data from at least two of these 3 T MR imaging modalities were included. Maximum peak height choline/creatinine ratio (Cho/Cr) and choline/N-acetylaspartate ratio (Cho/NAA) were measured within each lesion. Maximum intraläsional regional cerebral blood volume/normal white matter ratio (rCBV ratio) and minimum intraläsional apparent diffusion coefficient/normal white matter ratio (ADC ratio) were calculated. All available surgical histopathology from reoperation (3 cases) was combined with clinical-radiologic follow-up (12 patients) as gold standard. Suspicious lesions that did not undergo reoperation were classified as glioma recurrence (7 cases) if lesions enlarged progressively on at least two serial follow-up anatomical MR scans. Lesions that disappeared, decreased in size or were unchanged for at least 6 months by serial MR scans without further therapy were classified as postradiation change (5 cases). ROC analyses for each 3 T MR imaging parameter to distinguish malignant glioma recurrence from postradiation changes were calculated and compared. Logistic regression analysis also was undertaken to model the relationship of these independent variables with the dependent variable of recurrent tumor or postradiation change.

RESULTS
Fifteen patients with history of malignant glioma treated with prior radiation therapy who underwent 3 T MRS, DSC and/or DWI for suspicion of tumor recurrence were reviewed; 13, 15 and 15 patients had interpretable MRS, DSC and DWI studies, respectively. ROC analyses showed that fitted area under the curve for ADC ratio (Az = 0.91), Cho/Cr (Az = 0.89), and rCBV ratio (Az = 0.89) were comparable and slightly higher than for Cho/NAA (Az = 0.76). Coefficients of logistic regression analysis were not significantly different from zero, an effect of small sample size.

CONCLUSION
Our initial results using ROC analysis to compare diagnostic accuracies of different physiologic 3 T MR imaging parameters in distinguishing recurrent malignant glioma from postradiation change suggests that MRS, DSC and DWI values perform comparably, and that Cho/Cr may perform better than Cho/NAA. Logistic regression analysis of multi-parametric 3 T MRS, DSC and DWI data from a larger number of patients would be most helpful to confirm these results. Analysis of an additional patient cohort of equal or greater number will be undertaken to augment statistical power.

KEY WORDS: 3T MRI, malignant glioma, postradiation therapy
Relative Cerebral Blood Volume Values to Differentiate High-Grade Glioma Recurrence from Posttreatment Radiation Effect: Direct Correlation Between Image-Guided Tissue Histopathology and Localized Dynamic Susceptibility Contrast MR Imaging Measurements

Hu, L. S. · Baxter, L. C. · Smith, K. · Feuerstein, B. G. · Karis, J. · Eschbacher, J. · Coons, S. · Nakaji, P. · Debbins, J. · Yeh, R. · Heiserman, J. ·
¹Mayo Clinic, Scottsdale, AZ, ²Barrow Neurological Institute, Phoenix, AZ, ³University of California San Francisco, San Francisco, CA

PURPOSE
Differentiating tumor growth from posttreatment radiation effect (PTRE) remains a common problem in neurooncology practice. To our knowledge, useful threshold relative cerebral blood volume (rCBV) values that accurately distinguish the two entities do not exist. Our prospective study utilizes image-guided neuronavigation during surgical resection of MRI lesions to directly correlate specimen histopathology with localized dynamic susceptibility contrast (DSC) MRI measurements and establish accurate rCBV threshold values which differentiate PTRE from tumor recurrence.

MATERIALS & METHODS
Preoperative 3T gradient-echo DSC MRI and contrast-enhanced stereotactic T1-weighted images were obtained in high-grade glioma (HGG) patients previously treated with multimodality therapy. Intraoperative neuronavigation documented the stereotactic location of multiple tissue specimens taken randomly from the periphery of enhancing MRI lesions. Coregistration of DSC MRI and stereotactic images enabled calculation of localized rCBV within the previously recorded specimen locations. All tissue specimens were histopathologically categorized as tumor or PTRE and correlated with corresponding rCBV values. All rCBV values were T1-weighted leakage corrected with preload contrast bolus administration and T2/T2*-weighted leakage corrected with baseline subtraction integration.

RESULTS
Forty tissue specimens were collected from 13 subjects. Posttreatment radiation effect group (n=16) rCBV values ranged from 0.21 - 0.71; tumor (n=24) values ranged from 0.55 - 4.64. 8.3% of tumor rCBV values fell within the PTRE group range. A threshold value of 0.71 optimized differentiation of the histopathologic groups with a sensitivity of 91.7% and specificity of 100% (Figure).

CONCLUSION
Relative CBV measurements obtained using DSC MRI and the protocol we have described can differentiate HGG recurrence from PTRE with a high degree of accuracy.

KEY WORDS: DSC, glioma, recurrence

Correlation of MR Imaging Morphologic Abnormalities, MR Spectroscopy and Radiation Treatment Dose-Volumes in Histologically Proved Cerebral Radiation Necrosis

Sundgren, P. C. · Elias, A. · Rogers, L. · Junck, L. · Tsien, C. T. · McKeever, P. · Cao, Y. · Haaken, R. T. · Gomez Hassan, D. M.
University of Michigan
Ann Arbor, MI

PURPOSE
The purpose of this retrospective study was to determine the location and characteristics of radiation injury abnormalities in the brain and to correlate these to the MRS findings and to treatment radiation dose in patients treated for previous brain tumor.

MATERIALS & METHODS
Presurgical MR imaging of the brain of 11 patients (9 male, 2 female) previously treated with external beam radiation, dose range 60-81Gy, for primary brain neoplasm and with postsurgical histologically proved cerebral radiation necrosis (CRN) were reviewed retrospectively. The MR images were evaluated for the location, extent and size of T2/FLAIR signal abnormalities, and abnormal enhancement. MR spectroscopy was performed using 3D or 2D CSI (PRESS, TE/TR 144/2000ms) and following ratios were calculated NAA/Cr, Cho/Cr, Cho/NAA, presence of lactate and/or lipids were noted. Different enhancement patterns including spreading wave front, swiss cheese/soap bubble or homogeneous enhancement, and central necrosis were described. The MR and MRS findings were correlated to treatment radiation dose. Biologically corrected radiation dose plans (alpha/beta=2.5) Steele 2002 were coregistered to the preop-
operative MR imaging using an in-house functional imaging analysis tools. The CRN area was outlined as a volume of interest (vVOI) and percentage of the vVOI enclosed was determined as: central (>95% covered), in-field (> 80-95%), marginal (20-80%), or distant (<20%).

RESULTS
In the examined cases, the CRN volume was centrally located within the high dose region. MR imaging demonstrated areas of contrast enhancing lesions ranging from 1.76 to 25.9 cm, most commonly seen as spreading wave front or swiss cheese (10/11) in appearance with surrounding T2 and FLAIR abnormalities. The different metabolic ratios were Cho/Cr 0.72-4.95 (mean 2.29), Cho/NAA 0.45-2.63 (1.21), and NAA/Cr 0.93-2.59 (mean 1.96).

CONCLUSION
Postcontrast enhanced tissue changes of CRN occurred entirely within the high dose region with combined metabolic ratios not suggestive for recurrent tumor in most cases (10/11). Since the radiation treatment volume encompassed at least 1 to 2 centimeters around the initial enhancing tumor volume, these findings have important implications for our understanding of what tissues may be vulnerable to radiation injury.

KEY WORDS: Radiation necrosis, MR imaging, MR spectroscopy

Paper 396 Starting at 11:49 AM, Ending at 11:57 AM
Does an Experienced Neuroradiologist Need Diffusion Tensor Imaging to Localize the Cortical Spinal Tract in Patients with Brain Tumors?
Ozturk, A.1 · Farrell, J. A. D.1,2,1 · Landman, B. A.3 · Pillai, J. J.1 · Yousem, D. M.1
1Johns Hopkins University School of Medicine, Baltimore, MD, 2Kennedy Krieger Institute, Baltimore, MD, 3Johns Hopkins University, Whiting School of Engineering, Baltimore, MD

PURPOSE
Neoplasms may infiltrate or, depending on their invasive- ness, displace white matter (WM) tracts. The dual goals of surgical treatment are to maximize tumor resection and preserve vital brain functions. Resection may lead to transection of WM tracts, thereby creating clinically apparent deficits unrelated to cortical injury or the tumor infiltration itself. Diffusion tensor imaging (DTI) continues to gain prominence as a research tool and is increasingly part of clinical imaging protocols. Diffusion tensor imaging and fiber tracking can be used to delineate the corticospinal tract (CST) and describe its relationship to adjacent brain tumors. The purpose of this study was to evaluate whether trained neuroradiologists could predict CST location adjacent to tumors and/or infiltration based on conventional MR imaging sequences. These findings were compared to those from DTI. We hypothesized that DTI would add significant value to the localization of the CST and to the determination as to whether the tract was infiltrated.

MATERIALS & METHODS
Conventional MR imaging (axial T2-weighted, T2-weighted FLAIR, sagittal T1-weighted and postgadolinium T1-weighted) and DTI were obtained for 32 subjects (15/17 F/M, 11-67 years old, mean 47 years) on 3T MR systems. Of the histologically confirmed cases, there were eleven astrocytomas, seven glioblastome multiforme, five ependymoma, two cavernous angiomas, one glioma, one mixed glioma, and two metastases. The clinical and DTI data of 16 patients were evaluated blindly by two observers and one observer reviewed the data from the remaining 16 patients. The fibers of the CST were reconstructed using the Fiber Assignment by Continuous Tracking method in DTIStudio. Diffusion tensor imaging fiber tracking was used as gold standard in localization, displacement, and possible infiltration of CST adjacent to tumor. Clinical and intraoperative data were reviewed also for motor deficits and CST localization/infiltration assessment.

RESULTS
All three reviewers showed only fair ability (81%, 75%, and 75% = 26/32, 12/16, 12/16) to localize the CST with conventional MR imaging, using DTI tractography as the gold standard. Evaluation of infiltration of the CST with conventional MR images showed widely varied sensitivity (25%-100%) and specificity (38%-93%). The accuracy for detecting infiltration varied from 50-87.5%. Additionally, displacement of the CST also showed varied range of sensitivity (21% - 67%) and specificity (80%-100%). Accuracy of tract displacement ranged from 67.5% to 95.8%.

CONCLUSION
The outcome of surgical treatment could be improved by preoperative mapping of the tumor and its relationship to functional structures, including cerebral cortex via functional MR imaging and WM tracts using DTI. This may maximize the extent of tumor resection while minimizing postoperative neurologic deficits resulting from damage to intact WM tracts. Without the use of DTI, identification of the displacement and infiltration of the CST in brain tumor patients is highly variable both across patients and raters. Even experienced neuroradiologists have difficulty in accurately assessing the relationship of CSTs to brain tumors. Therefore, DTI is extremely promising method for improved localization of the CST, and possibly other WM tracts in tumor patients.

KEY WORDS: Diffusion tensor imaging, brain, tumor

Paper 397 Starting at 11:57 AM, Ending at 12:05 PM
Imaging-Based Classification of Suprasellar Craniopharyngiomas: Impact on Surgical Planning Prior to Expanded Endonasal Resection
Agarwal, V. · Rothfus, W. E. · Kassam, A. B. · Gardner, P. A. · Prevedello, D. M.
University of Pittsburgh Medical Center
Pittsburgh, PA

PURPOSE
Craniopharyngiomas have been historically very difficult lesions for neurosurgeons to treat. Expanding on earlier work using the endoscope, a purely endoscopic endonasal approach to resection has been developed recently (EEA). The anatomical location of craniopharyngiomas is critical
for surgical planning. With EEA, a new classification of the suprasellar extent of these tumors has been proposed which helps to determine the specific approach used during resection. Central to this scheme is the pituitary infundibulum and its relationship with the tumor. In this study, we review the imaging features key to this new classification system. In addition, we evaluate the ability to accurately predict the type of craniopharyngioma on imaging prior to resection using EEA.

**Materials & Methods**

IRB-approved retrospective analysis of preoperative MR imaging was performed on 27 patients who underwent resection of craniopharyngiomas via EEA at our institution. Images were reviewed simultaneously by two neuroradiologists who were blinded to the operative findings. Lesions were classified as Type I (preinfundibular), Type II (transinfundibular) or Type III (retroinfundibular). When possible, lesions thought to be Type III were further subdivided into A and B categories based on rostral extension into the anterior third ventricle or caudal extension into the interpeduncular fossa respectively. Type IV (isolated third ventricular) lesions were not included in this study due to the fact that they are not well accessed via endonasal routes. Radiologic classification then was correlated with operative classification based on retrospective review of the operative findings by the neurosurgeon(s) involved in the case.

**Results**

Type I lesions are anterior to the infundibulum and therefore displace it posteriorly. Their epicenter is related to the posterior aspect of the tuberculum sellae/sellar face. Extension superiorly into the prechiasmatic cistern can be seen with elevation and posterior displacement of the chiasm with upward and anterior displacement of the anterior communication artery (ACOM). Type II lesions are highlighted by tubular expansion of the infundibulum with an inability to clearly identify the infundibulum as an individual entity in its entirety. The posterior portion of the optic chiasm may be elevated and the chiasm anteriorly displaced. The hypothalamic floor and the mammillary bodies usually are displaced posteriorly and inferiorly. Type III lesions are posterior to the infundibulum and therefore thin and displace it anteriorly. Their epicenter is at or just superior to the dorsum sellae. Extension into the anterior third ventricle or interpeduncular fossa can be seen. In contrast to type II lesions, the hypothalamic floor and mammillary bodies usually are elevated.

**Conclusion**

Endoscopic endonasal approach is the standard of care for surgical approach and management of craniopharyngiomas. The ability to preoperatively classify lesions based on their relationship to the infundibulum significantly impacts surgical planning including the need for pituitary transposition. However, each tumor and its specific relationship with the anatomy of the sellar region must be considered separately.

**Key Words:** Craniopharyngioma, EEA, infundibulum

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**Paper 398 Starting at 12:05 PM, Ending at 12:13 PM**

Comparison of Contrast-Enhanced T1-Weighted FLAIR with Blade and Spin-Echo T1-Weighted Sequences in Intracranial Imaging

Alkan, Ö.¹ · Kizilkilic, O.¹ · Yildirim, T.¹ · Alibek, S.²
¹University of Baskent School of Medicine, Adana Teaching and Medical Research Center, Yuregir, Ankara, TURKEY, ²University of Erlangen, Erlangen, GERMANY

**Purpose**

We compared periodically rotated overlapping parallel lines with enhanced reconstruction (PROPPELLER, BLADE) MR technique with SE technique with focus on evaluation of the presence of artifacts, ability of detection and delineation of brain lesions.

**Materials & Methods**

Contrast-enhanced T1-weighted FLAIR images with BLADE technique (CE T1w-FLAIR BLADE) and contrast-enhanced T1-weighted SE (CE T1w-SE) were performed in 50 patients with intracranial enhancing lesions. Contrast-enhanced T1w-FLAIR BLADE and CE T1w-SE were compared on the basis of qualitative analysis (presence of artifacts, lesion detectability, lesion delineation from adjacent structures, and preferred imaging technique) and quantitative parameters (i.e., lesion-to-background and lesion-to-cerebrospinal fluid (CSF) contrast-to-noise ratios (CNR) by two neuroradiologists). Reader agreement was assessed by kappa statistics.

**Results**

All lesions depicted with the CE T1w-SE also were detected with the CE T1w-FLAIR BLADE technique. The delineation of lesions was better on CE T1w-FLAIR BLADE in the majority of patients. Flow-related artifacts were considerably reduced with CE T1w-FLAIR BLADE. A star-like artifact at the level of the 4th ventricle was noted on CE T1w-FLAIR BLADE and not on CE T1w-SE. The lesion-to-background CNR and lesion-to-CSF CNR did not show statistically significant difference between both techniques. Contrast-enhanced T1w-FLAIR BLADE images were preferred by the observers over the CE T1w-SE images, indicating a good interobserver agreement.

**Conclusion**

Contrast-enhanced T1w-FLAIR BLADE technique is superior to CE T1w-SE for delineation of lesions and reduction of flow-related artifacts especially within the posterior fossa and is preferred by readers. Contrast-enhanced T1w-FLAIR BLADE may be an alternative approach to imaging in patients especially for posterior fossa lesions.

**Key Words:** Brain, neoplasm, BLADE
**PURPOSE**

The objective of our study was to detect and evaluate intraperitumoral mean diffusivity and fractional anisotropy to differentiate between high-grade gliomas and brain metastases.

**MATERIALS & METHODS**

Eighteen previously untreated patients suffering from histologically proved high-grade glioma and 14 patients diagnosed with brain metastases from mammary cancer were examined in our study. MR imaging was performed using a 3 T scanner acquiring diffusion tensor images (DTI) with 12 directions. The regions of interest (ROI) were positioned for DTI evaluation into different parts of the tumor, on normal-appearing white matter and on the vasogenic edema surrounding the tumor depicted by abnormal T2-weighted images.

**RESULTS**

Significant decrease of fractional anisotropy (FA) (p<0.005) and significant increase of mean diffusivity (MD) (p<0.005) was found in the peritumoral regions compared to normal-appearing white matter. For brain metastases the peritumoral MD was significantly increased compared to high-grade gliomas (p<0.005). Peritumoral FA showed no significant differences comparing the two patient groups. Intratumoral FA was increased in high-grade gliomas and in metastatic disease.

**CONCLUSION**

Due to increased extracellular water, diffusion parameters show a pathologic change within peritumoral vasogenic edema in both high-grade gliomas and tumor metastases. Unlike FA, MD can be used to differentiate between high-grade gliomas and metastatic tumors, pointing towards probable tumor infiltration characterized by MD values.

**KEY WORDS:** Glioma, MRI, DTI
weighted GRE sequences; \(p \leq 0.02\), all readers) for CNR. The three readers noted percent lesion enhancement increases with Gd-BOPTA of 48.1% (\(p < 0.0001\)), 45.9% (\(p = 0.0004\)), and 46.8% (\(p = 0.0009\)), on T1-weighted SE images, and 48.6% (\(p = 0.0019\)), 46.2% (\(p = 0.0008\)), and 49.5% (\(p = 0.0026\)) on T1-weighted GRE images.

CONCLUSION
For CE-MRI brain imaging at 3T, Gd-BOPTA demonstrated improved vessel anatomical delineation, better detection/exclusion of pathology, and greater global diagnostic preference compared to an equal dose of Gd-DTPA.

KEY WORDS: MR imaging, gadobenate, gadopentetate

Thursday Morning
10:45 AM – 12:30 PM
Ballroom A

(50c) Adult Brain: Degenerative/Demyelinating/Metabolic Diseases I
(Scientific Papers 401 – 413)

See also Parallel Sessions
(50a) Adult Brain: Functional Imaging II
(50b) Adult Brain: Neoplasms II
(50d) Pediatric: Infections, Metabolic, Other & Spine
(50e) Excerpta Extraordinaire: Pediatrics

Moderators: TBD

Use of Automated MR Imaging Cortical Thickness and Volume Measurements with Neuropsychological Testing for Predicting Progression from Mild Cognitive Impairment to Alzheimer Disease

Desikan, R. S.1,2 · Cabral, H. J.3 · Settecase, F.4 · Hess, C. P.4 · Dillon, W. P.4 · Glastonbury, C. M.4 · Weiner, M. W.5,6 · Schmansky, N. J.1 · Greve, D. N.1 · Salat, D. H.1 · Buckner, R. L.1,6,7 · Fischl, B.1,8
1Massachusetts General Hospital, Boston, MA, 2Boston University School of Medicine, Boston, MA, 3Boston University, Boston, MA, 4University of California San Francisco, San Francisco, CA, 5San Francisco VA Medical Center, San Francisco, CA, 6Harvard University, Cambridge, MA, 7Howard Hughes Medical Institute, Bethesda, MD, 8Massachusetts Institute of Technology, Cambridge, MA

PURPOSE
Automated computer-based analysis of brain MRI data has developed over the past decade to the point where automated measurements now may be useful routinely as an adjunct to neuroradiologic interpretation in patients with Alzheimer disease (AD). The goal of this study was to determine if automated region-of-interest (ROI) based MRI measurements of cortical thickness and volume can predict clinical progression from mild cognitive impairment (MCI) to Alzheimer disease in individual patients, and whether these automated MRI measures can be statistically integrated with neuropsychological measures of disease progression to improve prediction accuracy.

MATERIALS & METHODS
Baseline high-resolution, volumetric T1-weighted brain MRIs from 116 patients with MCI were analyzed using automated software to identify the volume and mean thickness of 34 neocortical and nonneocortical regions. All participants were followed clinically until either (a) diagnostic criteria for probable AD were met, or (b) until completion of 2-year follow up. Multiple stepwise logistic regression models were used to identify the most important MRI measures and neuropsychological testing variables for optimal prediction of progression from MCI to AD and to determine whether a model combining MRI-based measurements with neuropsychological testing would improve prediction accuracy.

RESULTS
Prediction accuracy, as determined using the area under the curve (AUC), for neuropsychological testing alone was 76%. Prediction accuracy for the MRI-derived measures alone was 87%. The addition of the MRI-derived measurements to a model containing neuropsychological testing increased prediction accuracy to 91%, a significant improvement over neuropsychological testing alone (\(p < 0.001\)) (Table). The optimal model included middle temporal gyrus thickness (Odds Ratio (OR) = 0.073, \(p = 0.01\)), pars opercularis thickness (OR = 0.14, \(p = 0.08\)), inferior temporal gyrus volume (OR = 0.36, \(p = .0064\)), entorhinal cortex volume (OR = 0.35, \(p = 0.1\)), pars orbitalis volume (OR = 0.23, \(p = 0.05\)), the time to complete part B of the Trail Making Test (OR = 1.0, \(p = 0.12\)), and 5-minute recall from the Rey Auditory Verbal Learning Test (OR = 0.72, \(p = 0.006\)).
Table. Discrimination results from stepwise regression analyses.

<table>
<thead>
<tr>
<th>Area Under Curve (AUC)</th>
<th>Neurocognitive Testing 🍂</th>
<th>Automated ROI M1 Measures*</th>
<th>Neurocognitive Testing 🍂</th>
<th>Automated ROI MRI Measures*</th>
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<tr>
<td></td>
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<tr>
<td>Sensitivity</td>
<td>58%</td>
<td>81%</td>
<td>88%</td>
<td></td>
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<tr>
<td>Specificity</td>
<td>81%</td>
<td>83%</td>
<td>86%</td>
<td></td>
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<tr>
<td>Negative predictive value</td>
<td>67%</td>
<td>82%</td>
<td>88%</td>
<td></td>
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<tr>
<td>Positive predictive value</td>
<td>75%</td>
<td>82%</td>
<td>86%</td>
<td></td>
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<tr>
<td>Negative likelihood ratio</td>
<td>0.52</td>
<td>0.23</td>
<td>0.14</td>
<td></td>
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<tr>
<td>Positive likelihood ratio</td>
<td>3.1</td>
<td>4.8</td>
<td>6.5</td>
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</tr>
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</table>

*Combined time to complete part B of Trail Making Test and 5-minute recall from Rey Auditory Verbal Learning Test.

Table 1. The comparison of the corpus callosal area

<table>
<thead>
<tr>
<th></th>
<th>AD (mm²)</th>
<th>MCI (mm²)</th>
<th>HC (mm²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean ± SD</td>
<td>498.7±72.2</td>
<td>595.9±108.4</td>
<td>563.2±75.1</td>
</tr>
<tr>
<td>Minimum</td>
<td>398.5</td>
<td>445.7</td>
<td>436.7</td>
</tr>
<tr>
<td>Maximum</td>
<td>616.3</td>
<td>788.9</td>
<td>685.8</td>
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</table>

CONCLUSION
Automated ROI-based brain MRI measurements of cortical thickness and volume of specific regions can predict with a high degree of accuracy those patients likely to progress from mild cognitive impairment to Alzheimer disease. The increased prediction accuracy resulting from the integration of automated MRI measures with neuropsychological testing suggests the feasibility and clinical importance of utilizing these tools in a complementary fashion.

KEY WORDS: Alzheimer disease, mild cognitive impairment, structural MRI

Paper 402 Starting at 10:53 AM, Ending at 11:01 AM

Corpus Callosum Area and Brain Volume in Alzheimer Disease, Mild Cognitive Impairment and Healthy Control

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¹Korea University Ansan Hospital, Ansan-si, REPUBLIC OF KOREA, ²Dongguk University International Hospital, Goyang-si, REPUBLIC OF KOREA

PURPOSE
We wanted to evaluate the relationship between the corpus callosum (CC) area and brain volume and to compare the CC area and brain volume among Alzheimer disease (AD), mild cognitive impairment (MCI) and healthy control (HC).

MATERIALS & METHODS
To evaluate the relationship of the CC area and brain volume, the 111 subjects (M:F = 48:63; mean age 56.9 years) without memory disturbance and 28 patients (M:F = 11:17; mean age 66.7 years) with memory disturbance were evaluated. The 11 AD patients (M:F = 3:8; mean age 75.7 years), 17 MCI patients (M:F = 8:9; mean age 60.9 years), and 28 selected HC (M:F = 11:17; mean age 66.4 years) were investigated for comparison of the CC area and brain volume. The brain volume was estimated in forebrain subtracting cerebellum and CSF space. The CC area was measured by regions of interest placed on outer margin of CC in midsagittal slice.

RESULTS
There was good positive linear correlation between the CC area and brain volume in subjects without memory disturbance and patients with memory disturbance (r = 0.64 and 0.66, respectively, P < 0.01) (Figure). The CC area and brain volume in AD patients (498.7 ± 72 mm², 715.4 ± 107 cm³) was significantly smaller than MCI patients (595.9 ± 108 mm², 844.1 ± 85 cm³) (P<0.05) and HC (563.2 ± 75 mm², 818.9 ± 109 cm³) (P<0.05) (Table). There was no statistical significance in comparison of the CC area and brain volume between MCI and HC.

Table 1. The comparison of the corpus callosal area

<table>
<thead>
<tr>
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<td>788.9</td>
<td>685.8</td>
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</table>

CONCLUSION
The CC area is significantly correlated with the brain volume in subjects without memory disturbance and patients with memory disturbance. The CC area as well as brain volume was significantly smaller in AD than MCI and HC. The CC area would be useful in evaluation of patients with memory impairment.

KEY WORDS: Alzheimer disease, corpus callosum, MR

Paper 403 Starting at 11:01 AM, Ending at 11:09 AM

Comparison of 3 T and 7 T MR Imaging for Evaluation of the Mesial Temporal Lobe in Patients with Alzheimer Disease and Frontotemporal Dementia

Hess, C. P.¹ · Kerchner, G. A.¹ · Hammond, K. E.¹ · Xu, D.¹ · Kelley, D. A. C.² · Vigneron, D. B.¹ · Miller, B. L.¹ · Nelson, S. J.¹

¹University of California San Francisco, San Francisco, CA, ²General Electric, Menlo Park, CA

PURPOSE
Neuropsychology studies in patients with Alzheimer disease (AD) and certain forms of frontotemporal dementia (FTD) have implicated the disruption of different pathways within the temporal lobe as the substrate for observed differences in episodic and semantic memory in these disorders (1). Further corroborating this hypothesis are histopathology studies that point to selective vulnerability of different neuronal populations in each disease (2). We hypothesized that ultra-high field 7T MR imaging would better depict changes in morphology and signal within entorhinal, perirhinal and hippocampal regions than 3T MR imaging.

MATERIALS & METHODS
Healthy elderly controls (N=2), and patients with AD (N=6) and FTD (N=3) were recruited to undergo both 3T and 7T structural MR imaging using a protocol tailored to the medial temporal lobes. Both coronal T2*-weighted gradient-echo (TR/TE=250/15 ms, NEX=3, flip=20°) and T2-weighted FSE sequences (TR/TE=6000/86 ms, NEX=2,
ASSET=2, ETL=16) oriented along the hippocampal axis were obtained using 8-channel parallel receive coils. Both protocols were performed with 2mm slice thickness and matrix size 512x512. 3T and 7T images were assessed visually for neocortical volume loss, mesial temporal atrophy, and subfield-specific atrophy of CA1-CA4.

RESULTS
Mesial temporal structures were visualized with greater clarity at 7T than 3T, with more distinct gray-white differentiation and improved resolution of internal hippocampal laminar architecture at 7T. Both FTD and AD patients exhibited hippocampal volume loss. As shown in figure, disproportionate thinning of perirhinal cortex in a patient with the semantic dementia variant of FTD (top) is manifest by marked enlargement of the collateral sulci, with relative sparing of the subiculum and Ammon’s horn. In a patient with AD (bottom), there is severe volume loss within the subiculum and CA1 regions, more pronounced on the left. While these patterns of atrophy have been noted previously at lower field strength (3,4), cortical thickness measurements and delineation of hippocampal subfields are much more accurate at 7T than at 3T.

CONCLUSION
This pilot study demonstrates that evaluation of medial temporal lobe using T2* and T2-weighted MR imaging can be more reliably performed at 7T than 3T in patients with dementia, with gains in resolution that may ultimately prove useful for more precise computational morphometry.

REFERENCES
2. Jellinger KA. Neurodegener Dis 2008;5:118-121

KEY WORDS: Alzheimer, frontotemporal dementia, 7 T
and AD subjects. Since it is known that T2 values are altered significantly as a result of the fixation process, additional research is needed in order to better evaluate the utility of postmortem T2 relaxometry. Despite the series of changes to the brain tissue during fixation, hippocampal volume measured via postmortem MR imaging can be linked to ante-mortem cognitive status, a useful finding since postmortem specimens exhibit no bulk or physiologic motion and post-mortem imaging findings can be compared with histopathology. Therefore, postmortem imaging can potentially become a very valuable tool for testing new imaging techniques for dementia.

**Key Words:** Postmortem, MRI, Alzheimer’s

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**Paper 405 Starting at 11:17 AM, Ending at 11:25 AM**

**Detection of Amyloid Plaques Associated with Iron in Alzheimer Human Post-Mortem Brain Using MR Susceptibility-Weighted Imaging at 7 T**

Lin, E. P.; Ge, Y.; Tang, L.; Nijhawan, R. I.; Yang, J.; Li, Y.; de Leon, M.; Wisniewski, T.

New York University Hospitals Center
New York, NY

**Purpose**

Three-dimensional gradient-echo susceptibility-weighted imaging (SWI) at higher field strength MR imaging potentially can enhance susceptibility contrast. Our goal is to identify the imaging correlate of iron-containing amyloid plaques in human post-mortem brain of patients with Alzheimer disease (AD) and to evaluate imaging parameters that may improve detection of amyloid plaques using 7T MR imaging.

**Materials & Methods**

Post-mortem brain specimens of frontal and entorhinal cortex were obtained from two patients with clinically diagnosed AD and two age-matched control patients without AD. Coronal 10mm thick slices were preserved in 2% agar. High-resolution 3D SWI was performed using 24-element phased array head coil in a 7T magnet to maximize signal-to-noise ratio. To optimize susceptibility contrast, the TR/TE/BW/flip angles were varied from 30-100ms/12-24ms/60-140Hz/pixel/10-40°. Isotropic voxel size was 230μm. Following SWI acquisition, SWI filtered phase images were used (multiplication factor 4-8) to enhance contrast on magnitude images. Coronal vibratome sections were cut, stained with Thioflavin-S and correlated with SWI.

**Results**

Imaging parameters consisting of TR/TE/flip angle of 80ms/20ms/30° and phase multiplication factor of 6 exhibited the greatest contrast to detect paramagnetic substances on SWI. Compared to controls, AD brain samples revealed a large increase in the number of hypointense foci on post-processed SWI images along the cortical mantle of the frontal lobe (Figure) and entorhinal cortex. Histologic staining of AD samples also demonstrated an increase in the number of amyloid plaques relative to controls in the same regions.

**Conclusion**

Preliminary results suggest that hypointense foci, detected on 7T SWI along the cortical gray matter in AD patients, correlate with histologically stained amyloid plaques. These findings concur with studies of AD transgenic mouse models that previously have established correlation between “susceptibility stains” and iron-containing amyloid plaques. This relationship has not been confirmed previously in humans. The ability to detect amyloid plaques in vivo in patients with AD prior to clinical diagnosis supports the value of using ultra-high field SWI, by virtue of its superior resolution, high signal-to-noise ratio and susceptibility contrast. High field strength SWI may allow insights into the role of iron toxicity in the development of amyloid plaques, and provide a means of early diagnosis and monitoring disease progression.

**Key Words:** Alzheimer, MR

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**Paper 406 Starting at 11:25 AM, Ending at 11:33 AM**

**Influence of Fractional Anisotropy Threshold in Tract-Based Diffusion Tensor Analysis: Analysis of Uncinate Fascicles in Alzheimer Disease**


Nara Medical University
Kashiwara, JAPAN

**Purpose**

Tract-based diffusion tensor analysis can investigate required tract extracted from other neuronal tracts by using...
tractogram. This method is effective in the area which contains several different neuronal tracts such as temporal stem. However, range of tractogram and diffusion tensor parameters may be subjected to fractional anisotropy (FA) threshold for tractography. The purpose of the current study is to evaluate the influence of the FA threshold in measuring diffusion tensor parameters for tract-based analysis of uncinate fascicles in the cases with Alzheimer disease (AD).

**MATERIALS & METHODS**

Subjects of the current study includes 25 AD cases (5 severe, 7 moderate, 6 mild AD and 7 mild cognitive impairment (MCI) cases) and 10 normal controls. Diffusion tensor images were obtained by a single-shot echo-planar sequence (TR=4900 ms, TE=85 ms, b=1000 sec/mm², 6 axes encoding, averaging=6). We acquired tractographies of uncinate fasciculus using different FA thresholds (0.1, 0.15, 0.2, 0.25) using “dTV II” diffusion tensor imaging software (Department of Radiology, University of Tokyo). We measured FA and apparent diffusion coefficient (ADC) along uncinate fasciculus for different FA thresholds, and evaluated statistical difference of the values among AD cases, MCI cases and control subjects using ANOVA.

**RESULTS**

Uncinate fascicles showed higher FA and lower ADC values in more severe AD cases. Higher FA threshold bring lower value of ADC and higher value of FA along the uncinate fasciculus, while, relative order of measured value according to the severity of AD were not influenced by FA threshold (Figure). With FA threshold of 0.25, tractography of uncinate fasciculus could not be drawn in three cases. Fractional anisotropy threshold of 0.15 and 0.2 showed better discrimination among different severity of AD both for FA and ADC.

**CONCLUSION**

Although relative order was not influenced, FA threshold had influence for measured value of FA and ADC along the tract. In the current study, FA threshold of 0.15 and 0.2 showed better discrimination among different severity of AD for FA and ADC. For tract-based analysis of degenerative disease such as AD, appropriate selection of FA threshold to draw tractography is important for effective and meaningful evaluation.

**KEY WORDS:** Diffusion tensor, Alzheimer disease, fractional anisotropy

**Paper 407 Starting at 11:33 AM, Ending at 11:41 AM**

**Tumefactive Demyelinations vs High-Grade Gliomas of the Brain: Further Insights from Chemical Shift Imaging and Diffusion Tensor Imaging**

Thomas, B. · Kesavadas, C. · Gupta, A. K. · Kapilamoorthy, T. R.

Sree Chitra Tirunal Institute for Medical Sciences & Technology

Trivandrum, INDIA

**PURPOSE**

To evaluate the usefulness of multivoxel proton MR spectroscopy and diffusion tensor imaging in differentiating tumefactive demyelination and high-grade gliomas of the brain.

**MATERIALS & METHODS**

Seven cases of tumefactive demyelinations and four cases of glioblastomas were included in the study. All the cases had undergone MR imaging including on a 1.5T MR scanner. Multivoxel MR spectroscopy at TE 30 and 135 ms using a PRESS sequence and a SE- EPI DTI of the brain were obtained. Average mean diffusivity (Dav) and fractional anisotropy (FA) maps were created. Various metabolite ratios and asymmetry indices were calculated at the three concentric layers of the demyelinating lesions and the central and peripheral areas of the tumors. At TE 30 ms, glutamate-glutamine (GLX-2.1- 2.5 ppm) was compared in the lesion to the contralateral normal side. Average mean diffusivity and FA from different layers of the lesion also were calculated and compared to contralateral normal side . Histopathologic correlation was obtained in all the tumors and one demyelination. Therapeutic response was taken into account in other demyelinations.

**RESULTS**

The demyelinating lesions had three distinct layers within the lesion from central to periphery. On TE 135 ms, the innermost layer showed low choline (Cho) and significantly low N-acetyl aspartate (NAA) and high levels of lactate (Lac) without any lipids (Lip). Diffusion tensor imaging showed high Dav and very low FA here. The intermediate layer showed, high Cho and low NAA and less Lac. There was mild rise of Dav and low FA here. The outermost layer, which corresponded to the contrast-enhancing areas on MR imaging, showed highest Cho, low NAA and mild increase in Lac compares to contralateral normal side. This layer also showed significant restriction of water diffusion with marked reduction in Dav. On TE 30 ms, the GLX was raised inside the tumefactive lesions. The glioblastomas showed high Cho/ Cr ratio in the enhancing portions with Lip and Lac within the lesion. The clearly demarcated zones on DTI and spectroscopy like in demyelination were absent.
Inhibition of Myeloperoxidase Activity Improves Clinical Score and Inflammatory Lesion Load on Myeloperoxidase Molecular Imaging in the Murine Experimental Allergic Encephalomyelitis Model for Demyelinating Diseases

Forghani, R. · Wojtkiewicz, G. · Zhang, E. · Rodriguez, E. · Bautz, B. · Weissleder, R. · Chen, J. W.

1Massachusetts General Hospital, Boston, MA, 2Massachusetts General Hospital, Boston, MA

PURPOSE

Multiple sclerosis plaques result from an immune-mediated inflammatory response modulated by lymphocytes, macrophages, and monocytes that is detectable with the molecular imaging MR imaging contrast agent bis-5-hydroxytryptamide-DTPA(Gd) (MPO-Gd), an activatable imaging sensor of myeloperoxidase (MPO) activity. We hypothesized that inhibition of MPO activity would result in improved clinical scores in the murine experimental autoimmune encephalomyelitis (EAE) model for demyelinating diseases with a concomitant decline in lesion load and MPO activity on molecular imaging.

MATERIALS & METHODS

We induced EAE in 20 SJL mice and divided them into control (treated with saline; n = 10) and treated groups (n = 10) (4-aminobenzoic hydrazide (ABAH), a specific MPO inhibitor, 40 mg/kg IP bid). Molecular imaging for MPO activity was performed using a small animal 4.7 T Bruker Pharmascan MR scanner with a mouse brain coil (Bruker Biosciences, Billerica, MA). Spin-echo T1-weighted images were obtained before and after the intravenous administration of 0.3 mmol/kg of MPO-sensitive agent MPO-Gd (0.3 mmol/kg) at 6, 15, 30, 45, 60, and 75 min sequentially. Confirmation of the molecular imaging findings was performed using the tetramethylbenzidine (TMB) assay (Sigma-Aldrich) for MPO activity along with histopathologic analyses.

RESULTS

One mouse from the control group died shortly after induction from anaphylactic reaction from the induction reagents, and was excluded from analysis. Of the remaining 19 mice, the mean clinical score was 3.6 in the control group versus 1.4 in the ABAH treated group during the 15 days following induction (P ≤ 0.006; Student’s t-test, two-tailed). Four out of nine (44%) control animals died from the disease during this period versus none from the treated group. When we subdivided the mice by clinical symptoms into mild (no limb weakness, figure a), moderate (limb weakness, figure b), and severe (paralysis and moribound) categories, there were many more control animals with moderate and severe disease (89%) versus ABAH-treated mice (40%) (figure c). Molecular imaging for MPO activity, corroborated with biochemical and histopathologic analysis, confirmed these results.

CONCLUSION

Our findings demonstrate a significant contribution of MPO activity to clinical disease burden in a murine model of multiple sclerosis. In addition to the therapeutic implications of these findings, our results provide the basis for application of MPO-Gd molecular imaging for noninvasive investigation of demyelinating diseases in animal models and possibly humans.

KEY WORDS: Demyelinating disease, molecular imaging, myeloperoxidase

Evaluation of White Matter and Gray Matter Damage in the Earliest Stage of Multiple Sclerosis by Means of Voxel-Based Morphometry and Tract-Based Spatial Statistics

Raz, E. · Cercignani, M. · Sbardella, E. · Totaro, P. · Pozzilli, C. · Bozzali, M. · Pantano, P.

1Sapienza University of Rome, Rome, ITALY, 2Fondazione Santa Lucia IRCSS, Rome, ITALY, 3Istituto di Neuroscienze NCL, Rome, ITALY

PURPOSE

Diffuse MRI abnormalities have been largely described in patients with multiple sclerosis (MS), involving both white (WM) and gray matter (GM), even at the earliest stages of the disease. However, the relationship between WM and GM
damage is not fully understood. Our aim was to quantify WM and GM damage with voxel-based morphometry (VBM) and tract-based spatial statistics (TBSS) used in combination.

**MATERIALS & METHODS**
We recruited 34 consecutive patients [F/M=21/13; mean (SD) age=31.7 (7.7) years] presenting with symptoms suggestive of a first episode of MS. Median EDSS score was 1.5 (range 0-3). MR examination at 1.5 T, included dual-echo TSE, T1-SE before and after gadolinium, 3D T1-MPRAGE, DTI. Sixteen matched healthy volunteers served as controls. Patients were classified according to the revised McDonald criteria. T2-lesion volumes (LV) were assessed using a semiautomatic technique (Jim 4.0). SPM5 and FSL were respectively used for VBM GM (with an optimized protocol modified to account for the lesions) and WM analyses (with TBSS, part of FSL, in order to compare FA values across groups).

**RESULTS**
Following the revised McDonald criteria, patients were divided in two subgroups [early MS=24; clinically isolated syndrome (CIS)=10]. The two subgroups did not show any significant difference in demographic characteristics (gender, age, sex), mean EDSS score, and LV. All MS patients compared to controls did not reveal significant differences in global GM, WM, and CSF volume. Voxel-based morphometry analysis did not show any regional difference in GM volumes between MS patients and controls. Tract-based spatial statistics analysis revealed a diffuse decrease in regional FA in MS patients at voxel level (p<0.05). These regions were widespread along WM fiber tracts, with a prominent involvement of the corticospinal tracts, the corpus callosum, and the superior and inferior longitudinal fasciculi. Most of those abnormalities were localized in the normal appearing WM. Between CIS and early MS subgroups, no significant differences could be found.

**CONCLUSION**
This study demonstrates that diffuse WM damage is detectable in MS since the earliest stages of the disease. This damage involves most of the WM tracts. No significant changes were observable when considering regional GM volumes. These findings suggest that WM damage plays the most relevant role in determining the early steps of brain tissue damage in MS. The accumulation of GM damage is more likely to be secondary to Wallerian degeneration mechanisms rather than being related to a direct implication of GM.

**KEY WORDS:** Multiple sclerosis, DTI, VBM
Metabolite Concentrations in NAWM

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<th>CON</th>
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<td>NAA/Cho</td>
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<td>1.7 ± 0.1</td>
<td>1.5 ± 0.1</td>
</tr>
<tr>
<td>Cho/Cr</td>
<td>1.2 ± 0.1</td>
<td>1.2 ± 0.0</td>
<td>1.3 ± 0.1</td>
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<td>NAA [mM]</td>
<td>12.6 ± 0.6</td>
<td>12.3 ± 0.6</td>
<td>12.5 ± 0.4</td>
</tr>
<tr>
<td>Cho [mM]</td>
<td>2.6 ± 0.1</td>
<td>2.5 ± 0.1</td>
<td>2.7 ± 0.1</td>
</tr>
<tr>
<td>Cr [mM]</td>
<td>8.9 ± 0.5</td>
<td>8.4 ± 0.5</td>
<td>9.0 ± 0.2</td>
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</tbody>
</table>

CONCLUSION
As expected, metabolic damage of NAWM in NMO is absent. Surprisingly, the same result occurred in NMO matched MS group, may be due to only mild cerebral involvement in these patients. This suggests that in early stages of the respective disease, NMO and MS might not be differentiated using NAWM spectroscopy.

KEY WORDS: MR spectroscopy, neuromyelitis optica, normal appearing white matter

Dynamic Susceptibility Contrast Magnetic Perfusion Imaging Technique in Patients with Clinically Isolated Syndrome Suggestive of Multiple Sclerosis: Diffuse Involvement of White and Deep Gray Matter

Papadaki, E. Z. · Skoulikaris, N. · Amanakis, E. · Mastorodimos, V. · Maris, T. · Stilianaki, V. · Karampekios, S.
University Hospital of Heraklion
Heraklion, Crete, GREECE

PURPOSE
Previous studies on application of perfusion-weighted imaging (PWI) in patients with multiple sclerosis (MS) proved hemodynamic changes, such as decreased perfusion, in normal appearing white matter (NAWM) and deep gray matter, probably due to microvascular damage and ischemia. The aim of the current study is to investigate possible hemodynamic impairment at the earliest clinical stages of MS: in patients with clinically isolated syndrome (CIS) suggestive of multiple sclerosis.

MATERIALS & METHODS
Thirty patients with CIS and 10 healthy volunteers were studied at an 1.5 T MR scanner. Perfusion-weighted imaging technique was applied and absolute values of relative cerebral blood volume (rCBV) and relative cerebral blood flow (rCBF) were estimated. Six hundred forty measurements were performed concerning normal white matter of the healthy volunteers (NWM=80), normal appearing white matter of the patients (NAWM=240), and, also, the thalami, caudate and putamen nuclei, genu and splenium of the corpus callosum of the normal subjects (THAL-No=20, CAUD-No=20, PUT-No=20 and CALL-No=20) and the patients (THAL-CIS=60, CAUD-CIS=60, PUT-CIS=60 and CALL-CIS=60). The absolute values of rCBV and rCBF of the different estimated regions were compared with student’s t-test.

RESULTS
Normally appearing white matter is characterized by significantly higher rCBV and rCBF values compared to the respective values of NWM (p=0.005 and 0.01 respectively), while the rCBV and rCBF values of CAUD-CIS and PUT-CIS were significantly higher compared to the respective values of CAUD-No and PUT-No (p=0.002 and 0.03). There is no statistically significant difference between the rCBV and rCBF values of THAL-No and THAL-CIS (p=0.1 and 0.3 respectively), or between CALL-CIS and CALL-No (p=0.33 and 0.52 respectively).

CONCLUSION
Normal appearing white matter regions and the basal ganglia of patients with CIS suggestive of multiple sclerosis, are characterized by increased rCBV and rCBF values compared to the respective values of the healthy subjects, probably reflecting diffuse inflammation, while there is no analogous involvement of the corpus callosum and thalami. This finding suggests that diffuse perivascular inflammation at the earliest stage of CIS suggestive of MS, precedes the vascular occlusion and chronic ischemia at the stage of clinically definite MS.

CONCLUSION
As expected, metabolic damage of NAWM in NMO is absent. Surprisingly the same result occurred in NMO matched MS group, may be due to only mild cerebral involvement in these patients. This suggests that in early stages of the respective disease, NMO and MS might not be differentiated using NAWM spectroscopy.

KEY WORDS: MR spectroscopy, neuromyelitis optica, normal appearing white matter
REFERENCES

KEY WORDS: Clinically isolated syndrome

Paper 412 Starting at 12:13 PM, Ending at 12:21 PM

Diffusion-Weighted and FLAIR MR Imaging Findings in Patients with Acute Hepatic Encephalopathy and Hyperammonemia

Lohman, B. D. · McKinney, A. M. · Uhlmann, E. J. · Spanbauer, J. C. · Brace, J. R. · Tore, H.
University of Minnesota
Minneapolis, MN

PURPOSE
Diffusion-weighted imaging (DWI) and FLAIR MR imaging of hepatic encephalopathy (HE) in acute hepatic failure (AHF) can show cytotoxic edema and can be reversible; however, the relationship between ammonia levels and development of changes in FLAIR and DWI has not been investigated yet (1). We retrospectively analyzed DWI and FLAIR findings in AHF patients with and without hyperammonemia. We hypothesized that DWI and FLAIR MR imaging could distinguish those with AHF and hyperammonemia (HEHA) versus those with no hyperammonemia (HENA).

MATERIALS & METHODS
Fifteen patients with clinical symptoms of AHE were collected over 2 years, and reviewed by two staff neuroradiologists after IRB approval. Three were thereafter excluded due to having CT only, but no available MR imaging. Of the remaining 12, one was excluded since ammonia levels were obtained >3 days relative to MR imaging. Another three of these 12 had absent or normal ammonia levels. Of the remaining eight, each were hyperammonemic (HEHA). Diffusion-weighted imaging and FLAIR (with T2-weighted imaging) were reviewed by consensus, and apparent diffusion coefficient (ADC) measurements were recorded along with regions of involvement, and compared with ADC in normal appearing white matter (NAWM) using a t-test. Correlations were calculated between percent ADC decrease and serum ammonia level.

RESULTS
In eight patients with HEHA, involvement of the bilateral ventral thalamus (VT) was present in 7/8 on FLAIR, and 6/8 on DWI. PLIC involvement was present in 8/8 on FLAIR, and 5/8 on DWI. Periventricular white matter (PVWM) involvement was present in 7/8 on FLAIR, and 6/8 on DWI. Of the four patients without available ammonia levels or nonelevated levels within 3 days of the MR imaging, the VT was involved in two and the PLIC in two. The mean percentage decrease in ADC in the VT, PLIC and PVWM were 21.5% (p=0.013), 22.2% (p=0.004), and 17.3% (p=0.002), respectively relative to NAWM. No significant correlations were noted between percent ADC decrease and the ammonia level (all r’s <0.15). Only two of the eight HEHA patients had follow-up MR imaging, demonstrating progressive improvement of thalamic and PLIC involvement and progressively increasing ADC values over 6-7 months.

CONCLUSION
This preliminary report suggests that VT and PLIC involvement on DWI/FLAIR imaging can be an indicator for the presence of HEHA. Diffusion-weighted imaging and FLAIR abnormalities appear potentially reversible with therapy, although prospective studies are necessary.

REFERENCES

KEY WORDS: MRI, hepatic encephalopathy, hyperammonemia

Paper 413 Starting at 12:21 PM, Ending at 12:29 PM

Effects of Ginkgo Biloba on Cerebral Blood Flow Assessed by Quantitative MR Perfusion

Lin, D. · Dizon, M. · Yousem, D. · Barker, P.
Johns Hopkins University
Baltimore, MD

PURPOSE
Ginkgo biloba, a frequently used dietary supplement for dementia, peripheral vascular and cerebrovascular insufficiency, is thought to mediate an increased blood flow. The purpose of this study was to determine the effects on regional cerebral blood flow (CBF), using dynamic susceptibility contrast perfusion MR imaging, in elderly healthy humans before and after 4 weeks of oral intake of Ginkgo supplements.

MATERIALS & METHODS
Eleven healthy men (mean age 61± 10 years) participated in this study. Each subject underwent MR studies at baseline
and at 4 weeks after taking 60 mg Ginkgo biloba capsules twice daily. In one of the 11 subjects, six MR studies were conducted on different days at baseline prior to Ginkgo administration to evaluate the reproducibility of perfusion measurements. Whole brain perfusion MR imaging was performed at 1.5T using a gradient-echo EPI sequence (TR/TE 2000/60 ms, 30 dynamics) during bolus injection of 20 cc GdDTPA at 5 cc/sec. Cerebral blood flow (CBF) maps were generated using an arterial input function and singular value decomposition. Regions of interest (ROIs) were drawn from each cerebral hemisphere at the level of the centrum semiovale, as well as the right and left frontal-parietal gray matter and white matter. Cerebral blood flow computed from each region was normalized to that in the cerebellar hemispheres. The effects of Ginkgo were analyzed by comparison of the normalized CBF before and after treatment using a paired t-test.

RESULTS
Perfusion MR imaging provides reproducible measurements of CBF within the same individual, with a normalized CBF in the right cerebral hemisphere of 1.35 ± 0.14 (10.37% s.d.) and in the left cerebral hemisphere of 1.42 ± 0.14 (9.85% s.d.) For assessment of the effects of Ginkgo on CBF before and after treatment, 9 out of 11 studies were analyzable and shown in the Figure. There was no significant difference between the normalized CBF measurements (N=9) before and after treatment in the right hemisphere (P=0.66), left hemisphere (P=0.9), right white matter (P=0.54), left white matter (P=0.14), right gray matter (P=0.57) and left gray matter (0.73).

CONCLUSION
Quantitative determination of CBF can be made by MR perfusion techniques with a good reproducibility within the same individual, therefore may provide a useful means to assess physiological changes in normal subjects and individuals with dementia. Based on this method, no significant difference could be detected in CBF after Ginkgo administration in normal elderly individuals using the study design described here.

KEY WORDS: MR perfusion, cerebral blood flow, Ginkgo biloba

Thursday Morning

10:45 AM – 12:30 PM
Room 1

(50d) Pediatric: Infections, Metabolic, Other & Spine
(Scientific Papers 414 – 426)

See also Parallel Sessions
(50a) Adult Brain: Functional Imaging II
(50b) Adult Brain: Neoplasms II
(50c) Adult Brain: Degenerative/Demyelinating/Metabolic Diseases I
(50e) Excerpta Extraordinaire: Pediatrics

Moderators: P. Ellen Grant, MD
Chip Truwit, MD

Paper 414 Starting at 10:45 AM, Ending at 10:53 AM

Differences in Imaging Spectrum of Intracranial Tuberculosis in the Pediatric and Adult Age Groups

Agarwal, A. K.1 · Khandelwal, G.2 · Bathla, G.2 · Vijay, K.3
1Medical University of South Carolina, Charleston, SC, 2Maulana Azad Medical College, New Delhi, INDIA, 3Lokmanya Tilak Municipal Medical College, Mumbai, INDIA

PURPOSE
To study the imaging features of intracranial tuberculosis on computed tomography (CT) and/or MR imaging (MRI) and to characterize the types of intracranial tubercular involvement and its complications based on imaging findings. To assess the differences in pattern of adult and pediatric intracranial tuberculosis based on the imaging findings.

MATERIALS & METHODS
A total of 52 pediatric age group patients (mean age 8.7 years, ranging from 3 months to 16 years) and 56 patients in the adult age group (mean age 46.4 years ranging from 17 to 84 years) were included in our study. All of these patients fulfilled the criteria for diagnosis of intracranial tuberculosis based on clinical, pathologic, laboratory and radiologic findings. CT and MR imaging findings in the brain were recorded in the following categories: 1. Presence and nature of intraparenchymal space occupying lesion. (Tuberculoma/Abscess/Cerebritis: single/multiple lesions and pattern of enhancement). 2. Presence of meningeal enhancement. 3. Presence of basal exudates. 4. Presence of hydrocephalus (communicating versus noncommunicating). 5. Complications/manifestations: infarcts, vasculitis, cranial nerve involvement, subdural empyema or calcification.
Presence of lipid peak or choline peak on MR spectroscopy. 7. Diffusion restricted or facilitated. Clinical and radiologic long-term follow up was done in majority of patients. Seven of these patients (five children and two adults) died due to complications of primary disease.

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<th>Number of cases (Adult n=56)</th>
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<tr>
<td>Subdural effusion</td>
<td>4</td>
<td>7.69</td>
<td>1</td>
<td>1.78</td>
</tr>
</tbody>
</table>

RESULTS

Leptomeningal tuberculosis is the most common manifestation in the pediatric patients, seen in around 55% as compared to 30% in the adult patients. This result was statistically significant with Z Value 2.43 at 95% confidence interval (p<0.007). Parenchymal tuberculomas were the most common form of intracranial tuberculosis in the adults seen in 73% of patients in this group as compared to 52% in the pediatric age group. This was again statistically significant with Z Value 2.09 at 95% confidence interval (p<0.01). Complications secondary to intracranial tuberculosis were more common in the pediatric patients with 38% having infarcts and 80.7% having hydrocephalus. Major permanent neurologic morbidity was seen in 12 children (23%). Five children (9.6%) died of complications associated with their primary disease. Major neurologic morbidity or mortality was seen only in five patients (8.9%) in the adult group.

CONCLUSION

Intracranial tuberculosis manifests with more severe presentations during childhood. Leptomeningal involvement is the most common manifestation in pediatric patients which is slightly more common than intraparenchymal involvement. Parenchymal involvement in form of tuberculomas is the most common presentation in the adult age group. Hydrocephalus and infarcts are the most common complications of intracranial tuberculosis in both adults and pediatric patients. Long-term neurologic morbidity or mortality from the primary disease is more common in the pediatric age group.

KEY WORDS: Tuberculosis, pediatric, adult

Paper 415 Starting at 10:53 AM, Ending at 11:01 AM

Prevalence of Neuroimaging Findings in HIV-Infected Pediatric Patients in a Large Clinical Cohort

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Baltimore, MD

PURPOSE

Neuroradiologic manifestations of human immunodeficiency virus (HIV) infection occur in both adults and children.

Differences in these manifestations of HIV infection in children may be attributable to onset of HIV infection in the context of immature, developing neurologic and immunologic systems. The purpose of this study is to report the prevalence and characteristics of neuroradiologic manifestations in HIV-infected children at our institution.

MATERIALS & METHODS

We reviewed the electronic records of the 309 HIV-infected children seen at our pediatric HIV clinic since 1984. Patients were included who had undergone a neuroimaging study of any kind. The radiographic reports and images were reviewed to determine the prevalence and type of intracranial, sinonasal, cervical, and spinal abnormalities in these children identifiable by neuroimaging studies.

RESULTS

Fifty-one patients (mean age 15.5 years, 64.7% male) had undergone at least one neuroimaging study, comprising 16.5% of the total cohort. The most common neuroradiologic manifestations in the HIV infected patients were sinusitis (31/51, 60.8%), brain parenchymal atrophy (19/51, 37.3%), mastoiditis (10/51, 19.6%), lymphadenopathy (9/51, 17.6%), and leuкоencephalopathy (8/51, 15.7%). Cerebral infarctions occurred in seven patients (7/51, 13.7%), including six with ischemic infarctions, two with hemorrhagic infarctions, and one with both ischemic and hemorrhagic infarctions. Of the seven patients with infarction, all four (4/51, 7.8%) who underwent angiographic evaluation demonstrated cerebrovascular stenoses and/or aneurysms, consistent with HIV-related cerebral vasculopathy. Five patients (5/51, 9.8%) demonstrated intracranial calcifications, primarily in the basal ganglia. One of these patients also had periventricular calcifications. No spinal manifestations such as myelitis or vacuolar myelopathy were detected in this cohort. Patients with these neuroradiologic manifestations were diagnosed at a younger age than the mean age of the patient population.

Table. Summary of Neuroimaging Findings

<table>
<thead>
<tr>
<th>Neuroimaging Finding</th>
<th>Rate in overall cohort (n=309)</th>
<th>Rate among those studied (n=51)</th>
<th>Characteristics in those with abnormality, Mean age, % Male</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sinusitis</td>
<td>100%</td>
<td>60.8%</td>
<td>7.8, 61.3%</td>
</tr>
<tr>
<td>Mastoiditis</td>
<td>5.2%</td>
<td>19.6%</td>
<td>8.5, 40%</td>
</tr>
<tr>
<td>Atrophy</td>
<td>37.3%</td>
<td>19.6%</td>
<td>9.0, 73.7%</td>
</tr>
<tr>
<td>Leuкоencephalopathy</td>
<td>26.6%</td>
<td>15.7%</td>
<td>10.5, 100%</td>
</tr>
<tr>
<td>Lymphadenopathy</td>
<td>29.7%</td>
<td>17.6%</td>
<td>11.3, 55.6%</td>
</tr>
<tr>
<td>Infarction</td>
<td>23.4%</td>
<td>13.7%</td>
<td>13.9, 71.4%</td>
</tr>
<tr>
<td>Vasculopathy</td>
<td>1.3%</td>
<td>7.8%</td>
<td>16.0, 100%</td>
</tr>
<tr>
<td>Calcifications</td>
<td>1.6%</td>
<td>9.8%</td>
<td>8.8, 100%</td>
</tr>
</tbody>
</table>

CONCLUSION

The prevalence of neuroradiologic manifestations of HIV infection in children may be greater than previously reported in the literature. The clinical implications of the findings, particularly brain parenchymal atrophy, are worthy of study in long-term cohorts.

KEY WORDS: HIV, pediatric, neuroimaging
Paper 416 Starting at 11:01 AM, Ending at 11:09 AM

MR Imaging and MR Spectroscopy in mitCHAP-60: A Novel Hypomyelinating Leukodystrophy

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PURPOSE
To describe MR imaging and proton MR spectroscopy (MRS) in a novel pediatric neurodegenerative disorder - homozygous mutation, D29G, in the mitochondrial Hsp60 chaperonin associated with leukodystrophy.

MATERIALS & METHODS
Five patients, 1 month to 12 years range of age, presented with progressive spastic paraplegia early in life, severe motor impairment and profound mental retardation. They all had brain MR imaging performed with a 1.5 system using routine T1 (SE) and T2 (FSE), FLAIR, diffusion-weighted imaging sequences as well as a single voxel proton MRS in the affected white matter.

RESULTS
In all patients cerebral and cerebellar white matter was demonstrated with abnormal high intensity on T2-weighted images and there was no evidence of normal myelination. Various degree of brain atrophy was found, mainly of the cerebellum. MR spectroscopy of the affected white matter, presented a metabolic pattern indicative of hypomyelination.

CONCLUSION
Brain MR imaging and MRS in mitCHAP-60 disease resembles that of Pelizaeus-Merzbacher disease (PMD), but in a more severe form, and typically with a complete absence of myelinated white matter.

KEY WORDS: Congenital

Paper 417 Starting at 11:09 AM, Ending at 11:17 AM

Presentation of Orbital Involvement in Langerhans Cell Histiocytosis

Proscher, H.1 · Fahrner, B.1 · Grois, N.1 · Minkov, M.1 · Gadner, H.1 · Prayer, D.2
1St Anna Childrens Cancer Research Institute, Vienna, AUSTRIA, 2Medical University of Vienna, Vienna, AUSTRIA

PURPOSE
Orbital involvement is reported in up to 20% of patients with Langerhans cell histiocytosis (LCH), but only a few reports of MR imaging (MRI) findings of orbital involvement are found in the literature. It is the purpose of this study to describe the clinical and MRI presentation of orbital involvement in LCH.

MATERIALS & METHODS
We evaluated 18 LCH patients (11 males and 7 females, age 5 months - 15 years, median 4 years) with orbital involvement. The MR studies were performed in 16 different institutions and were thus following different imaging protocols. The studies were assessed for the number and location of orbital lesions, involvement of bony structures, meninges, sinus involvement, signal characteristics, contrast enhancement, size, intracranial changes, and the presence/absence of multisystem disease (i.e., involvement of more than one organ).

RESULTS
Orbital involvement occurred in 13 of 18 patients at the initial presentation, in five patients at a recurrence median 16 months (2 months - 13 years) after LCH diagnosis. Radiologic findings consisted of extracranal lesions in all but one patient. In 12 patients a single lesion was located in the superolateral wall, in three patients in the lateral wall and in two patients in the superior wall. In one patient without orbital bone lesions, bilateral intraconal soft tissue tumors encased the optical nerves. The maximal diameter of the tumor ranged from 10 - 30 mm (median 20 mm). The lesions were iso- to hypointense on T1-weighted images in 14 patients, in four no T1-weighted images were available. In six patients the lesion appeared hyperintense on T2-weighted imaging and iso to hypointense in seven patients. In five patients no T2-weighted images were available. Involvement of the adjacent meninges was observed in 12 of 18 patients. In nine patients the bony lesion involved the adjacent soft tissue. Paranasal sinus opacification was observed in 15 and mastoid lesions in five patients. The most sensitive sequence to detect orbital involvement was the T1-weighted fat-suppressed sequence with contrast media. Thirteen of 18 patients had single system disease, five patients had multisystem disease. Nine of 18 patients had further lesions in the craniofacial bones. Clinically, five of 18 patients presented with exophthalmus, five patients with visual impairment. Four patients had endocrine deficiencies (2 diabetes insipidus, 2 anterior pituitary hormone loss). In two patients neurodegenerative signal alterations were observed in the cerebellum (2/2), the basal ganglia (2/2) and the pons (1/2).

CONCLUSION
Orbital involvement in LCH is most frequently extracranal and limited to superior and lateral walls of the orbit. Main associated findings are meningeal involvement (70%) and opacification of the paranasal sinuses (80%). Involvement of other craniofacial bones is seen in 50% of the patients. Evaluation of the head in LCH cases should include T1-weighted fat-saturated sequences after administration of contrast media.

KEY WORDS: Langerhans cell histiocytosis, orbit, MR imaging

Paper 418 Starting at 11:17 AM, Ending at 11:25 AM

MEG in the Evaluation of Pediatric Epilepsy

Schwartz, E. S. · Zarnow, D. M. · Vossough, A. · Storm, P. B. · Dlugos, D. J. · Kessler, S. · Dell, J. · Roberts, T. P. L.
The Children’s Hospital of Philadelphia Philadelphia, PA

PURPOSE
To establish the roles of MEG with beamforming and detection of excess kurtosis in pediatric epilepsy and to evaluate the contribution of MEG in the workup of pediatric patients with medically refractory epilepsy.
**Materials & Methods**

Over a two-year period, 104 consecutive pediatric epilepsy patients (49 females, 55 males, age range: 2.5 - 20.8 years [mean: 11.8 years]) underwent MEG as a part of their presurgical assessment. Patients were medically refractory, suffering ongoing debilitating seizures and had nonlocalizing other tests (including video telemetry). MEG was performed using a 275-channel biomagnetometer, recording 15x 2-minute epochs of spontaneous (passive) brain activity. Source waveforms were inspected for artifacts (blinking, clenching, etc.) and were subjected to a beamforming analysis, with the construction of time-activity data from each voxel of brain (nominal 5mm spatial resolution). These time-activity curves were evaluated for evidence of significant excess kurtosis (a mathematical description of “spikiness”) and significant pixels were highlighted in a color overlay.

**Results**

In general, MEG contributed to the evaluation in one of several distinct ways: (1) by identifying and localizing a single focus of epileptogenic activity, permitting the patient to be considered a surgical candidate (n=40, 38.5%), such patients frequently were confirmed by restricted intracranial electrode implantation; (2) by identifying a single focus of epileptogenic activity in close proximity to eloquent cortex, arguing against surgery (n=8, 7.7%), such patients either proceeded to confirmatory intracranial electrode implantation or directly to alternative nonresective treatments [such as vagal nerve stimulator (VNS) implantation]; (3) by identifying diffuse or multiple independent sources of epileptiform activity, arguing against likely surgical success (n=42, 40.4%), these patients proceeded to alternative nonresective management; 4) by identification of reorganized (atypical) functional localization, allowing surgical approaches to be reconsidered (n=2, 1.9%). In 4 (3.8%) patients, MEG was degraded by artifact, but not necessarily nondiagnostic (i.e., from VNS or dental metal). In 19 (18.3%) patients, no pathologic activity could be found.

**Conclusion**

In the majority of cases, MEG was able to contribute to the evaluation of pediatric patients with medically refractory epilepsy in one of the above manners. While generally concordant with scalp EEG findings, MEG offered superior specificity of localization and, on occasion, determined additional foci not revealed by EEG. It has become a routine part of our management of these patients.

**Key Words:** MEG, pediatric, epilepsy

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**Analysis of MR Imaging Findings in the Brain and Orbits in Pediatric Patients Referred for Evaluation of Papilledema**

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1The Children’s Hospital of Philadelphia, Philadelphia, PA, 2Hospital of University of Pennsylvania, Philadelphia, PA

**Purpose**

To analyze MR imaging findings in the brain and orbits in pediatric patients referred for evaluation of papilledema, and correlate with etiology.

**Materials & Methods**

MR imaging examinations of brain and orbits in 100 patients who were referred for papilledema were reviewed. In addition to routine MR imaging of the brain, with and without gadolinium administration, the orbits were evaluated with thin section T2 and postgadolinium T1 images in axial and in coronal planes, with fat suppression. Diffusion imaging was performed on every patient. The age of the subjects ranged between 6 months and 15 years. All imaging was performed on 1.5 T or 3 T superconducting MR scanners.

**Results**

Evaluation of MR imaging findings in these patients revealed that 58% of patients referred for papilledema had positive imaging findings. The spectrum of positive findings in the orbits were protrusion (inversion) of the optic nerve heads and in some reduced diffusion and enhancement of the optic nerve heads classified as ischemic papillitis. Diameter of optic nerve sheath was evaluated, measured just 2 mm proximal to the optic nerve head. Enlargement greater than 8 mm (mean 7 mm ) was found in positive cases. Other features assessed were presence of hydrocephalus, mass lesions, and midline shift. The most common etiology in patients with MR imaging findings of papilledema was found to be due to hydrocephalus (56%), predominantly due to tumors or other causes (Chiari I, trauma, vascular anomalies and intracranial hemorrhage). Pseudo tumor cerebri (18%) was etiology in the second largest group of patients with imaging findings of papilledema. Venous sinus thrombosis was implicated as the cause in 13% of cases and later confirmed by MR venography. Other causes (11%) confirmed by imaging mainly included local orbital pathology like optic neuritis, trauma, inflammatory and neoplastic conditions.

**Conclusion**

Significant number of pediatric patients referred for papilledema had positive MR imaging findings. The large subset of positive by imaging cases was due to hydrocephalus, predominantly due to tumors. The imaging appearance of bilateral papilledema, complicated by ischemic papillitis is independent of its cause and seemingly is related to degree of raised intracranial pressure only.

**Key Words:** Diffusion abnormality, optic nerve head, pediatrics
Paper 420 Starting at 11:33 AM, Ending at 11:41 AM

MR Imaging Evaluation of the Proximal Efferent Cerebellar Pathway in Patients with Posterior Fossa Syndrome

Miller, N. G. · Reddick, W. E. · Kocak, M. · Glass, J. · Ji, Q. · Löbel, U. · Morris, B. · Gajjar, A. · Patay, Z.

St. Jude Children’s Research Hospital
Memphis, TN

PURPOSE

The dentato-thalamo-cortical pathway (or “efferent cerebellar pathway”, ECP) provides input to cerebral cortical areas through thalamo-cortical projections. Proximal components of the ECP (dentate nuclei, DN, superior cerebellar peduncles, SCP, ponto-mesencephalic tegmental decussation, PMTD) often are invaded by posterior fossa tumors and are prone to surgical damage from radical resection. Posterior fossa syndrome (PFS), also called cerebellar mutism, is a severe early postoperative complication recognized in up to 25% of pediatric patients following posterior fossa surgery. We hypothesized that PFS follows disruption of cerebellar input via the ECP to the cerebral cortex due to surgical damage to the proximal ECP. The purpose of this study was to: 1. Investigate whether conventional anatomical and diffusion-weighted MR imaging analysis of surgical damage to proximal ECP predicts the development of PFS following midline posterior fossa surgery. 2. Determine lesion patterns of predictive value regarding the development of PFS.

MATERIALS & METHODS

A cohort of 11 posterior fossa tumor patients (10M/1F, ages 3-11 years) with PFS after surgery was identified retrospectively from an IRB-approved therapeutic trial. Eleven age- and gender-matched patients from the same protocol with no PFS following posterior fossa surgery served as controls. A blinded, randomized analysis of the integrity of components of the proximal ECP following surgery was performed using axial and coronal T2-weighted as well as axial diffusion-weighted images of the earliest postoperative MR study (postop days 1-14). A damage value of 0 to 3 was coded for each of three structures (DN, SCP, PMTD) along the left and right proximal ECP (0 = no damage, 1 = edema only, 2 = possible structural damage, 3 = definite structural damage). A value of 3 for any of the structures on one side indicated disruption of the ipsilateral ECP. Patients then were assigned into three groups based on anatomical damage to the ECP: no damage, unilateral disruption, and bilateral disruption. Data were analyzed using logistic regression.

RESULTS

Logistic regression analysis showed a point estimate of the odds ratio of 12 (95% CI: 1.12, 129), suggesting positive correlation between PFS and macroscopic bilateral structural damage to the proximal ECP detected by conventional and diffusion-weighted MR imaging (p = 0.04). The data provide evidence that patients with bilateral damage are more likely to develop PFS than those with unilateral damage to the proximal ECP.

CONCLUSION

Our results suggest that bilateral surgical damage anywhere along the ECP is the likely cause of PFS. These findings are important because they indicate an apparent etiology for PFS that may be preventable through understanding the pathomechanism and adjusting surgical approaches. The fact that routine MR imaging may enable one to anticipate the onset of PFS may have additional clinical implications. As PFS has a delayed onset of a few days to 1 week after surgery, early identification of patients at risk may allow institution of rehabilitative measures to limit the clinical impact of PFS.

KEY WORDS: Posterior fossa syndrome, efferent cerebellar pathway, posterior fossa surgery

Paper 421 Starting at 11:41 AM, Ending at 11:49 AM

Dynamic Susceptibility-Weighted Contrast-Enhanced Perfusion Data Suggest that Posterior Fossa Syndrome in Patients Operated for Midline Cerebellar Tumors Is a Form of Cerebello-Cerebellar Diaschisis

Miller, N. G. · Reddick, W. E. · Kocak, M. · Glass, J. · Ji, Q. · Löbel, U. · Brannon, M. · Gajjar, A. · Patay, Z.

St. Jude Children’s Research Hospital
Memphis, TN

PURPOSE

Posterior fossa syndrome (PFS) is recognized in up to 25% of pediatric patients after surgical resection of a midline posterior fossa tumor. Posterior fossa syndrome is characterized by a complex neuropsychologic disturbance, the central clinical manifestation of which is cerebellar mutism. We hypothesized that cerebellar mutism is a form of speech apraxia. As such, it may be induced by a primary surgical injury in the posterior fossa that causes regional cerebral cortical dysfunction through a trans-synaptic mechanism, similar to what has been described in crossed cerebro-cerebellar diaschisis (CCD). Previous studies suggest that dynamic susceptibility-weighted contrast-enhanced (DSC) perfusion imaging can detect hemodynamic changes in cerebellar cortex in CCD. The purpose of this study was to investigate whether or not measurable changes in cerebral cortical perfusion develop in patients diagnosed with PFS and whether specific cortical areas are implicated using DSC perfusion imaging.

MATERIALS & METHODS

A cohort of 11 patients (10M/1F, age range 3-11 years) who developed PFS after surgery were recruited retrospectively from an IRB-approved therapeutic trial protocol. Eleven age and gender matched patients from the same protocol who had posterior fossa surgery without PFS, were used as controls. All patients were examined under general anesthesia on 1.5 T platforms 6-27 days after surgery using uniform DSC perfusion imaging sequence (multislice 2D-EPI, TR:1910 ms, TE:50 ms, Nex:1, FOV:210 mm, matrix:128x128, 15 slices, number of measurements per slice:50) and injection (0.2 ml/kg of Omniscan or Magnevist, through a 22 G iv. line at a rate of 0.8-1.0 ml/sec) parameters. Perfusion data were acquired by calculating the mean cerebral blood volume (CBV) and cerebral blood flow (CBF) for cortical gray matter divided into eight geometrically defined sectors on each slice which then were incorporated to provide aggregate values of CBF and CBV for each of the eight cortical regions. Cerebral perfusion parameters of patients with PFS and controls were compared at both the aggregate and slice level by region using the Wilcoxon Signed Rank Test.
RESULTS
Dynamic susceptibility-weighted contrast-enhanced perfusion imaging showed a significant decrease of CBV and CBF within the frontal lobes in patients with PFS compared to controls (p < 0.05). Additionally, there was a clear trend demonstrating global cortical hypoperfusion in patients with PFS compared to controls.

CONCLUSION
Our data suggests that patients with PFS have global depression of cerebral cortical perfusion compared to controls, which is most pronounced in frontal lobes. Since diaschisis is defined as a complex functional impairment affecting blood perfusion, oxygen utilization, and overall metabolism of brain tissue (typically cortex) in areas remote to a site of primary brain injury, global depression of cerebral cortical perfusion may correspond to diaschisis-related changes in patients with PFS that is likely secondary to surgical damage to the proximal efferent cerebellar (dentato-thalamo-cortical) pathway. We propose that PFS represents a peculiar form of reversed, cerebello-cerebral diaschisis and that its central clinical manifestation, cerebellar mutism, is indeed an apraxia secondary to bilateral frontal lobe dysfunction.

KEY WORDS: Posterior fossa syndrome, diaschisis, DSC perfusion imaging

Paper 422 Starting at 11:49 AM, Ending at 11:57 AM
Diffusion Tensor Imaging of the Pediatric Spinal Cord Injured Patients at 1.5 T: Preliminary Data in Normals and in Patients with Spinal Cord Injury

Faro, S. H.1 · Hunter, L.2 · Sair, H.4 · Samdani, A.2 · Mulcahey, M.2 · Betz, R.2 · Liu, J.1 · Mohamed, F.1
1Temple University School of Medicine, Philadelphia, PA, 2Shriners Hospital, Philadelphia, PA, 3Harvard University, Cambridge, MA

PURPOSE
1) To establish normative diffuse 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) and 2) To investigate the validity of DTI as a method to evaluate the consequence of SCI in children as compared to concurrent clinical examinations and imaging techniques.

MATERIALS & METHODS
Five subjects with idiopathic scoliosis (normal control) (mean age: 16.8 years) and three subjects with SCI (mean age: 12.6 years) were scanned using single-shot echo-planar diffusion-weighted imaging sequence at 1.5 T. Diffusion tensor imaging parameters: six different directions with a b value of 700 sec/mm² as well as an image acquired without diffusion weighting (b = 0 sec/mm²), slice 3 mm, 0 skip, TR=6000ms, TE=60ms, FOV=240 mm, 128x128, NA 4, TA 8 min. Routine cervical MR imaging also was performed. Normal controls were imaged from C1-C7, and in patients, two vertebral bodies above and below injury. All patients had ASIA clinical testing. Fractional anisotropy (FA) and diffusivity (D) values were obtained throughout all the sections of the cervical spinal cord. Written informed consent approved by the IRB was obtained.

RESULTS
Control subjects showed average FA = 0.57, s.d=0.15, and D = 1.4x10⁻³ mm²/sec. s.d=3x10⁻⁴. Spinal cord injury patients showed reduced FA values and increased D values compared with control subjects. Initial test-retest obtained in one patient and one control showed good reproducibility (Figure 1, FA and D values, with scan repeat, in a normal subject and an SCI patient with a focal C5 level lesion). In this SCI patient normal appearing spinal cord on MR imaging above a focal C5 lesion showed abnormal decreased FA and increased D values.

CONCLUSION
Preliminary normative FA and D values of the pediatric cervical spine were determined. There was reduced FA and increased diffusivity values in patients with SCI compared with normal controls. Good reproducibility was obtained in two subjects. Our preliminary work is encouraging and future work with DTI imaging of pediatric SCI patients may provide additional functional data of the spinal cord with reference to clinical exam and prognosis.

KEY WORDS: Spinal cord injury, diffusion tensor imaging

Paper 423 Starting at 11:57 AM, Ending at 12:05 PM
Syringohydromyelia in Children: A Retrospective Review

Jones, B. V · Morales, H.
Children’s Hospital Medical Center Cincinnati, OH

PURPOSE
Hydromyelia is defined as a cystic cavity in the spinal cord that is contiguous with the central canal; syringomyelia is a cavity that is not contiguous with the central canal, and syringohydromyelia is defined as having features of both. These lesions are encountered with some frequency in children, and there are differences of opinion on the appropriate manner in which they should be described, imaged, followed, and clinically managed. This is a retrospective study of children diagnosed with syringohydromyelia by MR imaging over an 8-year period at a single institution, for the purpose of identifying frequency of various imaging features and associated conditions, and to gain insight into the natural history of this lesion.

MATERIALS & METHODS
This IRB-approved study used a text search program to identify cases of syringohydromyelia diagnosed on MR imaging at our institution. The radiology database was searched over
an eight-year period, but older comparison studies were available in numerous cases. All imaging studies were reviewed and data on patient age and gender and associated conditions were collected, as well as documentation of specific imaging features including syrinx size and location, change over time with or without spinal intervention, and presence of flow voids, contrast enhancement, septations, or cord signal abnormalities.

RESULTS
A total of 121 syrinx cavities were identified in 103 patients, ranging in age from 4 days to 28 years. One hundred ten lesions were congenital in etiology, 6 idiopathic, 3 posttraumatic, 2 inflammatory, and 2 neoplastic. There was a slight female predominance, and the mean age at diagnosis was 10 years. Cranio-caudal extent ranged from 1 to 20 vertebral segments (mean 5.5), with cross-sectional diameters ranging from 0.7-19mm (mean 4-5mm). Fifty-six percent of lesions were either thoracic or cervico-thoracic in location. Thirty-six percent were associated with scoliosis, 26% with the Chiari 1 malformation, and 25.6% with the Chiari 2 malformation. The largest lesions were found in those cases with a combination of the Chiari 1 malformation and scoliosis, a statistically significant association. One hundred six cases had more than one MR study, with an average length of follow up of 3.4 years. Eight cases had complete resolution on follow up, all in association with surgical intervention. Twenty-two cases had no spinal intervention, and were followed for an average of 2.6 years. In 12 of these cases there was no change in the syrinx on follow-up imaging, with four showing a decrease in size, and six showing an increase. There was no significant difference in imaging features between these latter three groups.

CONCLUSION
This large series indicates that most pediatric syringohydromyelia are congenital in nature, and are associated most frequently with scoliosis, Chiari 1, or Chiari 2. The largest lesions are seen in those children with both Chiari 1 and scoliosis. This presentation will review the various imaging features that have been emphasized in earlier smaller series and their association, if any, with changes in imaging over time. The findings should guide imaging strategy, including decisions on contrast administration and follow-up interval and length.

KEY WORDS: Syrinx, syringomyelia, syringohydromyelia

Paper 424 Starting at 12:05 PM, Ending at 12:13 PM
Which Children with History of Trauma Require Cervical Spine CT? Putting Mode of Injury into Perspective with Estimated Radiation Dose and the Likelihood of Injury

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Oregon Health and Science University
Portland, OR

PURPOSE
The purpose of this study is to review selection criteria used for requesting a diagnostic CT of the cervical spine in pediatric trauma patients at a University-based level 1 trauma emergency room. Further, we calculated the effective radiation dose and tabulated results of the examinations in order to evaluate the clinical need for cervical spine CT versus cervical spine radiography and to provide guidelines for imaging modality selection.

MATERIALS & METHODS
One hundred eighty-five consecutive pediatric trauma patients underwent cervical spine CT over a 1-year period. Patients were separated into age groups (0-24 months), (2-9 years), (10-15 years) and (16-18 years). The mechanism of trauma was graded as minor (highly unlikely to result in injury), moderate (potential to result in injury) and severe (likely to result in injury) overall and within each age group. Clinical presentation, physical examination findings were utilized to make this determination. Cervical spine CT results were reviewed within each age group and in the entire cohort. Estimated effective radiation dose and radiographic findings were tabulated. Effective radiation dose of cervical spine radiography and reported incidence of positive findings in pediatric trauma patients was established through literature review. Based on mechanism of injury, age of the patient, and physical examination, imaging guideline recommendations are made.

RESULTS
The total patient population included 16 (0-24 months), 45 (2-9 years), 67 (10-15 years) and 57 (16-18 years), with 19 minor, 24 mild, 46 moderate and 96 severe injuries. Of patients with minor injury 9(47%), mild injury 24(100%), moderate injury 39(85%), and serious injury 84(86%), had normal cervical spine CT exams. In the entire group, findings were definitively abnormal in only 14 (7%). The effective radiation dose of cervical spine CT in our patients ranged from 1.4-4.3 mSv, with the greatest dose delivered in those less than 24 months of age. Cervical spine radiographs are reported to be normal in up to 25% of pediatric patients with spinal cord injury and in 81% of all traumatically injured children. Depending on the number of views, estimated effective radiation dose for cervical spine radiography is 0.1-0.5 mSv.

CONCLUSION
Given 84% of children with traumatic injury including 86% of those with serious injury and only 47% of those with minor injury have normal cervical spine CT examination; we believe the effective radiation dose, ranging between 1.4-3.3 mSv, is likely excessive. When warranted by physical examination and mechanism of traumatic injury, radiographic examination with cervical spine radiographs should be performed as the initial examination because the exam is sensitive and specific for detecting osseous injury. When neurologic injury is discovered on physical examination, MR of the cervical spine should be the primary imaging investigation, following radiographs.

Cervical spine CT should be limited to judicious use only when radiographic findings are found or questioned in the absence of neurologic deficit. When cervical spine CT is performed, only the level of the questioned radiographic finding should be scanned.

KEY WORDS: Cervical spine CT, radiation dose, cervical spine trauma
Prenatal Ultrasound and MR Imaging Diagnosis of Closed Spinal Dysraphism

Pugash, D.¹ · Brugger, P. C.² · Prayer, D.²
¹University of British Columbia, Vancouver, BC, CANADA, ²Medical University of Vienna, Vienna, AUSTRIA

PURPOSE
To observe prenatal ultrasound and MR imaging features seen in fetuses with closed spinal dysraphism (CSD) and their value in the prenatal diagnosis of CSD.

MATERIALS & METHODS
Clinical records from the Spina Bifida Clinic at BC Children’s Hospital were reviewed to identify children born with radiologic and/or surgical evidence of spinal lipoma between 1997 and 2007. In 12 cases, prenatal ultrasounds were available for retrospective review. Eight additional cases of CSD were identified on prenatal ultrasound and/or MR imaging between 2003 and 2008.

RESULTS
In total, there were 20 cases of CSD. None had evidence of a Chiari II malformation; and none had ventriculomegaly. Spinal lipomas were found postnatally in 13 out of 20 cases. Fourteen out of 20 cases of CSD were detected antenatally (6 missed on prenatal US; all were spinal lipomas). Seven cases were diagnosed with ultrasound alone (no MR imaging offered); seven additional cases were diagnosed with both. Eighteen out of 20 had a subcutaneous cyst or mass. Two out of 20 had no mass; one of these had vertebral and cord abnormalities (cervical diastematomyelia), one fetus had a long cord without mass (before 24 weeks). Maternal serum alpha-fetoprotein was negative in three cases and elevated in two cases; in one of these, amniotic fluid PCR diagnosed coexistent CMV infection. Both AFAFP and acetyl cholinesterase were elevated in one case in which serum screening was not offered. Among the seven spinal lipomas detected antenatally, antenatal US findings included cystic and/or solid mass dorsal to spine (seven cases), vertebral anomalies (five cases), and foot deformities (two cases). In one case of spinal lipoma, a low conus and a subcutaneous tail-like mass with fat entering spinal canal and displacing cord anteriorly was seen with both US and fetal MR imaging. The seven cases in which there was no lipoma were a morphologically heterogeneous group. Four had skin-covered predominantly cystic masses on US and MR imaging (two thoracic myelocystoceles and two terminal myelocystoceles). One had isolated low conus without mass at 22 weeks; this fetus had cloacal dysgenesis. One fetus had a low conus with small cystic sacral mass (OEIS). One fetus had cervical diastematomyelia.

CONCLUSION
The prenatal diagnosis of CSD remains more challenging than open spinal dysraphism since typical intracranial findings are normal. Maternal serum screening for AFP can be negative or positive in CSD despite the skin covering; AFAFP and ACE also can be positive should amniocentesis be performed. Prenatal US and MR imaging findings of soft tissue cysts or masses dorsal to the spine, vertebral and/or foot abnormalities are frequent indicators of CSD. A low conus (below T3) is a reliable finding in lumbosacral CSD with US and MR imaging. However, spinal lipomas may be subtle or inapparent with US. This may be due to a paucity of body fat before 24 gestational weeks. Fetal MR imaging may also fail to demonstrate typical characteristics of fat on T2- and T1-weighted sequences before 24 weeks. Therefore, spinal lipomas may be missed with both modalities.

Key Words: Dysraphism, fetus, MRI

Paper 426 Starting at 12:21 PM, Ending at 12:29 PM

Novel Association between a RASA1 Mutation and Spinal Arteriovenous Lesions

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PURPOSE
Capillary malformation-arteriovenous malformation (CM-AVM) is a recently recognized autosomal dominant disorder associated with mutations in the RASA1 gene. This gene code for RASp21 protein activator 1, which is believed to be involved in the organization of endothelial cells into networks based on RASA1+ murine embryo studies. Arteriovenous lesions have been reported in the brain, limbs, and the face in two thirds of patients. Previously reported intracranial arteriovenous lesions in CM-AVM are typically macrofistulous, usually presenting with neurologic signs at birth or before the age of 1 year. We report a novel association between RASA1 mutation and spinal arteriovenous lesions.

MATERIALS & METHODS
In a collaborative study, four index patients (2 females, 2 males) with spinal AVM or AVF and cutaneous multifocal capillary lesions were investigated for RASA1 gene mutation.

RESULTS
All four patients were found to have a RASA1 mutation (2 de novo, 2 familial) and had multifocal capillary malformations at birth. The early development of neurologic deficits, at ages ranging from 16 months to 6 years, reflected the complexity, extent, and fast-flow character of the spinal lesions (2 AVMs at the conus, one cervical and one thoracic AVF). The complex nature of the lesions required multidisciplinary treatment.

CONCLUSION
The association of RASA1 mutation and spinal AVM/AVF has not been described before. Patients with characteristic cutaneous capillary malformations and even minor neurologic symptoms presenting at a young age should be screened with MR imaging for the possible presence of fast-flow intracranial or intraspinal arteriovenous anomalies.

Key Words: Capillary malformation-arteriovenous malformation, RASA-1 mutation, spinal arteriovenous lesions
Paper 427 Starting at 10:45 AM, Ending at 10:50 AM

Endovascular Management of Traumatic Carotid Artery Injury in Children

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PURPOSE
To describe endovascular management of traumatic carotid artery injury in young children and infants.

CASE REPORT
Endovascular management of traumatic cerebral aneurysm in young children and in infants is technically challenging. This arises in particular from the small number of cases and other technical considerations such as the available coils sizes, catheters and the higher tendency to induce arterial spasm in young children and infants. Furthermore, typically a balloon test occlusion of the internal carotid will be done to ensure that permanent internal carotid artery occlusion would be tolerated and to prevent the secondary brain injury. However this option is not technically feasible in young children and infants. We report two children with history of traumatic carotid injury. Eight-year-old male and 14-month-old female have sustained head, neck and body injuries caused by a falling television. These two patients underwent CT and CTA of the head and neck, MR brain and arterial angiogram.

IMAGING FINDINGS
Case 1: 8-year-old male had pulled the flat screen TV from wall brackets. CT showed widely diastatic obliquely orient-ed skull fracture extending from left orbital wall across less-
er sphenoid wing into right petrous temporal bone, in absence of significant intracranial hemorrhage. CT angiography showed a large right cavernous internal carotid pseudoaneurysm which was confirmed by cerebral angiogram. An occlusion balloon mounted on the 5 French catheter was advanced into the proximal right ICA. A microcatheter was advanced through the occlusion balloon and across the aneurysm distal to the aneurysm. Multiple detached coils ranges from 3mm-6mm were deployed distal and across the aneurysm down to the petrous segment. A repeat post left internal carotid arteriogram showed satisfactory cross filling. The subsequent brain MR image showed small watershed infarcts. Patient was discharged to rehab with no focal neurologic deficit. Case 2: 14-month-old female sustained sever skull fractures after pulling 32” flat screen TV off the entertainment console. She developed profuse nasal bleeding complicated by cardiac arrest. CT/CTA showed diastatic skull base fractures extending from left orbit to the right petrous temporal bone and large paraseller hematoma. Cerebral angiogram showed large traumatic CC fistula. Multiple coils ranging in size from 2mm-4 mm were deployed through microcatheter in the supraclinoid segment of right ICA immediately below the ophthalmic artery origin and across the pseudoaneurysm. A repeat post left internal carotid arteriogram showed satisfactory cross filling. Follow-up MR imaging showed multiple focal acute infarctions predominantly in the watershed distribution and both basal ganglions consistent with profound global ischemia likely sustained by the cardiac arrest incidence at time of the admission. Patient died 1 week later from bihemispheric anoxic injury.

SUMMARY
Traumatic carotid life threatening injuries can be treated endovascularly in young children and infants. However technical success is not always associated with good clinical outcome.

KEY WORDS: Internal carotid artery embolization, television tipover

Paper 428 Starting at 10:50 AM, Ending at 10:55 AM

MR Perfusion Pattern in Childhood Moyamoya Disease with “Ivy Sign”

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PURPOSE
Diffuse leptomeningeal enhancement, the so called “ivy sign”, has been reported in childhood moyamoya disease, and is thought to reflect extensive leptomeningeal arterial anastomosis. The purpose of this study was to investigate, using dynamic susceptibility contrast MR perfusion imaging, the hemodynamic abnormalities associated with the ivy sign, and to follow perfusion changes after pial angioplasty.

CASE REPORT
A 12-year-old girl with idiopathic moyamoya disease who had her first stroke at age 3 ½ years, causing only mild left hemiparesis, was studied. Over time her disease progressed
and she had further episodes of subclinical infarction and gradual cognitive decline, at which time (at age 12) she underwent bilateral pial synangiosis.

**IMAGING FINDINGS**

MR imaging and MRA presynangiosis showed severe stenosis of proximal intracranial arteries with diffuse leptomeningeal enhancement, in addition to prominent lenticulostriate collateral vessels. Cerebral angiography showed profuse leptomeningeal anastomosis from anterior internal and external, as well as posterior, circulations. MR perfusion based on time-to-peak (TTP) revealed diffusely prolonged bolus transit in the cortical regions. TTP was preserved in the deep gray matter and cerebellum (Figure 1). Using optimized singular value decomposition, increased regional cerebral blood flow (rCBF) was found in the basal ganglia, compared to the normally perfused cerebellum. Following revascularization procedures, diffuse leptomeningeal enhancement was still evident on MR imaging. However, decreased lenticulostriate collaterals and normalization of rCBF in the deep gray nuclei was found, accompanied by a more normal, homogeneous rCBF pattern in cortical regions (Figure 2).

**SUMMARY**

MR perfusion in moyamoya disease with ivy sign shows homogeneously decreased cortical perfusion despite leptomeningeal anastomosis, and augmented central perfusion (increased rCBF) in the deep gray nuclei. Following successful revascularization, the perfusion pattern became more normal even though leptomeningeal enhancement persisted.

**KEY WORDS:** moyamoya, MR perfusion, ivy sign
SUMMARY
Type I hyperlipoproteinemia is caused by a deficiency in lipoprotein lipase enzyme. Chylomicrons are produced in the intestines after ingesting fat and subsequently are removed from the circulation by lipoprotein lipase. Excessive fat concentration in blood may be noticeable on imaging. Dural venous sinus density is usually greater in newborns compared to older infants and children owing to relative hematocrit concentration. Anemia may result in abnormal hypodensity of blood density. Hyperlipidemia should be entertained since it is very rare to observe fat density/signal intensity in blood vessels.

KEY WORDS: Lipoprotein lipase deficiency, lipemia

IMAGING FINDINGS
The baseline MR imaging disclosed global abnormal myelination sparing only the corpus callosum. Serial imaging showed little change in the myelination pattern. The most recent MR imaging demonstrates diffuse cerebral and cerebellar atrophy. The imaging findings in our patient will be compared with those described in the literature.

SUMMARY
It is important to recognize CFD because it is potentially treatable if early management is instituted. We present a case of CFD and the imaging findings before, during, and after treatment. Serial MR imaging is an important tool for monitoring the treatment response for suspected CFD. Although our patient had significant improvement in his gross motor skills with resolution of seizures after folinic acid therapy, he has not regained fine motor and language skills as has been reported in similar patients. Prompt diagnosis and timely intervention will assist in early remyelination which is expected to correlate with a more dramatic treatment response.

KEY WORDS: Cerebral folate deficiency, dysmyelination, myelination

Cerebral Folate Deficiency: Imaging Findings Before and After Treatment
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PURPOSE
Cerebral folate deficiency (CFD) is a neurologic syndrome with a low cerebrospinal fluid (CSF) level of 5-methyltetrahydrofolate (5-MTHF) in the setting of a normal folate metabolism outside the brain and normal serum folate levels. Patients with CFD are treated with folinic acid, which bypasses the abnormal folate transport into the central nervous system. Folate is crucial for many metabolic processes especially myelination. We present a case of CFD with emphasis on clinico-radiologic correlation. Comparison of imaging findings before, during, and after treatment will be undertaken.

CASE REPORT
A 4-year-old Hispanic male child presented with global developmental delay and refractory seizures. His diagnosis was unclear until 3 years of age when he was found to have CFD.

Baseline (pretreatment) MR imaging: global abnormal myelination sparing only the corpus callosum.

Posttreatment MR imaging: diffuse cerebral atrophy with little change in myelination pattern.
Neuroprogenitor Cell Imaging and Its Associated Biomarkers in Cortical Malformations at 3 T: A MR Spectroscopy and Diffusion Tensor Imaging Study

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Asiri Surgical Hospitals, Colombo, SRI LANKA, ¶Nizam’s Institute of Medical Sciences, Hyderabad AP India, INDIA, ¶Vijaya Diagnostics and Research, Hyderabad AP India, INDIA, ¶Krishna Institute of Medical Sciences, Hyderabad AP India, INDIA, ¶University of Hyderabad, Hyderabad AP India, INDIA

PURPOSE
Magnetic resonance spectroscopy identifies neural progenitor cells in the live human brain. Louis N. Manganas et al: The identification of neural stem and progenitor cells (NPCs) by in vivo brain imaging could have important implications for diagnostic, prognostic, and therapeutic purposes. Here is described a metabolic biomarker for the detection and quantification of NPCs in the human brain in vivo and to demonstrate its use as a reference for monitoring neurogenesis. To evaluate the role of neuro progenitor cell signal and associated biomarkers in patients with cortical malformations.

CASE REPORT
Twenty-five patients with cortical malformations who have visited our out-patient clinic for follow-up scan for refractory epilepsy and 25 age- and sex-matched controls are included in the study after the IRB approval. All patients had undergone a comprehensive epilepsy protocol on a 3 T MR system and in addition a MR spectroscopy exam using short and long TE from both hippocampi and cortical malformation zone and ipsilateral normal cortex. Then DTI exam was performed using a B value of 2000 and 15 directions and FA values were calculated from cortical malformation, ipsilateral and contra lateral cortices and hippocampi. Six tract graphic trajectories from the clock face of ROIs between hippocampi and malformations then are constructed and called as probable migrational pathways. Values were analyzed for following: NPC signal in hippocampi and cortex, hippocampal myoinositol: cortical myoinositol ratio A. from malformation and B. from normal contra lateral cortex, hippocampal FA: cortical malformation FA ratio, FA values along six probable migrational pathways then were analyzed.

IMAGING FINDINGS
There were following types of cortical malformations: Hemimegalencephaly (n=2), FCD (n=13), polymicrogyria (n=8), perisylvian syndromes(n=2). In normals (n=17) and patient group (n=11) NPC signal was seen on MRS at 1.28ppm. The mean hippocampal and cortical myoinositol ratio was 0.8 from the normal cortex and 0.45 at site of malformations. Cortical and hippocampal FA value ratio in normal controls was one and in patients with focal cortical malformations about 0.5. Tract trajectories with FA weighting between cortical malformations and ipsilateral cortex reconstructed from six ROI show variable FA in malformation and hippocampi.

SUMMARY
Cortical dysplasias are migrational anomalies which cause refractory epilepsy and neuroprogenitor cell imaging and associated emerging biomarkers add new characterization information. Clinical relevance: Neurogenesis can be in vivo mapped by NPC signal on MRS. This study yields new biomarkers which help us to understand the neurogenesis and migration in normals and in patients with cortical malformations.

REFERENCES
3. Friedman S. Science 2008;321:640

KEY WORDS: Fractional anisotropy, tractography, migrational anomalies
SUMMARY
MR imaging can provide a useful tool for assessing the abducent nerve and the Dorello’s canal in Duane syndrome. MR imaging may be helpful to confirm the diagnosis in atypical presentations.

KEY WORDS: Abducens nerve, Duane syndrome, high-resolution 3D Fast Spin Echo MRI of the post

Paper 433 Starting at 11:15 AM, Ending at 11:20 AM

Post, R. D. · Sato, Y. · Singh, A. · Morgan, T.
University of Iowa
Iowa City, IA

PURPOSE
Present a case of a 4-year-old girl with Sturge-Weber syndrome who developed fibro-osseous hypertrophic changes to the frontal, orbital, maxillary and mandibular regions that corresponded to the distribution of the port-wine stain. This is an extremely rare association which only has been reported once previously.

CASE REPORT
A 4-year-old girl with Sturge-Weber syndrome was noted to have painless swelling of the right jaw by her mother. The patient’s port-wine stain was distributed bilaterally and spared the left lower face. The patient had extensive leptomeningeal angiomatosis involving the entire right hemisphere and the frontoparietal region of the left hemisphere which resulted in progressive brain atrophy and cortical calcification. The CT obtained demonstrated extensive ground-glass appearance and expansion of the diploic space that corresponded to the distribution of the port-wine stain. The fibro-osseous hypertrophy secondary to the angiodysplasia of the Sturge-Weber syndrome was considered to be the likely etiology.

IMAGING FINDINGS
CT demonstrated a groundglass appearance to the calvarium, skull base, sinuses, right maxilla and right mandible with additional extracortical thickening of the mandible. These changes corresponded with the distribution of the port-wine stain. There was cerebral atrophy and extensive cortical calcifications of the right cerebral hemisphere and the left frontoparietal cerebral hemisphere.

SUMMARY
Fibro-osseous changes can occur in the osseous structures underlying the port-wine stain and is thought to be secondary to the angiodysplasia.

REFERENCES
CASE REPORT

Tuberous sclerosis complex (TSC) is an autosomal dominant genetic disorder affecting approximately 1 in 6000 live births. It is characterized by the presence of a number of lesions including cortical tubers, subependymal nodules, white matter heterotopias, and subependymal giant cell astrocytomas (SEGAs). This case involves monozygotic twins both diagnosed with TSC who have presented with dissimilar clinical presentation. Here we have assessed the differences between the twins’ brain’s morphology on MR imaging and fidelity of the white matter tracts using diffusion tensor imaging (DTI) in order to elucidate some of the neurologic and development basis for their difference in disease phenotype.

PURPOSE

The difference in clinical course between these two girls cannot be explained exclusively by genetics, and furthermore the number of tubers between them is identical. Therefore the discrepancies between the two clinical courses must be the result of difference in size, location of the tubers and degree of penetrance.

CONCLUSION

The difference in clinical course between these two girls cannot be explained exclusively by genetics, and furthermore the number of tubers between them is identical. Therefore the discrepancies between the two clinical courses must be the result of difference in size, location of the tubers and degree of penetrance.

KEY WORDS: Tuberous sclerosis, monozygotic twin, diffusion tensor imaging
SUMMARY
A variety of cerebral manifestations of X-linked lymphoproliferative disorder exists. Brain imaging findings are crucial for the distinction of these manifestations and choice of appropriate treatment. The imaging findings in this case, confirmed on pathologic analysis, contributed to the correct diagnosis and successful treatment of CNS vasculopathy.

KEY WORDS: X-linked lymphoproliferative, vasculopathy
The follow-up MR imaging, performed 3 months later, showed resolution of the spinal cord signal abnormalities. The areas of T2 prolongation within the cerebral white matter and cerebellum were unchanged, but the parenchymal and leptomeningeal enhancement had resolved. Although previous case reports of *Baylisascaris* infection have described cerebral and cerebellar signal abnormalities, to our knowledge, this is the first such case in which abnormal signal was also demonstrated in the spinal cord.

**KEY WORDS:** Eosinophilic, meningitis, *baylisascaris*

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**Paper 437 Starting at 11:35 AM, Ending at 11:40 AM**

**Mycotic Aneurysm of the Right Vertebral Artery Following an Epidural Abscess in a Child**

Tang, P.
Kandang Kerbau Women’s and Children’s Hospital
Singapore, SINGAPORE

**PURPOSE**
This is a case report of a previously well 3-year-old Malay boy who presented with a 3-day history of fever and neck stiffness.

**CASE REPORT**
Staphylococcus bacteremia was diagnosed on blood culture. CT and MR imaging subsequently were performed.

**IMAGING FINDINGS**
Initial CT showed a 1.8 x 0.6 cm rim enhancing abscess between the right skull base and C1, extending into the epidural space, indenting slightly on the thecal sac. The right vertebral artery was not clearly seen in this region. MR imaging done the next day confirmed the finding of a right epidural abscess. Contrast-enhanced MRA showed irregular narrowing of the right vertebral artery as it coursed superio-medially at the level of C1 with normal signal seen in the right vertebral artery more distally/superiorly. Serial follow-up MR imaging and MR angiography were performed 1 month later with those showing resolution of the abscess but development of a 0.8 cm mycotic aneurysm of the right vertebral artery just before the narrowed segment. MR imaging done 3 weeks later showed the findings were stable and another follow-up MR imaging done another 6 weeks later showed the aneurysm to be smaller and the segment of narrowing stable.

**SUMMARY**
This is the first case report of a solitary mycotic aneurysm developing in the vertebral artery in a child following an epidural abscess.

**KEY WORDS:** Mycotic, aneurysm, epidural

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**Paper 438 Starting at 11:40 AM, Ending at 11:45 AM**

**Disseminated Subarachnoid Chordoma Without Skeletal Involvement**

Sato, Y. · Kirby, P. · Singh, A. K. · Buatti, J. M. · Menezes, A.
University of Iowa
Iowa City, IA

**PURPOSE**
Clinical, radiologic and pathologic correlation of an unusual case of chordoma presented with multiple subarachnoid cysts without skeletal involvement.

**CASE REPORT**
A 13-year-old female presented with progressive headache of 2-year duration. MR imaging revealed caudal displacement of the cerebellar tonsils by 10 mm and multiple cystic subarachnoid masses in the prepontine cistern, cerebellar...
hemispheric surface and cervicothoracic spinal canal. The size of cysts variety 2-10 mm, and the MR signal of the contents was similar to CSF on T1- and T2-weighted images without contrast enhancement.

IMAGING FINDINGS
On T2-weighted images, cystic lesions in the prepontine cistern and in the spinal canal demonstrate lack of pulsation artifact of CSF maintaining hyperintensity signal of the cyst content. No erosive or destructive changes of the craniospinal skeleton are present at either CT or MR imaging. With working diagnosis of Chiari I anomaly and “multiple arachnoid cysts,” the patient underwent a posterior fossa craniotomy which revealed caudally herniated cerebellar tonsils and multiple “millet grind” subarachnoid masses. Pathologic findings were compatible with chordoma. CSF sample obtained during the operation was also positive for tumor cells. She underwent the craniospinal axis radiation of 30.6 Gy, resulting in a total dose of 55.8 Gy to the posterior fossa and 45 Gy to the C5-T5 spine. Four years after the operation and radiotherapy she has been doing well with no further symptoms or development of new neurologic deficits in spite of continued MR imaging evidence of multiple subarachnoid cystic masses without interval growth and without bony or metastatic lesions.

SUMMARY
We presented radiologic-pathologic correlation of an unusual case of “chordoma” presented with multiple subarachnoid cystic masses of the posterior fossa and cervicothoracic spine without bony involvement. In spite of multiple residual lesions, the patient is doing well after radiation therapy.

KEY WORDS: Chordoma, echordosis physliphora, arachnoid cyst

Infrasellar Craniopharyngioma
Sato, T. · Kirby, P. A. · Greenlee, J. D. · Manaligod, J. M. · Sato, Y.
University of Iowa
Iowa City, IA

PURPOSE
We describe a radiologic-pathologic correlation of an unusual craniopharyngioma located in the nasopharynx, occupying the sphenoid and posterior ethmoid sinuses without involving the sella turcica.

CASE REPORT
An 11-year-old boy presented with 2-year history of progressive breathing difficulty and nasal obstruction. He was seen by an outside otolaryngologist with a plan for an adenoidectomy. During the surgery a “tumor” was found and the biopsy revealed craniopharyngioma. He was transferred to our institution.

IMAGING FINDINGS
CT and MR imaging revealed a large nasopharyngeal mass occupying the posterior nasal cavity, sphenoid and posterior ethmoid sinuses. The mass measured 40 x 47 x 53 mm and consisted of solid and cystic components with heterogeneous enhancement. The skull base, including planum sphenoidale, sella floor and the ventral clivus, were eroded but no intracranial extension was evident. Endoscopic transnasal and transsphenoidal resection of the tumor was performed successfully, followed by radiation therapy. Pathology revealed adamantinomatous craniopharyngioma.
SUMMARY
Since 1924, less than 10 cases of infrasellar nasopharyngeal in the pediatric patient have been described in the medical literature. The tumor is thought to have originated from the pharyngeal hypophysis, i.e., the craniopharyngeal canal rests along the ascending route of the embryologic Rathke pouch.

KEY WORDS: Craniopharyngioma, nasopharyngeal, sphenoid sinus

Paper 440 Starting at 11:50 AM, Ending at 11:55 AM
Radiation-Induced Supratentorial Primitive Neuroectodermal Tumor in a Pediatric Patient

Kaminsky, I. A. · Wang, A. · Wilson, J. · Zakalik, K. · Jamil, S.
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Royal Oak, MI

PURPOSE
To present MR imaging of a radiation-induced primitive neuroectodermal tumor 6 years after treatment of a CNS malignant B-cell lymphoma.

CASE REPORT
A 12-year-old male presents with severe headache. Initial imaging and biopsy demonstrate supratentorial malignant B-cell lymphoma. Patient underwent partial brain radiation with 4860 CGy and DeAngelis protocol chemotherapy. Apparent resolution is demonstrated on MR imaging 4 years after treatment. Six years after treatment, a new left frontal mass is identified on MR imaging for work up of headache.

IMAGING FINDINGS
Initial MR imaging demonstrates a relatively homogeneous mass lesion involving the bilateral thalami. Posttreatment MR imaging demonstrates apparent resolution. Follow-up evaluation for headache demonstrates a new heterogeneous mass lesion in the left basal ganglia and left frontal lobe with associated mass effect.
SUMMARY
Primary pediatric CNS lymphoma is a rare diagnosis. Subsequent radiation-induced primitive neuroectodermal tumor is extremely rare and adds to the unique nature of this case. There are 11 reported cases in the literature of secondary PNETs in all age groups following radiation therapy after an average of 8.5 years following therapy.

KEY WORDS: Radiation-induced, PNET, supratentorial

Paper 441 Starting at 11:55 AM, Ending at 12:00 PM
Imaging of Traumatic EDH: Active Extravasation on CT Angiography

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San Francisco, CA

PURPOSE
In patients with nontraumatic intracerebral hemorrhage (ICH), active extravasation of contrast seen on CT angiography (CTA) and/or postcontrast CT has been associated with both hematoma expansion and poor outcome. At our institution, contrast-enhanced exams, including dynamically enhanced perfusion CT, CTA and postcontrast CT, are increasingly being performed on patients presenting with head trauma.

CASE REPORT
We present a case of traumatic EDH with active contrast extravasation identified on CT angiogram. The 13-year-old male patient fell and struck his head while rollerblading without a helmet.

IMAGING FINDINGS
The initial noncontrast head CT (NCCT) demonstrated a small 1.5cm extraaxial hematoma subjacent to a nondisplaced linear occipital bone fracture. Approximately 4 hours following this scan, the patient developed worsening nausea, vomiting and lethargy and a repeat NCCT/CT angiogram (CTA) was performed. The NCCT demonstrated enlargement of the presumed venous EDH with worsening mass effect. An area of heterogenous, low attenuation within an otherwise hyperattenuating hematoma was noted (“swirl sign”). The CTA demonstrated a linear focus of active contrast extravasation into the medial aspect of the hematoma.

SUMMARY
To our knowledge, this is the first case of traumatic EDH with active contrast extravasation identified on CT angiography. Contrast enhancement within EDHs has been reported previously; however all cases were on postcontrast CT scans (1, 2). Similar to the “spot sign” of nontraumatic ICH (3), active extravasation within EDHs on CT angiography may provide additional diagnostic/prognostic information with further study.

REFERENCES

KEY WORDS: EDH, traumatic brain injury, CT angiography
PURPOSE
The temporal bone houses the ossicles, the inner ear structures including the cochlea, vestibule and semicircular canals in a very compact space. In addition, numerous small nerves course through this region. The complex, multispatial orientation of these sub-centimeter sized structures makes it difficult to understand the anatomy of the temporal bone. The purpose of this study is to demonstrate the role of 3D CT to 1. better appreciate the anatomy of the temporal bone and 2. illustrate its role in evaluation of temporal bone pathology.

MATERIALS & METHODS
High-resolution axial CT scans of the temporal bone were obtained in 168 patients with complaints related to the auditory system, using 16-slice spiral CT (Somatom Sensation 16, Siemens Medical Solutions, Malvern, PA, USA), at 120 kv, 200 mAs yielding 0.7 mm thick sections reconstructed at 0.1 mm intervals. Volume-rendered 3D images of the temporal bone were reconstructed on Terarecon (Aquarius Workstation, V 3.3, San Mateo, CA) to display the temporal bone anatomy. In addition to obtaining volume-rendered 3D CT images in the standard axial, coronal and sagittal planes, special oblique planes were also utilized to better illustrate the underlying anatomy and pathology. Pathological cases thus assessed included congenital anomalies of the temporal bone such as those involving the tympanic cavity and the inner ear structures, large vestibular aqueduct syndrome, vascular anomalies such as an aberrant carotid artery, inflammatory and infections conditions including cholesteatoma, and trauma including complex fractures and ossicular dislocation. Comparison of such 3D images was then made with corresponding 2D image data set to highlight the role played by 3D CT while evaluating temporal bone anatomy and pathology.

RESULTS
The 3D CT images can be rotated in space, and sectioned in any desired plane allowing for better understanding of underlying anatomy and pathology than conventional 2D imaging. Specifically, select representative images will help to exquisitely display the normal anatomy of the temporal bone, allowing for better appreciation of the multispatial orientation of the numerous small structures of the temporal bone, such as the complex winding course of the facial nerve, and the scala vestibule and tympani. In addition, structures such as the Bill’s bar, osseous spiral lamina not readily demonstrated on conventional 2D imaging will be displayed. Select pathological cases will help better display an absent oval window (not readily appreciated on conventional imaging), absent common crus, extent of the erosion of the ossicles by cholesteatoma, and better visualization of fractures and their extent on volume-rendered 3D images when compared to conventional 2D images.

CONCLUSION
The case material so illustrated documents that 3D CT reformations provide additional information not easily obtained on 2D images. This helps us better understand underlying anatomy and pathology. Further, such additional information obtained sheds significant light on our understanding of underlying embryology. It also contributes meaningfully to further treatment options, including better surgical planning based on the supplementary information so provided by the 3D CT images.
To correlate the degree of hearing improvement based on audiometry findings in cochlear implant patients, with the cochlear canal/nerve size (measured on HRCT/MR imaging) between patients who have normal radiologic findings and those with congenital anomalies.

**MATERIALS & METHODS**
Preoperative HRCT temporal bones of 19 children with profound sensorineural hearing loss, aged between 1 and 7 years who underwent cochlear implantation were analyzed retrospectively, of which 10 had normal-appearing CT findings (group A) and nine others had congenital anomalies (group B). The cochlear anomalies included were incomplete partition type II, common cavity, based on classification by Sennaroglu et al (1), attenuated modiolus, isolated cochlea and cochlear nerve deficiency. The bony cochlear canal diameters on CT and the corresponding cochlear nerve size on MRI 3D FIESTA sequence were measured retrospectively and documented in all ears on the operated side, in each case. The findings were correlated with postoperative follow-up of hearing improvement (done between approximately 8 months to 2 years, following the implant) with audiometry, including CAP (Category of Auditory Performance) Score.

**RESULTS**
1) Overall, patients in group A [Mean (± SD) CAP Score = 5.5±0.707] showed better response on the postimplant follow-up audiometry, which was statistically significant (P=0.038) than patients in group B [Mean (± SD) CAP Score = 4.67±0.866]. 2) No statistically significant correlation was found between cochlear nerve size and follow-up audiometry on the operated side in cochlear implant patients in both group A and group B by both observers (radiologists 1 and 2). [CAP scores and cochlear nerve sizes have been compared using Pearson’s correlation coefficient. In group A , p=0.129 and p=0.7652 ,while in group B, p=0.5572 and p=0.1995 by radiologists 1 and 2 respectively]. 3) The poor response in group B appears to be due to congenital anomaly, rather than directly to cochlear canal diameter on CT, or cochlear nerve size on MR imaging. 4) Lin’s concordance correlation coefficient shows that for both cochlear canal (81.16%) and nerve (90%), agreement between both observers (radiologists 1 and 2) is excellent. All concordance correlation coefficient’s are statistically very highly significant (p<0.0001).

**CONCLUSION**
Bony cochlear canal diameter on HRCT, and the cochlear nerve size on MR imaging has no correlation with the audiometry outcome, in cochlear implant patients. Improvement on audiometry appears to be better correlated with congenital cochlear malformations (group B in our series), compared to the ones who have no obvious anomalies on imaging (group A).

**KEY WORDS:** HRCT, cochlear canal, audiometry
is excellent. Concordance correlation coefficients between both radiologists being 0.89 and 0.84 for the right and left ear cochlear canals and 0.72 and 0.74 for the right and left cochlear nerves respectively. All concordance correlation coefficients are statistically very highly significant (p<0.0001).

CONCLUSION
There is no significant statistical correlation between the two groups in the bony cochlear canal and nerve size. Although statistically significant correlation was found between the cochlear canal and nerve in group B by one of the radiologist on one side, this was not statistically significant by the other radiologist. What we observed is that if the bony canal is small in size, the nerve is always small, whereas if the canal is large or normal in size, the nerve may be absent, small or normal in size.

KEY WORDS: MRI cochlear nerve, HRCT, cochlear canal

Paper 445 Starting at 1:54 PM, Ending at 2:02 PM

Split-Array Cochlear Implants: A New Technology with an Unexpected Radiographic Appearance

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Pittsburgh, PA

PURPOSE
Cochlear implantation is a well accepted method of improving hearing in patients with severe hearing loss. For acceptable programming of the device, 12-22 electrodes from the main lead must be inserted successfully into the cochlea. Unfortunately, many patients with hearing loss have labyrinthitis ossificans, in which bony or fibrous ingrowth replaces the normal endolymph and perilymph of the cochlea. In this circumstance, it becomes difficult to surgically place the electrodes, and traditional cochlear implants can only be inserted to 7 or 8 electrodes. To combat this problem, a new type of device, the split-array cochlear implant, has been developed. These devices are subtly different in radiographic appearance than traditional cochlear implants, and these differences can be mistaken for abnormalities or defects in the device.

MATERIALS & METHODS
Five patients with split-array electrodes were identified from the electronic medical record. Intraoperative and postoperative conventional radiographs and multidetector CT scans were reviewed and compared to patients with traditional cochlear implants.

RESULTS
A split-array cochlear implant contains 11 electrodes on each of two leads, instead of 22 electrodes on a single lead. The electrodes are spaced more closely along the lead, which increases the number of electrodes that are in contact with the cochlea, but results in a narrower area of stimulation. Unlike traditional cochlear implants, which are inserted into the basal turn of the cochlea and then advanced as far as possible into the upper turns, each lead of the split-array device can be inserted separately. The two leads may be placed next to each other in the basal turn, or may be placed through separate access holes, one in the basal turn and one in the second turn of the cochlea. Conventional radiographs (using a modified Stenver’s view) and multidetector CT can be used to image split-array cochlear implants. If the two leads are placed into separate portions of the cochlea, they will be distinguishable on the conventional radiograph. However, if they are placed through the same opening, they may appear as a single thickened lead. On CT, separated leads may be seen on different axial images, but close leads may overlap on a single image and may even be indistinguishable on reformatted images. If the two leads are close together, they may be mistaken for a single lead that has fractured. Leads placed in different parts of the cochlea may be mistaken for displaced electrodes from a traditional implant.

CONCLUSION
Split-array cochlear implants are a relatively new prosthetic device with a unique radiographic appearance. Neuroradiologists should become familiar with the appearance of these devices on conventional radiographs and CT to avoid mistaking the new device for a failure of a traditional cochlear implant.

KEY WORDS: Cochlear implant, split-array

Paper 446 Starting at 2:02 PM, Ending at 2:10 PM

Direct Visualization of Endolymphatic Hydrops in Patients with Endolymphatic Sac Tumors

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PURPOSE
To use delayed postcontrast FLAIR to directly visualize the presence or absence of endolymphatic hydrops in a population of von Hippel Lindau (VHL) patients with a history of endolymphatic sac tumors (ELSTs).

MATERIALS & METHODS
Eight VHL patients with small unilateral ELSTs (7 with prior surgery) enrolled in a natural history study (ClinicalTrials.gov identifier: NCT00005902) received two doses of contrast for routine brain and spine MR imaging. This was followed by delayed FLAIR inner ear imaging 5-17 hours later on a 3.0 T device using a 6 channel 8 coil whole-head phased array. Contrast parameters were TR 11000, TE 120, ETL 27, TI 2550. Geometric parameters were: FOV 150 mm, thickness 1.7 mm, gap 0, matrix 320 x 243. Imaging time was per signal average, and four averages were performed. The scan plane paralleled that of the horizontal semicircular canal. T2-weighted images were obtained with an identical geometry for anatomical reference.

RESULTS
Delayed FLAIR imaging successfully demonstrating the utricle and sacule of the membranous labyrinth in the vestibule in the normal ears in all cases. The scala media is virtually nondetectable in the normal cochlea. In five cases,
Two mechanisms have been proposed to account for the audivestibular dysfunction associated with small ELSTs, intralabyrinthine hemorrhage and endolymphatic hydrops. The direct association of sudden SNHL and MRI evidence of intralabyrinthine hemorrhage has been shown previously. The second mechanism, endolymphatic hydrops, had been inferred from a normal appearing labyrinth, symptoms mimicking Meniere’s disease, and an autopsy case demonstrating hydrops. In the current study, we directly demonstrate endolymphatic hydrops in VHL patients with a history of ELST. Despite the confound introduced by prior surgeries, this study suggests that ELSTs induce endolymphatic hydrops. Confirmation in a larger series of unoperated patients is needed.

**KEY WORDS:** Hydrops, labyrinth, FLAIR

**CONCLUSION**

Two mechanisms have been proposed to account for the audivestibular dysfunction associated with small ELSTs, intralabyrinthine hemorrhage and endolymphatic hydrops. The direct association of sudden SNHL and MRI evidence of intralabyrinthine hemorrhage has been shown previously. The second mechanism, endolymphatic hydrops, had been inferred from a normal appearing labyrinth, symptoms mimicking Meniere’s disease, and an autopsy case demonstrating hydrops. In the current study, we directly demonstrate endolymphatic hydrops in VHL patients with a history of ELST. Despite the confound introduced by prior surgeries, this study suggests that ELSTs induce endolymphatic hydrops. Confirmation in a larger series of unoperated patients is needed.

**KEY WORDS:** Hydrops, labyrinth, FLAIR

**RESULTS**

Of the 21 ears with schwannomas, four had prior surgery, namely, one total labyrinthectomy (excluded), two partial labyrinthectomies, and one resection of the intracranial component. Intralabyrinthine extension of tumor was present in nine ears. Of the 17 nonsurgically treated ears, hyperintense signal was present on precontrast FLAIR in the perilymph in 13 ears. Of these, hyperintensity also was present in the endolymph in two ears. On delayed postcontrast FLAIR, enhancement of the perilymph was seen in all cases. Enhancement of the endolymph occurred in only two cases. Enlargement of the scala media of the cochlea (endolymphatic hydrops) was present in both ears in which a partial labyrinthectomy (resection of vestibule and SCCs) had been performed, but in none of the ears which were not surgically treated.

**CONCLUSION**

Differentiation of the perilymph and endolymph compartments in the ear can be made by high-resolution FLAIR imaging when subtle alterations of T1 generate a contrast between these two compartments. This occurs physiologically on delayed FLAIR imaging, and may occur pathologically in certain disease states. Increased protein content in the labyrinth is associated with vestibular schwannomas. Here we demonstrate that this increased protein content is confined to the perilymph. The endolymph signal is normal. Furthermore, endolymphatic hydrops does not appear to be a consequence of vestibular schwannoma. However, we suggest that cochlear endolymphatic hydrops may develop secondarily following resection of the vestibule and semicircular canals.

**KEY WORDS:** Meniere’s disease, internal auditory canal, FLAIR
PURPOSE
Metastatic lesions to the cerebellopontine angle (CPA) and internal auditory canal (IAC) present with distinct patterns of spread with respect to regional anatomy. The purpose of this study is to identify the various imaging appearances of metastatic disease within the CPA and IAC. It is important to differentiate metastatic lesions in this location from the more common lesions of the CPA and IAC, as it greatly impacts treatment decisions and patient prognosis.

MATERIALS & METHODS
Twenty-nine cases of metastatic disease to the CPA and/or IAC diagnosed on MR imaging were reviewed retrospectively. Data collected included demographics, presenting symptoms, imaging characteristics, anatomical location, multiplicity, and pathologic diagnoses.

RESULTS
Four anatomical patterns emerged as a consistent means for categorizing metastatic disease processes within the CPA and IAC. These included 1) pial, 2) dural, 3) floccular, and 4) choroid plexus. Cranial nerve (CN) 7 and 8 enhancement reflecting pial metastases presented as the most common pattern. Twelve (12/29) lesions were classified as involving the pial surface of CN7 and CN8. Eight (8/29) lesions were based within the dura. Five (5/29) lesions were parenchymal metastases within the flocculus of the cerebellum, and 4/29 lesions emanated from choroid plexus extending through the foramen of Lushka. Thirteen cases were bilateral.

CONCLUSION
Four specific patterns of metastatic disease can be identified within the CPA-IAC based on regional anatomy: pial, dural, floccular, and choroid plexus. Knowledge of these possible imaging presentations helps the radiologist suggest metastatic disease as a possible CPA-IAC diagnosis when present.

KEY WORDS: Cerebellopontine angle, internal auditory canal, metastasis
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PURPOSE
Aim of this study was to illustrate the development of the fetal ear with MR metric data.

MATERIALS & METHODS
Two hundred eight unsedated fetuses of single pregnancies with assumed normal auditory development were reviewed retrospectively. Using a 1.5 T unit with T2-weighted 2-4 mm thick coronal sections through the temporal bone we reviewed five groups according to their gestational week. Group A (n = 13) comprised fetuses of 16th to 20th gestational week, group B (n = 81) of 21st-25th week, group C (n = 61) of 26th to 30th week, group D (n = 43) of 31st to 35th week and group E (n = 10) those of 36th week until date of birth. Measured parameters included the length of the auricle (LA), the widest diameter of the cochlea (WDSCD), of the semicircular canals and ducts (WDSCD) and the largest width of one semicircular duct (LWSD).

RESULTS
The mean LA differed significantly between group A (11.25 mm) and C (17.27 mm), between A and D (19.07 mm), A and E (22.47 mm), B (14.85 mm) and E (22.47). The WDSCD (A 4.82 mm, B 4.77 mm, C 5.05 mm, D 5.08 mm and E 4.85 mm) did not differ significantly between the groups. The WDSCD showed significant differences between A (10.83 mm) and C (13.60 mm), A and D (14.99 mm) as well as between A and E (15.99 mm). Furthermore, the comparison between B (12.24 mm) and D (14.99 mm), B with E (15.99 mm) and that of C (13.60 mm) with E (15.99 mm) showed significant differences. The LWSD showed no significant differences in the post-hoc-test by Hochberg between A (2.44 mm), B (2.68 mm), C (3.07 mm), D (3.63 mm) and E (3.08 mm).

CONCLUSION
The presented normal values of three-dimensional scanning of human ear development will be helpful in the evaluation of fetal ear pathology. However, larger sampling sizes will be necessary to define percentile curves.

KEY WORDS: Fetal ear, in vivo fetal MR
ence between measurements is optimal. The potential therefore exists that the use of an optimal interval will reduce the false negative and positive rates seen in this retrospective review.

**KEY WORDS:** PET/CT, skullbase, dual time point

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**Paper 452 Starting at 2:50 PM, Ending at 2:55 PM**

**Postradiation Pleomorphic Sarcoma after Gamma Knife Radiosurgery of a Presumed Vestibular Schwannoma**

Diehn, F. E. · Morris, J. M. · Lindell, E. P.

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**PURPOSE**

To describe a rare case of a high-grade pleomorphic sarcoma of the cerebellopontine angle–internal auditory canal arising 7 years after gamma knife radiosurgery of a presumed vestibular schwannoma.

**CASE REPORT**

A 51-year-old man presented in 2001 with chronic bilateral sensorineural hearing loss that had progressed to complete hearing loss on the right. An MR image demonstrated an enhancing mass in the right cerebellopontine angle, extending into and widening the internal auditory canal, most consistent with a vestibular schwannoma. He underwent gamma knife radiosurgery in May 2001 (volume of 19 cc, with 12 Gy to the margin and 30 Gy maximum). Approximately 6 months postoperatively, he developed increasing edema in the cerebellum as well as hydrocephalus, necessitating a shunt placement. The patient was treated with oral steroids, the edema resolved, and the tumor decreased in size. Serial MR scans over 6 years demonstrated that the mass was stable to decreasing in size. Serial MR scans over 6 years demonstrated that the mass was stable to decreasing in size. Despite mild right hemiataxia, the patient did well, maintaining all of his activities, including his work as a cabinet maker. Clinically, he also had mild right-sided facial weakness preoperatively which improved slightly after gamma knife and had been stable. However, in the summer of 2008, he developed worsening right facial weakness and numbness. A follow-up MR imaging demonstrated slight increase in the size of the mass. He was followed clinically, but when the facial weakness progressed to complete in November 2008, a repeat MR imaging was performed and demonstrated increase in size. The patient subsequently underwent translabyrinthine tumor resection, and pathology revealed a high-grade pleomorphic sarcoma.

**IMAGING FINDINGS**

MR imaging initially demonstrated a $4 \times 3 \times 3$ cm homogeneously enhancing T2 hyperintense mass extending from the right cerebellopontine angle into an expanded right internal auditory canal, presumed to be a vestibular schwannoma. After treatment the mass initially decreased in size.

**SUMMARY**

This case demonstrates rare malignant transformation of a presumed internal auditory canal vestibular schwannoma most likely induced by radiosurgery. To our knowledge, it is only the second reported sarcoma in the cerebellopontine angle–internal auditory canal region after gamma knife radiosurgery, and the first high-grade pleomorphic type. Although the tumor was not biopsied before gamma knife, we believe that it was initially a vestibular schwannoma, given the characteristic imaging findings, chronic declining sensorineural hearing loss in that ear prior to presentation, and nearly 7 years of stability following gamma knife. Although very low, the exact risk of a radiation-induced tumor after radiosurgery is unknown.

**KEY WORDS:** Cerebellopontine angle, radiosurgery, sarcoma

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**Paper 453 Starting at 2:55 PM, Ending at 3:00 PM**

**Severe Degenerative Changes Seen with Temporomandibular Joint Implants**

Tamimi, D.
Epic Teleradiology
Orlando, FL

**PURPOSE**

Familiarize the radiologist with the severe destruction seen with temporomandibular joint (TMJ) implants used in the 1980s. The FDA’s regulation of new medical devices entering the market began with the 1976 Medical Device Amendments. Temporomandibular joint implants are pre-amendments devices, meaning they entered the market before 1976. This allowed sale of TMJ implants marketed before May 28, 1976 to continue without demonstrating safety and effectiveness. These devices introduced after 1976 required FDA clearance. In 1993, the Dental Products Advisory Panel reclassified them into Class III - the highest risk category.

**CASE REPORTS**

The problems that patients experience include but are not limited to severe pain around the ear and jaw, radiographic evidence of severe bone loss in the condyle and the glenoid fossa, fragmentation/displacement of the implant, infection, necrosis of bone, vision and hearing problems and giant cell granulomatous reaction. Cases with these implants still surface from time to time at TMJ and ENT clinics globally, and some examples will be shown in this presentation.

**IMAGING FINDINGS**

Severe destruction of the glenoid fossa and surrounding temporal bone as well as of the condylar head/neck. A bilaminar foreign body representing the meniscal prosthesis, sometimes seen with fixation wires attaching it to the surrounding tissues. This may be complete or fragmented. On MR imaging, severe granulomatous reaction and avascular necrosis of bone can be appreciated.

**SUMMARY**

Although the implants associated with the aforementioned complication have been discontinued, it is important that the
radiologist recognize the appearance associated with these implants, as close to 50,000 have been distributed before they were taken off the market in the late 1980s. It is not known how many actually have been implanted.

**KEY WORDS:** TMJ, implant failure, teflon

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### Thursday Afternoon

1:30 PM – 3:00 PM

**Ballroom B**

(52b) Adult Brain: Cerebrovascular Occlusive Disease II

(Scientific Papers 454 – 464)

See also Parallel Sessions

(52a) Head & Neck: Temporal Bone & Skull Base

(52c) Adult Brain: Degenerative/Demyelinating/Metabolic Diseases II

(52d) Pediatric: Developmental/Congenital Malformations

Moderators: Howard A. Rowley, MD

Pamela W. Schaefer, MD

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**Paper 454 Starting at 1:30 PM, Ending at 1:38 PM**

**Artery of Percheron Infarction: Imaging and Clinical Spectrum of Thirty-Three Cases**

Lazzaro, N. A. · Wright, B. · Osborn, A. G. · Fischbein, N. J. · Castillo, M. · Glastonbury, C. M. · Hildenbrand, P. G. · Wiggins, R. H.

¹University of Utah, Salt Lake City, UT, ²Stanford University, Stanford, CA, ³University of North Carolina, Chapel Hill, NC, ⁴University of California San Francisco, San Francisco, CA, ⁵Lahey Clinic, Burlington, MA

**PURPOSE**

The artery of Percheron (AOP) is an uncommon anatomical variant in which a single dominant thalamoperforating artery supplies the rostral midbrain and medial thalami. Occlusion results in a characteristic pattern of ischemia: bilateral paramedian thalamic infarcts with or without midbrain involvement. Although the classic imaging findings often are recognized, a comprehensive evaluation of AOP infarction and its imaging spectrum has not been documented because most investigations report only a few isolated cases. We report a large case series that characterizes the different radiographic appearances of AOP infarction and describe a striking new finding (the “V” sign) that should suggest this diagnosis.

**MATERIALS & METHODS**

We identified 33 patients with AOP infarctions (age range: 28 – 93 years, mean: 58.1) based on radiographic and clinical data. Twenty-one patients from our institution were identified retrospectively by searching MR imaging and CT reports from the PACS from 2000 to present. Twelve patients with AOP infarctions were contributed from other institutions. MR imaging was performed in 29/33 patients; CT was performed in 18/33 patients. The clinical and imaging features including distribution and characterization of ischemic foci were tabulated.

**RESULTS**

Bilateral paramedian thalamic infarctions were demonstrated in 97% of patients (32/33). Thalamic involvement was asymmetric in 72% (23/32) and symmetric in 28% of cases (9/32). Bilateral paramedian thalamic with rostral midbrain infarction was identified in 58% of patients (19/33). Bilateral paramedian thalamic without midbrain infarction was demonstrated in 39% of patients (13/33). Unilateral medial thalamic with midbrain infarction was identified in one case. A distinct pattern of V-shaped hyperintensity on axial FLAIR and diffusion-weighted imaging was present along the pial surface of the midbrain adjacent to the interpeduncular fossa in one third of all patients. Synchronous infarcts were identified in the cerebellum in 21% of patients (7/33), occipital lobe in 6% of patients (2/33), and MCA territory in 6% of patients (2/33). A clinical chart review was performed and the most common presumed etiology was cardio-embolic.

**CONCLUSION**

Three patterns of AOP infarction in our series were identified: Bilateral paramedian thalamic with rostral midbrain (58%), bilateral paramedian thalamic without midbrain (39%), and unilateral thalamic with midbrain infarction (3%). These three distinct patterns are likely due to variations of the AOP supply to the thalami and midbrain. Synchronous posterior circulation infarcts involving the cerebellum and occipital lobes were present in 27% of patients, likely as a consequence of the presumed embolic etiology in most patients. The “V” sign describes a distinctive imaging finding seen in a third of our cases. The “V” sign along with the three distinct patterns of ischemia identified in our series well characterizes this uncommon entity and should improve recognition of AOP infarction.

**KEY WORDS:** Artery of Percheron, bithalamic infarction, midbrain infarction

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**Paper 455 Starting at 1:38 PM, Ending at 1:46 PM**

**A Small Diffusion-Weighted Imaging Lesion in the Setting of an Anterior Circulation Proximal Artery Occlusion Predicts the Presence of a Large Diffusion-Perfusion Mismatch**

Hakimelahi, R. · Copen, W. A. · Schaefer, P. W. · Wu, O. · Yoo, A. J. · Schwamm, L. H. · Gonzalez, R. G.

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Boston, MA

**PURPOSE**

In acute stroke patients, mismatch between lesions in diffusion-weighted images (DWI) and mean transit time (MTT)
perfusion maps has been tested as a means of identifying patients most likely to benefit from revascularization. We tested the hypothesis that a small DWI lesion in the presence of a proximal anterior circulation artery occlusion predicts the presence of a large mismatch in stroke patients presenting within 24 hours of stroke onset.

**Materials & Methods**

In this IRB-approved, HIPAA-compliant study, we retrospectively identified 68 consecutive patients who presented to our hospital’s ED, underwent DWI and PWI within 24 hours of stroke onset, and had terminal internal carotid artery and/or proximal middle cerebral artery occlusion identified by CTA or MRA. DWI/PWI mismatch was calculated as the difference between lesion volumes in DWI images, and those in MTT maps produced by the delay-sensitive deconvolution method used in several recent successful clinical trials. A significant mismatch was arbitrarily defined as a mismatch volume equal to or greater than the DWI lesion volume (100% or more mismatch). In light of recent findings that patients with DWI lesions larger than 70 ml have poor outcomes regardless of treatment, patients were categorized into those with DWI lesions larger vs. smaller than 70 ml.

**Results**

Proximal anterior circulation artery occlusion was identified in 68 patients. Of these 49 (72%) had DWI lesion volume ≤70 ml (mean, 20.17 ml; SD, 20.02), and 19 (28%) >70 ml (mean, 163.33 ml; SD, 72.10). A DWI/MTT mismatch of 100% or greater was observed in all of the 49 patients with DWI lesion ≤70 ml (mismatch volume mean, 121.03 ml; SD, 66.28). A significant mismatch was identified in only four of 19 patients with large DWI lesions (mean, 74.41 ml; SD, 63.15). A DWI abnormality of ≤70 ml was significantly associated with the presence of a mismatch of 100% or greater (P<.0001). No significant correlation was found between time since stroke onset and infarct volume (r, -0.87; P, 0.36), or between time since stroke onset and mismatch volume (r, -0.6; P, 0.53).

**Conclusion**

Acute stroke patients with proximal anterior circulation artery occlusion are extremely likely to have a significant diffusion/perfusion mismatch if the DWI lesion volume is ≤70 ml, using perfusion analysis methods that are widely employed. It is possible that newer methods (i.e., those that are insensitive to delays in bolus arrival) would show much reduced mismatch volumes.

**Key Words:** Ischemic stroke, proximal artery occlusion, DWI/PWI mismatch
CONCLUSION
For patients with large-vessel anterior circulation strokes who undergo IA therapy, final infarct volume appears to be the best predictor of clinical outcome. This supports its use as a surrogate endpoint in trials involving this subset of patients. Furthermore, these findings support the emerging data that suggests that an infarct volume threshold may be an effective means of selecting patients for intraarterial therapy. The optimal infarct volume threshold for treatment selection may be between 50cm³-60cm³, although this needs to be tested in the acute setting.

KEY WORDS: Intraarterial therapy, infarct volume, outcome

Paper 457 Starting at 1:54 PM, Ending at 2:02 PM
Determining Infarct Core versus Penumbra Using Autofusion of Diffusion-Weighted Imaging and Dynamic CT Perfusion in Hyperacute Stroke
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Minneapolis, MN

PURPOSE
To analyze various perfusion parameters in regions of infarction versus penumbral areas using “autofusion” of MR imaging diffusion-weighted images (DWI) to dynamic CT perfusion (CTP) images obtained in hyperacute phase (<4hours) in untreated patients.

MATERIALS & METHODS
After IRB approval, 15 patients were selected of 371 who underwent CTP examinations on a 64-slice CT scanner for suspected acute stroke <4 hours after symptom onset, and also underwent DWI MR imaging within 4 hours of the CTP examination. Patients were only included who did not receive treatment or angiography between CTP and MR examinations. The DWI abnormality was considered the infarct “core.” Using automatic fusion software (Fusion 7D, Siemens Medical Solutions USA Inc., Oxford, UK), DW images were “autofused” to the same orientation/angle and slice thickness (1cm) as the postprocessed CTP images (VITREA, Vital Images, Minnetonka, MN). Two neuroradiologists reviewed the fused images by consensus to confirm fusion, and placed ROIs precisely in the infarct “core” on CTP (based on DWI) as well as in the “penumbra” (uninvolved on DWI) at least 5 mm away from the “core.” Control values were obtained via an “automirror” function. Several CTP parameters were measured, including cerebral blood volume (CBV), blood flow (CBF), time to peak (TTP), mean transit time (MTT), and Delay (D). Tests for significance were performed (one-tailed t test).

RESULTS
Three patients were not able to be fused due to technical errors and complications such as patient motion. In the remaining 12, there was a significant difference for each of the CTP parameters between the infarct core values and the control side including CBV (p=0.036), CBF (p=0.031), MTT (p=0.018), TTP (p=0.017), and D (p=0.010). There was a significant difference between penumbra versus control for CBF (p=0.008), MTT (p=0.005), TTP (p=0.011), and D (p=0.016), but not for CBV (p=0.304). When comparing for differences in infarcted versus the penumbral regions, there were significant differences regarding CBV (p=0.008) and CBF (p=0.017), but not for MTT (p=0.305), TTP (p=0.167), or D (p=0.417).

CONCLUSION
This small, preliminary study using fusion to directly compare CTP to DWI of the same slice thickness and orientation suggests that the CTP parameters of CBF and CBV may be able to predict infarct core from penumbra hyperacutely in untreated patients, although thresholds for this discrimination are still under debate. The parameters of MTT, TTP, and D can distinguish abnormal versus normal tissue, but may be problematic in distinguishing penumbra from infarcted tissue.

KEY WORDS: Autofusion, infarct, penumbra
Paper 458 Starting at 2:02 PM, Ending at 2:10 PM

Delay-Corrected Software and Relative (Rather Than Absolute) Thresholds Are Required for Optimal CT Cerebral Blood Volume/Diffusion-Weighted Imaging Correlation of Admission Infarct Core in Acute Stroke Patients

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PURPOSE
Recent studies suggest that CT cerebral blood volume (CBV) maps - like MR diffusion weighted imaging (DWI) - can delineate infarct “core” (irreversibly ischemic tissue). An absolute threshold of 2cc/100g has been advocated for segmentation of core. Quantitative CBV values, however, can vary with the choice of vascular input functions, and gray and white matter have different baseline CBV values, making use of absolute thresholds problematic. Moreover, it has been suggested that marked hemodynamic derangements - such as severe extracranial internal carotid artery (ICA) stenosis/occlusion, or low ejection fraction due to atrial fibrillation - can result in inaccurate CT perfusion (CTP) map construction with the use of standard algorithms that do not account for contrast arrival time delay. Our purpose was to determine which thresholds would optimize the correlation between CBV and DWI admission core volumes, stratified according to contrast arrival delay, using standard deconvolution software from two commercial vendors.

MATERIALS & METHODS
We identified 44 CTP exams in 40 consecutive acute stroke cases with admission CT and DWI obtained within 3 hours of each other. Cerebral blood volume maps were acquired with a 60-second monophasic acquisition, and processed/segmented with automated software - not optimized to account for arrival time delays - from two vendors, using multiple absolute and relative thresholds. To assess the effect of delayed contrast arrival, cases were stratified into two subgroups (Group A: 23 patients without severe ipsilateral contrast arrival time delay; Group B: 21 patients with severe ipsilateral contrast arrival time delay defined as atrial fibrillation or ipsilateral extracranial ICA hairline stenosis/occlusion). Ischemic lesion volumes were compared to those of corresponding manually segmented co-registered DWI maps.

RESULTS
A relative threshold of 55% (Vendor 1) and 60% (Vendor 2) versus the contralateral normal brain resulted in optimal correlation between CBV and DWI lesion volumes for the automated segmentation software for both vendors in group A (Vendor 1: R^2= 0.92/ slope= 1.08; Vendor 2: R^2= 0.83/ slope= 1.03). The best case recommended absolute thresholds resulted in inferior results for both vendors in group A (Vendor 1: R^2= 0.85/ slope= 1.18; Vendor 2: R^2= 0.78/ slope=0.96). Group B showed lower correlations for the same thresholds (Vendor 1: R^2= 0.62/ slope= 0.9; Vendor 2: R^2=0.7/ slope=1 for relative thresholds, and Vendor 1: R^2= 0.4/ slope= 0.9; Vendor 2: R^2= 0.59/ slope=0.81 for absolute thresholds).

CONCLUSION
Cerebral blood volume core volumes are highly correlated with those of coregistered DWI when relative - rather than absolute - thresholds are applied to acute stroke patients with normal extracranial circulation, using commercially available automated software, not algorithmically optimized to account for arrival time delay. Use of nonoptimized software in patients with severe contrast arrival time delays - such as extracranial ICA occlusion or atrial fibrillation - can produce unreliable results.

KEY WORDS: CT perfusion, infarction core, CBV

Paper 459 Starting at 2:10 PM, Ending at 2:18 PM

Semiquantitative Assessments of Infarct Burden Using ABC/2 Methodology and ASPECTS Are Highly Correlated with Computer-Assisted Volumetric Analysis in Large Vessel Anterior Circulation Strokes

Romero, J. · Hakimelahi, R. · Nogueira, R. G. · Rabinov, J. D. · Pryor, J. C. · Schaefer, P. W. · Hirsch, J. A. · Gonzalez, R. G. · Yoo, A. J.
Massachusetts General Hospital
Boston, MA

PURPOSE
Acute infarct volume on presentation is being increasingly employed in the selection of patients for both intravenous and intraarterial stroke therapies. A quick and reliable method of estimating infarct volume will be needed for both clinical trials and real-world use. We sought to compare two different semiquantitative methods for assessing infarct burden with computer-assisted volumetric analysis, and to further validate them against clinical outcome.

MATERIALS & METHODS
This retrospective study examined all anterior circulation stroke patients from 2005 to the present, who had large vessel intracranial occlusions and who underwent intraarterial stroke therapies. A quick and reliable method of estimating infarct volume will be needed for both clinical trials and real-world use. We sought to compare two different semiquantitative methods for assessing infarct burden with computer-assisted volumetric analysis, and to further validate them against clinical outcome.

RESULTS
Eighty-one patients were studied. The median NIHSS was 18 (14-20.25). There were 26 ICA, 47 M1 and 8 M2 occlusions. The median Mori score was 2 (1-3). The average time from symptom onset to vessel opening was 435.7±145.8 minutes. The median mRS was 4 (2-5). There were 26 ICA, 47 M1 and 8 M2 occlusions. The median mRS was 4 (2-6). Twenty-three patients had a good outcome at 3 months. Both ABC/2 (rho=0.96, p<0.0001) and ASPECTS (rho=0.91, p<0.0001) were highly correlated with final infarct volume. Receiver-
operator characteristic analysis for final infarct volume, ABC/2 and ASPECTS yielded an area under the curve of 0.883, 0.871 and 0.863, respectively (p<0.0001). There was no statistical difference between the ROC curves (Figure). An ABC/2 score between 50cm³-60cm³ optimized sensitivity(83%) and specificity(~70-80%) for a good outcome. A similar cutpoint for ASPECTS was between 4-5 (sensitivity 87-96%, specificity 66-86%).

CONCLUSION
For patients with large vessel anterior circulation strokes, ABC/2 and ASPECTS are highly correlated with final infarct volume. Furthermore, these semiquantitative methods are strongly predictive of clinical outcome. These findings support the use of both methods as clinical prognostic tools, as well as important selection criteria for clinical trials of intraarterial therapies.

KEY WORDS: Ischemic stroke, semiquantitative assessments, final infarct

Paper 460 Starting at 2:18 PM, Ending at 2:26 PM
Thrombotic Microangiopathy: A Unique Imaging Pattern
Ellchuk, T. N. · Shah, L. M. · Osborn, A. G.
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Salt Lake City, UT

PURPOSE
Several patients diagnosed with thrombotic microangiopathy have presented to our institution with neurologic manifestations and a unique imaging pattern of peripheral, hemorrhagic infarctions (Figure). Although the literature describes a spectrum of imaging findings, we hypothesized that a review of a large cohort of patients with thrombotic microangiopathy would uncover a unique imaging pattern, particularly given the advances in CT and MR imaging technology.

MATERIALS & METHODS
The electronic records at our institution from 1997 to the present (mid 2008) were searched for all patients diagnosed with one of the following thrombotic microangiopathies: thrombotic thrombocytopenic purpura (TTP), disseminated intravascular coagulation (DIC) and malignant hypertension. This patient list was cross-referenced with our imaging database to identify all patients with CT and/or MR imaging of the brain. Subsequently, all CT and/or MR images of the brain were reviewed and the findings documented.

RESULTS
The electronic record search yielded 623 patients with a diagnosis of thrombotic microangiopathy. Cross-referencing with the imaging database reduced the number to 249. These patients are categorized as DIC: 195, malignant hypertension: 48, primary thrombocytopenia: 19, and thrombocytopenia unspecified: 51. Of the 249 patients, five demonstrated a unique imaging pattern of peripheral, hemorrhagic infarctions; 1 demonstrated a pattern of peripheral infarctions without appreciable hemorrhage.

CONCLUSION
Early recognition of thrombotic microangiopathy is essential for appropriate patient disposition and management. Prompt treatment, in particular plasmaphoresis in cases of TTP significantly reduces morbidity and mortality. As neuroimaging assumes a more active role in the initial management and triage of patients, the neuroradiologist may be the first to raise the possibility of a thrombotic microangiopathy, with the potential to expedite hematologic evaluation. Thus an awareness of all imaging patterns is crucial. We present a unique imaging pattern, which expands the imaging spectrum of the thrombotic microangiopathies, thus facilitating early diagnosis.

KEY WORDS: Thrombotic microangiopathy, thrombotic thrombocytopenic purpura, peripheral hemorrhagic infarctions
**Paper 461 Starting at 2:26 PM, Ending at 2:34 PM**

**Consistency of Clinical Evaluation on Three Ischemic Signs in Patients with Hyperacute Cerebral Ischemia Observed by T2*-Weighted 3 T MR Imaging**

Harada, M.¹ · Morita, N.¹ · Uno, M.¹ · Nishitani, H.¹ · Kubo, H.¹ · Matsuda, T.²

¹University of Tokushima, Tokushima City, JAPAN, ²GE Yokogawa Medical Co. Ltd., Tokyo, JAPAN

**PURPOSE**

We have reported the three ischemic findings on gradient-echo type T2*-weighted images by 3 T MR imaging in patients with acute ischemic stroke. These were 1) cortical vessel sign (hypointensity and enlargement of the cortical vessels), 2) brush sign (hypointensity of of the deep white matter vessels) and 3) ischemic tissue sign (decreased intensity in the ischemic parenchyma). In this study, the evaluation of these signs was conducted by grading into four classes to determine presence or absence of the signs, and the consistency of individual observations were assessed by kappa statistics. In addition, the quantification of susceptibility effect caused by increase of deoxyhemoglobin was conducted and the obtained susceptibility map was compared to the T2*-weighted imaging and perfusion imaging. The purposes of this study are to evaluate the consistency of visual estimation for judge of ischemic signs and to compare the susceptibility map, T2*-weighted imaging and perfusion imaging.

**MATERIALS & METHODS**

The subjects were 24 patients with cerebral ischemic events (17 patients within 3 hours from onset, 7 within 12 hours). The gradient-echo type T2*-weighted imaging and spin-echo type T2-weighted imaging with double echo were obtained. The grading of visual estimation for three ischemic signs was conducted as follows; 1) definitely present (remarkable asymmetry), 2) likely present (recognized asymmetry), 3) equivocal (obscure asymmetry), 4) likely not present (no asymmetry). After the individual judgment by two observers, the consistency was evaluated by kappa statistics. The quantified map of the susceptibility effect was made following the equation after the correction of distortion in gradient-echo imaging; 1/T2'=1/T2*-1/T2. The T2' map and the perfusion images with FLAIR technique were generated. The asymmetry ratio between the ischemic and opposite sides was calculated on T2' map, T2*-weighted imaging and perfusion image.

**RESULTS**

The positive rate of ischemic tissue sign was lower than those of the other signs, but all of kappa values of three signs showed more than 0.70, indicating good consistency confirmed by statistical threshold (p<0.05). The positive cases of ischemic tissue sign revealed more hypoperfusion than that of the negative cases. T2' map showed smaller hypointense area than the hypoperfusion area, but larger than diffusion abnormality. By the evaluation between the decrease rates of T2' and perfusion, the decrease rate of T2' value was about 10% which was less than that of perfusion, but the high correlation (r=0.74) was found between T2' and T2* asymmetry ratios.

**CONCLUSION**

The observer’s bias would be small for the judgment of three ischemic signs on T2*-weighted imaging, and it suggests these findings can be used with acceptable consistency as clinical indices of acute ischemia. The T2' map would indicate increase of the susceptibility effect by deoxyhemoglobin and the high correlation of asymmetry ratio might show that T2*-weighted imaging reflects the density of deoxyhemoglobin in superacute phase, because T1 and T2 changes remarkably have not yet occurred.

**KEY WORDS:** Stroke, MRI, ischemia

**Paper 462 Starting at 2:34 PM, Ending at 2:42 PM**

**Evaluation of the Anisotropy of the Water Diffusion Tensor in Hyperacute, Acute and Subacute Stages of Brain Ischemia**

Albayram, S.¹ · Akan, M.² · Ceyhan, E.¹ · Gurbuz, D.² · Savas, Y.²

¹Istanbul University, Cerrahpasa Medical School, Istanbul, TURKEY, ²Haseki Training Research Hospital, Istanbul, TURKEY, ³Koc University, Istanbul, TURKEY

**PURPOSE**

Diffusion tensor imaging (DTI) studies of the human ischemic stroke within 48 hours of symptom onset have demonstrated various types of and forms of changes in diffusion anisotropy. Diffusion tensor imaging on different ischemia patients with different ischemic onset times may clarify these heterogeneous results. Our main goal in this study is to investigate the relationship between DTI results of cases at the three stages of cerebral ischemia, namely hyperacute, acute, or subacute stages of the illness.

**MATERIALS & METHODS**

We examined 24 cases of hyperacute and acute cerebral infarctions. Supratentorial white matter region was implicated in all of them. The interval between the onset of symptom and MR imaging was 3 to 8 hours (which is called the hyperacute stage) in seven cases, 8 to 48 hours (acute?) in seven cases, and between 48 hours and 96 hours (subacute?) in 10 cases. All examinations were performed on a 1.5 T superconductive system (Philips Achieva) using an 8-channel head coil. Single-shot spin-echo-planar imaging was performed to obtain diffusion tensor imaging applying diffusion weighting of b value of 1000 s/mm² in 14 different directions. The images were produced with TR/TE of 1000/70 ms, 224 mm FOV, 128×128 matrix, and 2 mm slice thickness. From the DTI data, fractional anisotropy (FA) and average diffusion coefficient (ADC) maps were generated, and FA, ADC within lesion region of interests (ROIs) and contralateral control ROIs were measured. For the analysis of DTI data from hyperacute, acute, and subacute ischemia patients, nonparametric tests (Kruskal-Wallis test for multigroup comparisons and Wilcoxon rank sum test for pairwise comparisons) are employed since assumption of normality (i.e., Gaussianity) and equality of the variances are violated by some groups. The data comprised of percent change in ADC and FA values.

**RESULTS**

It has been observed that the percent reduction in FA was (-
presence or absence of a susceptibility vessel sign (SVS), discharge. Pretreatment GRE sequences were rated for the nondisabled status (modified Rankin Scale (MCA occlusion, 2) treatment with the Merci Retriever, and at an academic medical center. Inclusion criteria were: 1) M1 occlusive intervention between January 2002 and October 2008 consecutive acute ischemic stroke patients treated with endovascular therapy. The effect of thrombus shape on outcome of endovascular recanalization therapy has reported that larger clot burden (length or volume) is associated with reduced recanalization rates. Thrombus size may be less influential in determining response to mechanical thrombectomy. The effect of thrombus shape on outcome of endovascular recanalization has not been studied previously. We hypothesized that GRE MRI thrombus appearance prior to angiograph may disclose key predictors of recanalization success.

MATERIALS & METHODS
We analyzed from a prospectively maintained database consecutive acute ischemic stroke patients treated with endovascular intervention between January 2002 and October 2008 at an academic medical center. Inclusion criteria were: 1) M1 MCA occlusion, 2) treatment with the Merci Retriever, and 3) pretreatment GRE. The primary clinical outcome was nondisabled status (modified Rankin Scale ≤ 2) at 7 days or discharge. Pretreatment GRE sequences were rated for the presence or absence of a susceptibility vessel sign (SVS), reflecting thrombus within a cerebral artery. In cases with SVS, the curvature, angulation, and length of the SVS were rated. Revascularization from the Merci procedure was rated on catheter angiograms using the Thrombolysis in Cerebral Infarction (TICI) score, Thrombolysis in Myocardial Infarction Recanalization (TIMI) score, Arterial Occlusion Lesion (AOL) score, and Qureshi scale. Primary analyses were of any recanalization (TICI 2-3) and substantial recanalization (TICI 2b-3).

RESULTS
Among the 65 patients meeting study criteria, mean age was 65 ± 20 years and 69% were female. Median pretreatment National Institutes of Health Stroke Scale (NIHSS) score was 18 (range 5-24). Mean time from onset to start of recanalization therapy was 325 ± 95 minutes (range 91-468). Forty-five of 65 patients (69%) had a SVS present. Rates of recanalization did not differ among those with and without a SVS sign. In patients with a SVS sign, the length of the SVS sign was mean 13.03±6.88 mm (range 5.66-34.91). Clot length did not differ among those with any recanalization vs no recanalization (13.30±6.94 vs 12.26±6.94, P = 0.657) or among those with and without nondisabled outcome (9.98±14.73 vs 14.13±7.43, P = 0.072). Based on curvature and angulation, irregular shape was present in 18 of the 45 patients with SVS (40%) and single, straight line shape in 27 (60%). Substantial recanalization was more frequent in patients with regular than irregular clot shape (56% vs 22%, OR = 0.23, P = 0.035) Multivariate logistic regression analysis showed that high NIHSS score (OR 0.71, P = 0.011) and irregular clot (OR 0.43) were independent predictors for a poor clinical outcome.

CONCLUSION
Irregular thrombus shape decreases the technical and clinical success of mechanical thrombectomy in M1 occlusions. In contrast, Retriever intervention outcomes are not strongly influenced by the volume or deoxyhemoglobin content of the clot to be cleared. Irregular shape indicates clot extension into multiple branches or a more tortuous target artery, complicating device access to the thrombus and clot retrieval.

PAPER 463 STARTING AT 2:42 PM, ENDING AT 2:50 PM
GRE Thrombus Shape Is More Important than Thrombus Size in Predicting Recanalization and Clinical Outcome of Acute Ischemic Stroke Patients Undergoing Mechanical Thrombectomy
Zhu, L. · Liebeskind, D. S. · Starkman, S. · Ovbiagele, B. · Pablo, V. · Jahan, R. · Saver, J. L. · for the UCLA Cerebral Recanalization Investigators
University of California Los Angeles
Los Angeles, CA

PURPOSE
Mechanical thrombectomy increases recanalization rates and may improve clinical outcome in acute stroke. Studies of intravenous thrombolytic therapy have reported that larger clot burden (length or volume) is associated with reduced recanalization rates. Thrombus size may be less influential in determining response to mechanical thrombectomy. The effect of thrombus shape on outcome of endovascular recanalization has not been studied previously. We hypothesized that GRE MRI thrombus appearance prior to angiograph may disclose key predictors of recanalization success.

PAPER 464 STARTING AT 2:50 PM, ENDING AT 2:58 PM
Iwata, T. · Mori, T. · Tajiri, H. · Nakazaki, M.
Shonan Kamakura General Hospital
Kamakura, JAPAN

PURPOSE
To anticipate high risk of hyperperfusion syndrome (HPS) following carotid angioplasty and stent placement (CAS) is useful for perioperative management. The purpose of our retrospective study was to find predictors of HPS before and immediately after CAS and to investigate the utility of single-photon emission computed tomography (SPECT) and
and immediately after CAS, (4) who underwent acetazolamide (ACZ) challenge test of 99mTc-ECD SPECT study before CAS and (5) who underwent TCCS study before and immediately after CAS. Regional cerebral blood flow (rCBF) by using 99mTc-ECD SPECT and mean blood flow velocity (mBFV) in the middle cerebral artery (MCA) by using TCCS were examined before and immediately after CAS. Clinical HPS was defined as symptoms as follows: (1) throbbing ipsilateral frontotemporal or periorbital headache and (2) at least one symptom of temporary deterioration of consciousness level, focal seizure and hemiparesis. Age, sex, degree of stenosis, hypertension (HT), hyperlipidemia (HL), diabetes mellitus (DM), asymmetry index (AI)=[rCBF in the affected hemisphere coupled with a carotid stenosis/rCBF in the contralateral hemisphere] before and immediately after CAS, AI change=(AI immediately after CAS-AI before CAS), AI ratio=(AI change/AI before CAS), regional activity-to-cerebellar activity (R/CE) ratio=(rCBF in the affected hemisphere coupled with a carotid stenosis/rCBF in the ipsilateral cerebellum hemisphere) before and immediately after CAS, R/CE ratio-change=(R/CE immediately after CAS-R/CE before CAS), R/CE ratio-ratio=(R/CE ratio-change)/(R/CE before CAS), CVR=[[(post-ACZ rCBF-resting rCBF)/resting rCBF], MCA mBFV in the affected hemisphere before CAS and MCA mBFV ratio=(MCA mBFV immediately after CAS in the affected hemisphere/MCA mBFV before CAS in the affected hemisphere) were assessed.

RESULT
Eighty consecutive patients underwent CAS and ten of them presented HPS after CAS. In TCCS study, the dropout rate due to an insufficient acoustic temporal bone window was 20% (16/80). Between HPS and non-HPS groups, there were significant differences in severe carotid stenosis, CVR and MCA mBFV in the affected hemisphere (p<0.05: Mann-Whitney U test) in the preoperative items, and significant differences in AI after CAS, AI change, AI ratio, R/CE ratio after CAS, R/CE ratio-change, R/CE ratio-ratio and MCA mBFV ratio (p<0.05: Mann-Whitney U test) in the postoperative items, although there were no significant differences in age, sex, HT, HL, DM, AI before CAS and R/CE before CAS. Logistic regression analysis showed that CVR [Odds ratio (95%CI); 0.674 (0.492-0.926), p=0.015] was the significant predictor among the preoperative items, and that MCA mBFV ratio [Odds ratio (95%CI); 9.696 (1.550-60.657), p=0.015] and R/CE ratio-change [Odds ratio (95%CI); 1.169 (1.018-1.342), p=0.027] were the significant predictors among the postoperative items.

CONCLUSION
Significant predictors of HPS were CVR before CAS and MCA mBFV ratio and R/CE ratio-change immediately after CAS. SPECT and TCCS studies are useful to predict HPS.

KEY WORDS: Cerebral hyperperfusion, CAS, SPECT and TCCS

Thursday Afternoon
1:30 PM – 3:00 PM
Ballroom A

(52c) Head & Neck: Degenerative/ Demyelinating/Metabolic Diseases II
(Scientific Papers 465 – 475)

Hippocampal Atrophy on 3 T MR Imaging Is a Marker of Cognitive Deterioration and Dementia in Parkinson Disease, Applicable with Automated Classification Procedures

Gómez-Ansón, B.1,2 · López-Mourelo, O.3,4 · Rotger, R.1 · Monte, G. C.2,4 · Pagonabarraga, J.1 · Llebaria, G.1 · Klöppel, S.1 · Granell, E.1
1Hospital Santa Creu i Sant Pau, Barcelona, SPAIN, 2PIC (IAFE), Universitat Autònoma, Barcelona, SPAIN, 3Fundació Recerca HSP, Barcelona, SPAIN, 4Universitat Autònoma, Barcelona, SPAIN, 5Fundació Clinic, Barcelona, SPAIN, 6Freiburg Universität, Freiburg, GERMANY

PURPOSE
Cognitive impairment eventually leading to dementia is integral to Parkinson disease (PD). Neuropsychologically, Parkinson disease with dementia (PDD) is characterized by neocortical cognitive deficits, added to progressive frontal-subcortical impairment. However, nondemented PD also patients may present “cortical-type” cognitive defects, suggesting that hippocampal atrophy (HA) may begin in earlier stages like the mild cognitive impairment (1,2). To explore the presence of HA on 3T MR imaging along the progression of cognitive impairment in PD, from intact cognition (CgInt), to MCI and PDD. To investigate the capacity of HA to discriminate between patients using automated classification procedures.

MATERIALS & METHODS
Prospective study of 46 PD patients (16 CgInt, 15 MCD, 15 PDD), matched for age and education. Cognitive impairment was assessed by the Clinical Dementia Rating scale (CDR),
and CDR1 and DSM-IV-TR criteria diagnosed dementia. Hippocampal volumes (HV) were calculated using ITK-SNAP (same observer; ICC=0.93; p=0.02) on 3T (Philips Intera 2.1) MR imaging (3DMPRAGE: TR=6.7; TE=3.1; Voxel 1x1x1.2; NSA=1). Statistical analysis included ANCOVA, correlation analysis (Spearman’s Rho), and a general lineal model (significance at p<0.01). Whole-brain voxel-based morphometry (VBM) analysis was performed (SPM5; MATLAB 7.0), searching for areas of grey matter volume loss (design matrix with 4 covariates -age, sex, UPDRS III, PD duration-, full factorial analysis). Furthermore, an automated classification procedure, the Support Vector Machine (SVM)(3) was implemented for separating PD without cognitive dementia and PDD using a VOI centered around the hippocampus.

RESULTS

ANCOVA analysis, with disease duration as a covariate, showed total HVs to be decreased selectively between cognitive groups (F 6.08; p <0.005). Post-hoc analysis showed right (p=0.01), left (p=0.003), and total HVs (0.006) to be decreased in patients with PDD compared to MCI and CgInt, but no differences were found between CgInt and MCI patients (Table). Two tailed bivariate correlations showed a tendency towards significance between total HVs and memory tests (Rho= 0.419; p= 0.006). Voxel-based morphometry analysis showed decreased gray matter concentration in both hippocampi, but more on the left (uncorrected p<0.005). SVM achieved an accuracy of around 70% for separating PDD from CgInt patients.

Table 1: HVs (cc3) normalized to intracranial volume

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<tr>
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<th>CgInt</th>
<th>MCI</th>
<th>PDD</th>
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<tbody>
<tr>
<td>Total HV</td>
<td>7.23 ± 0.66</td>
<td>7.15 ± 0.87</td>
<td>6.30 ± 0.44</td>
</tr>
<tr>
<td>Right HV</td>
<td>3.67 ± 0.34</td>
<td>3.62 ± 0.44</td>
<td>3.23 ± 0.22</td>
</tr>
<tr>
<td>Left HV</td>
<td>3.56 ± 0.33</td>
<td>3.53 ± 0.44</td>
<td>3.07 ± 0.23</td>
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</table>

CONCLUSION

Hippocampal atrophy is detected selectively in the transition from MCI to dementia, and seems a potential biomarker of cognitive deterioration in PD, that may be used with automated diagnostic procedures like SVM. Clinical heterogeneity within the MCI condition may be responsible for lack of significant HV differences between MCI and CgInt PD patients.

REFERENCES


Acknowledgment: This study was supported by SERAM 07; Spanish Ministry of Health (FISS PI 07/0770).

KEY WORDS: Parkinson disease, 3 T MRI, hippocampus

Paper 466 Starting at 1:38 PM, Ending at 1:46 PM

Sidero Tractography of Striatonigral Pathways in Parkinsonism and Parkinsonian Plus Syndromes at 3 T

Vadapalli, R.1 · Vadapalli, R.2 · Meena, A.3 · Rupam, B.1 · Manas, P.1
1Asiri Surgical Hospitals, Colombo, SRI LANKA; 2Vijaya Diagnostics and Research, Hyderabad AP India, INDIA; 3Nizam’s Institute of Medical Sciences, Hyderabad AP India, INDIA

PURPOSE

To evaluate the role of 3T MR siderotractography for characterization of Parkinsonism and Parkinsonian Plus syndromes.

MATERIALS & METHODS

Fifteen normal controls and 25 patients in age range of 55 - 75 years M:F ratio 3:2 were included in the study. The clinical categories were classical Parkinsonism (n=6); MSA-P (n=4); MSA-C(n=7); Shy-Drager’s syndrome (n=2); cortico basal degeneration (n=3); Progressive nuclear palsy (n=2); DLBD (1). All patients were imaged on a 3 T Achieva XR system (Philips Medical Systems, Netherlands) with movement disorder protocol followed by MR siderography sequence which is an isotropic susceptibility venous BOLD sequence with following parameters: GRSP TR 35 TE 22.9 NEX:1 Slice thickness 1mm matrix 232x128. Movement disorder also included a conventional diffusion tensor imaging (DTI) sequence with B value of 1000 and 25 directions to generate directional color-coded tractograms and which were fused with 3D venous BOLD images. The data then were used to reconstruct minimal intensity siderographic trajectories of striato nigral pathways in controls and patients. The venous BOLD susceptibility axial data were fused with DTI color-coded directionality data to depict Gullian Mollet triangle patterns (1,2,3). The following features then were evaluated: venous Bold and min IPRecons, 1. Thickness of pars compacta; 2. Red nucleus and substantia nigra susceptibility; 3. Hot cross bun sign; 4. Putaminal hypointensity; 5. Slit-like putaminal hyperintensity; 6. Dentate nuclear hypointensity; 7. Cortical subcortical hypointensity. DTI, 1. Thickness of transverse ponto cerebellar fibers; 2. Hot cross bun sign.

RESULTS

Brain iron rich areas in normal controls (n=15) and patients with PD (n=6) MSA P (n=4); MSA-C (7), Shy-Drager’s syndrome (n=2), CBD (n=3), PSP (n=2), DLBD (1) showed distinctive striato nigral patterns for characterization depicted as Pattern A, B, C and D respectively with aid of 3D susceptibility trajectories of striato nigral pathways. GM triangles were categorized as GM-1, GM-2, GM-3.
CONCLUSION
MR sidcorotragraphy with the four patterns of susceptibility signal characteristics of striato nigral pathways with fused DTI and 2D venous BOLD susceptibility image data to recon Gullian Mollet triangle patterns adds characterization information to differentiate Parkinsonism and MSA.

KEY WORDS: Siderotragraphy, striatrilgial pathways, Gullian Mollet triangle

Paper 467 Starting at 1:46 PM, Ending at 1:54 PM
Brain Changes on 3 T MR Imaging and MR Spectroscopy in Fragile X Premutation Carriers: Evidence for Prefrontal Dysfunction

Gómez-Anson, B.1,2 · López-Mourelo, O.3,4 · Pagonabarraga, J.1 · Monte, G. C.5,6 · Milá, M.6,7 · Rodríguez-Revenaga, L.6,7 · Sánchez-González, J.6 · De Juan, M.1
1Hospital Santa Creu i Sant Pau, Barcelona, SPAIN, 2PIC (IFAE), Universitat Autònoma, Barcelona, SPAIN, 3Fundació Recerca HSP, Barcelona, SPAIN, 4Universitat Autònoma, Barcelona, SPAIN, 5Fundació Clinic, Barcelona, SPAIN, 6Hospital Clínic, Barcelona, SPAIN, 7IDIBAPS, Universitat Autònoma, Barcelona, SPAIN

PURPOSE
To search for brain changes on 3T MR imaging and spectroscopy (MRS) in fragile X premutation carriers (FXpre), with or without the fragile X tremor ataxia syndrome (FXTAS), and their correlation to cognition.

MATERIALS & METHODS
Prospective study of 34 subjects (21 FXpre, aged 33-80, and 13 controls), matched for age and sex. 3T (Philips Intera 2.1) MR imaging included 3D FLAIR (TR=8000; TE shortest; IR=2400; NSA=1; Voxel 1x1x0.6), 3D MPRA (TR=6.7; TE=3.1; Voxel 1x1x1.2; NSA=1), MRS (SVS 1H-MRS PRESS TR=2000; TE=38; NSA=128; VOI=20x20x20), and dedicated SVS 1HMR Glutamate and GABA editing technique(1) (T/R coil, SVS 1H-MRS MEGA-PRESS TR=2000; TE=73; NSA=128; VOI=20x30x30). Metabolite concentrations obtained from prefrontal and left dorsolateral VOIs were quantitated using the LC Model. MR imaging findings as previously described(2) were assessed. Neurologic and neuropsychologic evaluations (executive, memory, attention, global intelligence, and conductual symptoms) were performed. Statistical analysis included group comparisons (Student’s t-test and one-way ANOVA), and regression analysis (Spearman’s Rho; significance at p=0.05).

RESULTS
MR imaging findings were: middle cerebellar peduncle, brainstem, and cerebral white matter hyperintensities, cerebellar, brainstem and cerebral atrophy. In the prefrontal region, glutamate values were reduced significantly in FXpre compared to controls (Fxpre: 216 ± 88; C: 314 ± 130; p=0.017), similarly to CrPCr levels (Fxpre: 5.3 ± 0.7; C: 5.9 ± 0.4; p=0.01). Additionally, there was a tendency (p=0.075) for reduced NAA+NAAG levels in the prefrontal region in FXpre (6.2 ± 0.8; p=0.075) compared to controls (6.7± 0.7). On neuropsychology, there was evidence of dysfunction in FXpre in prefrontal (Frontal System Behavior Scale, FrSBe: FXpre: 58.43 ± 10.3; p=0.08 vs C: 49.33 ± 5.4) and left hippocampal (Auditory Verbal Learning Test, AVLT; FXpre: 9.52 ± 3.7; p=0.03 vs C: 12.17 ± 1.9) cognitive performances. No differences were found in metabolite levels in the left dorsolateral prefrontal region. On regression analysis, glutamate correlated to Cr+PCr concentrations in the prefrontal region. Glutamate also correlated to neuropsychologic performance (Table).

| Category | SNPC Thickness | Cross Sign | MCP Thickness | Cortical Susceptibility | Dementic Nuclear Susceptibility | Putaminal Hypointensity | Scl-like Hypointensity of Putamal
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<tbody>
<tr>
<td>Control</td>
<td>Athritis</td>
<td>More than 0.05</td>
<td>Absent</td>
<td>Absent</td>
<td>Absent</td>
<td>Absent</td>
<td>Absent</td>
</tr>
<tr>
<td>Parknism</td>
<td>Mean 1.4mm Absent (n=3)</td>
<td>Symmetrical</td>
<td>Mean 0.836</td>
<td>Present</td>
<td>Present</td>
<td>Absent</td>
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<tr>
<td>Pattern A</td>
<td>Mean 1.4mm Absent</td>
<td>1.0-1.5cm Absent</td>
<td>Mean 1166</td>
<td>Present</td>
<td>Present</td>
<td>Absent</td>
<td></td>
</tr>
<tr>
<td>Pattern B</td>
<td>Mean 2.0mm Positive</td>
<td>5mm-10mm Absent</td>
<td>1200-1400</td>
<td>Present</td>
<td>Present</td>
<td>Absent</td>
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</tr>
<tr>
<td>Pattern C</td>
<td>Cross sign</td>
<td>CRGID/PSP: 3.1mm Absent</td>
<td>Dorsolateral</td>
<td>Asymmetrical</td>
<td>Present</td>
<td>Mean 1101-1200</td>
<td>Not Marked</td>
</tr>
<tr>
<td>Pattern D</td>
<td>Cross sign</td>
<td>Dorsolateral</td>
<td>Asymmetrical</td>
<td>Present</td>
<td>Mean 1101-1200</td>
<td>Not Marked</td>
<td>Not marked</td>
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<table>
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<tr>
<th>Material</th>
<th>Glutamate</th>
<th>Spearman’s correlations</th>
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<tbody>
<tr>
<td>Cr+PCr</td>
<td>Rho=0.39; p=0.039</td>
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<tr>
<td>FrSBe (Frontal System Behavior)</td>
<td>Rho=0.34; p=0.07</td>
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<tr>
<td>FrSBe (Dysexecutive Subscale)</td>
<td>Rho=0.371; p=0.047</td>
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<tr>
<td>FAB (Frontal Assessment Battery)</td>
<td>Rho=0.39; p=0.038</td>
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CONCLUSION
There are brain changes on MR imaging and MRS already present in FXpre, involving mainly the prefrontal region. These reflect neuropsychologic impairment of related brain functions. 3T MR imaging and MRS seem to provide in vivo biomarkers of the fragile X premutation, which may prove to be clinically useful.

REFERENCES

Acknowledgment: This study was supported by Spanish Ministry of Health (FISS PI 07/ 0770).

KEY WORDS: Premutated fragile X carriers, 3 T MRI, spectroscopy

Paper 468 Starting at 1:54 PM, Ending at 2:02 PM
Diffusion Tensor Imaging of Corpus Callosum Integrity in Multiple Sclerosis: Correlation with Disease Variables

Tal, S. · Achiron, A.
Sheba Medical Center Ramat-Gan, ISRAEL

PURPOSE
To investigate the relation between the corpus callosum (CC) volume and diffusion tensor imaging (DTI) parameters in multiple sclerosis (MS) patients and healthy subjects and further identify imaging parameters that specifically corre-

<table>
<thead>
<tr>
<th>MATERIAL</th>
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<tr>
<td>Control</td>
<td>Athritis</td>
</tr>
<tr>
<td>Parknism</td>
<td>Mean 1.4mm Absent (n=3)</td>
</tr>
<tr>
<td>Pattern A</td>
<td>Mean 1.4mm Absent</td>
</tr>
<tr>
<td>Pattern B</td>
<td>Mean 2.0mm Positive</td>
</tr>
<tr>
<td>Pattern C</td>
<td>Cross sign</td>
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<tr>
<td>Pattern D</td>
<td>Cross sign</td>
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late with clinical disease variables. The thickness of CC reflects the underlying integrity of neuronal cell bodies, synaptic connections, and myelination of fibers. Conventional MR imaging in MS patients demonstrates CC atrophy. Diffusion tensor imaging measures the directionality and magnitude of water diffusion and further indicates abnormalities within tissue organization. Thus, DTI analysis of the CC integrity may provide new insights into its microstructural damage.

**MATERIALS & METHODS**

Thirty MS patients (16 females, age 36.8 ± 2.4 years, disease duration 6.4 ± 1.1 years, EDSS 1.9 ± 0.3) and 10 age- and sex-matched healthy subjects were evaluated. Corpus callosum volume was measured on 3.0 T brain MR imaging using the MSAnalyze software. Diffusion tensor imaging data were acquired by single shot echo-planner imaging sequence, along 31 independent directions (TE 75 ms, TR 14000, B value 1000 s/mm², FOV 240x240 mm, matrix 128x128, slice thickness 2.6 mm, no gap). Diffusion tensor imaging metrics of fractional anisotropy (FA), mean diffusivity (ADC), longitudinal (E1) and transverse (E2, E3) diffusivity were obtained and analyzed by DTI-studio software.

**RESULTS**

Corpus callosum volume was significantly reduced in MS patients compared to healthy subjects, 6.9 cm³ and 8.36 cm³ respectively, p = 0.0402. FA, E1, E2 and E3 also significantly differed in MS patients and healthy subjects. In MS patients, ADC (r = 0.62, p = 0.0004), E1 (r = 0.55, p = 0.0020), E2 (r = 0.60, p = 0.0007), and E3 (r = 0.63, p = 0.0002) inversely correlated with CC volume, while FA (r = 0.56, p = 0.0018) positively correlated with CC volume. Disease duration, EDSS, and relapse rate significantly correlated with ADC (r = 0.44, p = 0.02, r = 0.57, p = 0.001, r = 0.41, p = 0.03) and E3 (r = 0.41, p = 0.02, r = 0.56, p = 0.001, r = 0.43, p = 0.02). Disease duration and EDSS significantly correlated with E1 (r = 0.46, p = 0.01, r = 0.51, p = 0.005). EDSS, and relapse rate significantly correlated with E2 (r = 0.55, p = 0.002, r = 0.42, p = 0.02). EDSS inversely correlated with FA (r = 0.46, p = 0.01). No correlations were found between CC volume and disease parameters.

**CONCLUSION**

Corpus callosum volume and DTI parameters differentiate between MS patients and healthy subjects. Corpus callosum DTI parameter’s, especially ADC and E3, are better to detect MS disease activity than CC volume.

**KEY WORDS:** DTI, Multiple sclerosis, corpus callosum

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**Paper 469 Starting at 2:02 PM, Ending at 2:10 PM**

**Evaluating Normal-Appearing Thalamus in Multiple Sclerosis with Apparent Diffusion Coefficient**

White, M. L. · Zhang, Y. · Healey, K. · Helvey, J. T. · Omojola, M. F. · Poage, D. P. · Hahn, F. J.

University of Nebraska

Omaha, NE

**PURPOSE**

Thalamic involvement in multiple sclerosis (MS) has been proven by neuroimaging and neuropathology. The purpose of this study is to determine if apparent diffusion coefficient (ADC) analysis may demonstrate abnormalities within the thalamus that are not detectable by conventional imaging.

**MATERIALS & METHODS**

A retrospective analysis was performed of 46 patients who met MS diagnostic criteria and had undergone MR (GE HDX, 8 channel head coil) including diffusion-tensor imaging (DTI). Forty-three patients had a relapsing-remitting course, two had a secondary progressive course, and one had clinically isolated syndrome. The median Expanded Disability Status Scale (EDSS) score was 2.23 (range, 0 to 8) and the disease duration ranged from 1 to 25 years. Regions of interests (ROIs) were drawn in the anterior, central, and posterior regions of normal appearing thalamus. These ROIs were confirmed on DTI tractograms to be the seed ROIs of anterior, superior, and posterior thalamic radiations, respectively. Apparent diffusion coefficient values were measured and compared with 27 healthy controls who were matched age and sex.

**RESULTS**

The mean ADC values for thalamus were 7.457 x 10⁻⁴ mm²/s (right) and 7.778 x 10⁻⁴ mm²/s (left) in patients and 7.324 x 10⁻⁴ mm²/s (right) and 7.594 x 10⁻⁴ mm²/s (left) in controls (P<0.05). The Mean ADC value for each part of thalamus (anterior, central, or posterior) in the patients was not significantly different compare to the controls. No ADC correlation was found related to the severity of imaging abnormalities (lesion numbers and sizes, atrophy, and diffuse white matter changes) in the corresponding cerebral areas (frontal lobe, premotor and primary motor cortex, or parietal and occipital lobes). In addition, no significant correlation was found between ADC values and patient age, clinical features (EDSS score), or disease duration.

**CONCLUSION**

Apparent diffusion coefficient values failed to demonstrate thalamic injury that would otherwise be undetected by conventional imaging. No increased water diffusion in the thalamus in patients with MS was found as previously reported.

**KEY WORDS:** Multiple sclerosis, apparent diffusion coefficient, thalamus

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**Paper 470 Starting at 2:10 PM, Ending at 2:18 PM**

**Imaging and Clinical Differentiation of Neuromyelitis Optica from Multiple Sclerosis following Discovery of Aquaporin 4**

Sidhu, G. · Glastonbury, C. M.

University of California San Francisco

San Francisco, CA

**PURPOSE**

Until recently, neumyelitis optica (NMO) or Devic’s disease, was considered a variant of multiple sclerosis (MS). With the discovery in 2004 of an autoantibody relatively specific for NMO, however, there has been great progress in characterizing NMO as a unique clinicopathologic entity with a different pathophysiology from MS and different therapeutic implications. As such, early and accurate diagnosis of NMO has become important. This work describes the...
spectrum of imaging findings seen in antibody-positive NMO and contrasts this with the traditional radiologic description of NMO and with the findings of MS. New insights into the pathophysiology and treatment of NMO also are reviewed.

**Materials & Methods**

A search of all neuroradiology reports generated at our institution from 2003 to the present using targeted keywords (myelitis, Devic, neuritis) resulted in a list of 2076 cases. Review of the clinical data for these cases yielded 11 patients with evidence of brain or spine imaging abnormality with proved antibody-positive NMO. The scans for these patients were reviewed and the frequency, location and appearance of spine and brain imaging findings was determined. These findings were compared to 100 consecutively imaged patients with the firm clinical diagnosis of MS.

**Results**

Of the 11 antibody-positive NMO patients, 10 had brain MR imaging and 10 had spine MR imaging. Of those with spine imaging, all 10 had imaging features of myelitis extending over a length of greater than two vertebral bodies. For eight of these cases, the intramedullary T2 prolongation could be characterized as central or holocord whereas in the control MS group, this pattern of cord involvement was rare and was more frequently focal peripheral areas of T2 signal with or without enhancement. Of the 10 patients with myelitis who also had brain imaging, only three patients had MR evidence for optic neuritis. Four of 10 imaged brains demonstrated focal “periependymal” or hypothalamic T2 signal abnormality. Characteristic callosal and “Dawson’s fingers” demyelinating brain lesions of MS typically were not found in the NMO group.

**Conclusion**

The last 4 years have shown significant progress in the understanding of the pathophysiology of NMO such that it is considered a distinct entity from MS. Isolated spinal cord disease and isolated recurrent optic neuritis now are included in the diagnostic spectrum of NMO. Cord disease is characterized centrally or holocord, and covers multiple vertebral body levels. The presence of hypothalamic or “periependymal” T2 abnormality appears to be a relatively specific finding for NMO, and corresponds to the distribution in the brain of the known target of the NMO autoantibody, a water conducting membrane channel, Aquaporin 4. The identification by the radiologist of these patterns of CNS involvement may allow for earlier diagnosis and therefore institution of specific NMO treatment.

**Key Words:** Devic, neuromyelitis optica, Aquaporin

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**Paper 471 Starting at 2:18 PM, Ending at 2:26 PM**

**Optic Radiation Diffusion Tensor Imaging Measures of White Matter Integrity Inversely Correlate with Visual Acuity in Multiple Sclerosis**

Bermel, R. A. · Lin, J. · Sakaie, K. · Frost, N. · Cohen, J. A. · Lowe, M. J. · Phillips, M. D.

‘Cleveland Clinic, Cleveland, OH, ‘Dean Neurosciences, Madison, WI

**Purpose**

There are generally poor correlations between lesion load measures on MR imaging and composite disability measures in multiple sclerosis (MS), attributed to the lack of specificity of both whole-brain MR imaging and clinical metrics. Restricting imaging experiments to single anatomic pathways where structure and function can be quantified specifically may provide insights into MS pathogenesis and yield outcome measures for testing neuroprotective therapies. Diffusion tensor imaging (DTI) provides one method which may provide stronger correlations between structure and function. We applied DTI to the optic radiation (OR) in patients with MS.

**Materials & Methods**

Fourteen patients with a prior history of unilateral optic neuritis underwent DTI, optical coherence tomography (OCT), and visual acuity testing with a 2.5% contrast (gray-on-white) Sloan chart during a single study visit. Retinal nerve fiber layer thickness (RNFLT) was quantified using Zeiss Stratus OCT by the Fast RNFL protocol. Diffusion tensor imaging measurements were performed on a Siemens TIM Trio with a standard 12-channel head coil. HARDI data were acquired with a twice-refocused spin echo (TE/TR=102/7700msec, 128x128x48 matrix, FOV=256x256x96mm), 71 b=1000 sec/mm² acquisitions with gradient directions selected by a coulomb repulsion algorithm, and 8 b=0 acquisitions at equally spaced intervals. Motion correction was performed using FSL. Spherical deconvolution, with regularization optimized by generalized cross validation, was performed in each voxel to estimate fiber orientation. Regions of interest (ROI) were manually drawn on the lateral geniculate nucleus and occipital cortex using AFNI, which served as seed points and targets for OR fiber tracking. Probabilistic tracking between seed and target regions was performed. The number of tracks intersecting a given voxel is used to estimate connectivity between that voxel and the seed/target regions. An anatomical white matter mask was applied for each individual patient.

**Results**

Longitudinal diffusivity (r=-0.63, p=0.008) and transverse diffusivity (r=-0.49, p=0.038) in the OR correlated inversely with visual function measured by Sloan low-contrast letter acuity eye chart (Figure). There was a trend but no significant correlation with fractional anisotropy. No significant correlations were observed between retinal thickness and visual acuity or retinal thickness and DTI measures.
CONCLUSION
Diffusion tensor imaging measures in the optic radiations correlate with clinical function in patients with MS and may represent a measure to quantify structural integrity in the visual system. Future studies will address whether these changes affect the visual system preferentially versus a diffuse process affecting all cerebral white matter.

KEY WORDS: Multiple sclerosis, diffusion tensor imaging, visual

Paper 472 Starting at 2:26 PM, Ending at 2:34 PM
Differentiation of Tumefactive Demyelinating Lesions and High-Grade Glioma by Diffusion Tensor Imaging
Liu, X. · Tian, W. · Ekholm, S.
University of Rochester School of Medicine & Dentistry Rochester, NY

PURPOSE
It is important to differentiate between tumefactive demyelinating lesions (TDLs) and high-grade gliomas to avoid unnecessary surgical procedures. However, this can be difficult on conventional MR imaging alone. Although MR perfusion-weighted imaging has been reported to improve the accuracy of the diagnosis, this technique is limited in clinical practice since some patients cannot handle the rapid bolus injection. The aim of this study was to evaluate if diffusion tensor imaging (DTI), can be of help in differentiating between TDLs and high-grade gliomas.

MATERIALS & METHODS
We gathered 11 cases with tumefactive demyelinating disease diagnosed through a combination of laboratory tests, clinical outcome and follow-up imaging for retrospective review. Another 11 patients with morphologically imaging-matched and pathology confirmed high-grade gliomas were used for comparison. The trace apparent diffusion coefficient (trace ADC) and fractional anisotropy (FA) calculated in enhancing and unenhancing TDLs as well as in enhanced and centrally unenhanced tumor portions. The main eigenvector of ROIs in perilesional and contralateral regions were assessed. Tractography fiber seeds through the lesions were generated from Trackvis 0.4.2, and the fiber density ratio (ratio of fibers amount/seed ROI voxel numbers) was compared between TDL and glioma groups. Differences were analyzed with a nonparameter Mann-Whitney test.

RESULTS
The mean FA value of the enhancing TDLs was 0.193±0.07 and the unenhancing TDLs was 0.214±0.04. In contrast, the mean FA value of the enhanced high-grade gliomas was 0.131±0.03 and 0.131±0.04 in the unenhancing tumor portions. There was a significant difference of mean FA values between the enhancing high-grade gliomas and the enhanced TDLs (P=0.005) as well as between unenhancing high-grade glioma regions and unenhanced TDLs (P=0.000). The mean trace ADC value of the enhancing TDLs was 1.048±0.17 and the mean trace ADC value of the unenhancing TDLs was 1.042±0.22 which should be compared with the mean trace ADC value of the enhancing high-grade gliomas of 1.12±0.23 and of 1.53±0.26 in unenhancing high-grade gliomas. There was no significant difference of mean trace ADC values between enhancing TDL and high-grade gliomas, but the mean trace ADC of unenhancing high-grade gliomas was significantly higher than unenhancing TDLs (P=0.000). The main eigenvector in peri-TDL regions was similar to the contralateral ROIs, while the main eigenvector in peri-tumoral regions was changed significantly (P<0.01), indicating tumor infiltration and vasogenic edema. The fiber density ratio in the high-grade gliomas was significantly lower than in the TDL group, indicating sever tumor destruction and displacement.

ConCLUSION
Diffusion tensor imaging can be useful to assist in differentiating between TDLs and high-grade gliomas.

KEY WORDS: Tumefactive demyelinating lesion, glioma, diffusion

Paper 473 Starting at 2:34 PM, Ending at 2:42 PM
Longitudinal Imaging of Myelin Repair and Axonal Loss in Multiple Sclerosis
Fox, R. J. · Cronin, T. · Lin, J. · Wang, X. · Sakaie, K. · Lowe, M. J. · Phillips, M. D.
Cleveland Clinic Foundation Cleveland, OH

PURPOSE
Evaluate the long-term changes in diffusion tensor imaging (DTI) in multiple sclerosis (MS) patients starting highly effective anti-inflammatory therapy. Diffusion tensor imaging (DTI) is an MR imaging measure of brain tissue integrity and is an attractive metric for use in clinical trials evaluating neuroprotective agents. Pathology-imaging correlation studies suggest that longitudinal diffusivity (parallel to fiber tracts, λ₁) represents axonal integrity, while transverse diffusivity (across fiber tracts, λ₂) represents myelin integrity (1,2). Little is known about the responsiveness of DTI metrics to anti-inflammatory MS therapies.

MATERIALS & METHODS
Nineteen MS patients starting natalizumab were imaged serially for 1 year. Imaging was performed on a 3T Siemens Trio. Diffusion-weighted imaging used 71 noncollinear diffusion-weighted gradients (2.5 x 2.5 x 2.5mm voxels, b=2000sec/mm², 8 b=0 acquisitions). Anatomical imaging was performed for lesion detection and coregistration. Gad lesions and 20 normal-appearing white and gray brain tissue (NABT) regions of interest (ROIs) were outlined on each baseline image set. Regions of interest were followed using FSL and AFNI software. Average values within each ROI were derived for fractional anisotropy (FA), mean diffusiv-
ity (MD), \( \lambda_c \), and \( \lambda_L \). Analysis was performed using mixed model regression analysis.

**Results**
At baseline, 11 of 19 patients demonstrated a total of 60 (median = 5) gadolinium-enhancing lesions. Over 1 year, FA increased in gad lesions (2.10/month), but decreased in NABT (-2.13 \( \times 10^{-6} \) mm\(^2\)/sec/month, \( p<0.0001 \)). Changes in FA were driven by decreased \( \lambda_L \) in gad lesions (-1.95 \( \times 10^{-6} \) mm\(^2\)/sec/month, \( p<0.001 \); NABT was n.s.), but decreased \( \lambda_L \) in NABT (-2.13 \( \times 10^{-6} \) mm\(^2\)/sec/month, \( p=0.0001 \); gad lesions was n.s.). MD decreased in both gad lesions (-1.11 \( \times 10^{-6} \) mm\(^2\)/sec/month, \( p=0.03 \)) and NABT (-0.54 \( \times 10^{-6} \) mm\(^2\)/sec/month \( p=0.01 \)), but was greater in gad lesions (\( p=0.003 \)).

**Conclusion**
The results are consistent with short-term remyelination within acute lesions and long-term axonal degeneration in normal appearing white matter. These results also suggest that DTI may provide pathology-specific insights into MS. Two-year follow-up is underway.

**References**

**Key Words:** multiple sclerosis, diffusion tensor imaging, therapy

**Paper 474 Starting at 2:42 PM, Ending at 2:50 PM**
**MR Imaging and Clinical Measures in the Assessment of the Response to Interferon Beta in Multiple Sclerosis**

Rovira, A. · Rio, J. · Huerga, E. · Tintoré, M. · Sastre-Garriga, J. · Aymerich, X. · Montalban, X.
Hospital Vall d’Hebron
Barcelona, SPAIN

**Purpose**
Several criteria for treatment response to interferon (IFN) beta have been proposed although there is no consensus among different investigators. Hence, the aim of this study was to investigate MR imaging and clinical predictors of response during the first months of therapy in relapsing-remitting multiple sclerosis (RRMS) patients.

**Materials & Methods**
This is a prospective and longitudinal study of RRMS patients treated with IFN beta. All patients included underwent brain MR imaging before the onset of therapy, and 12 months after, and a neurologic assessment every 3 or 6 months. Patients were classified based on the presence of new lesions, relapses, disability increase or combinations of all these variables after 1 year of therapy. Regression analysis was performed in order to identify variables of response after a follow up of 3 years.

**Results**
We included 222 RRMS patients. After 1 year of therapy 23% of the patients had relapses, 15%, had increase of disability and 32% had more than two active lesions. The logistic model demonstrated that only the combination of new active lesions with the presence of relapses (OR 4.4; 95% CI 1.6-12.5) or disability progression (OR 7.1; 95% CI 1.6-33.9), or both (OR 6.5; 95% CI 1.9-23.4) achieved significant values to identify those patients with a poor outcome.

**Conclusion**
In RRMS patients treated with IFN beta the combination of measures of disease activity and the presence of new active lesions may have a prognostic value for identifying patients with a poor outcome within the ensuing years of therapy.

**Key Words:** Multiple sclerosis, MR imaging

**Paper 475 Starting at 2:50 PM, Ending at 2:58 PM**
**Changes in Brain Volume and T2 Lesion Load Following Liver Transplantation over a 8-Year Period**

Rovira, A. · Garcia-Martinez, R. · Alonso, J. · Huerga, E. · Cordoba, J.
Hospital Vall d’Hebron
Barcelona, SPAIN

**Purpose**
Several factors such as prior hepatic encephalopathy (HE) or neurologic impairment associated to vascular risk factors could cause a decrease in brain volume following liver transplantation (LTx). The aim of this study was to assess brain volume changes at long term following LTx.

**Materials & Methods**
Thirty-five patients who underwent LTx between April 1998 and December 2001 were included in a prospective study. Eighteen alive patients (age: 65±8 years, 16 males, HCV: 9, alcohol: 4, HCV+alcohol 4, others: 1) with good liver function (ALT 44±35 IU/L, bilirubin 0.7±0.3 mg/dl, INR 1±0.1) were reassessed after 7.7 years. Patients were studied shortly before LTx (pre-LTx), 6-12 months (short-term post-LTx) and 7-10 years after LTx (long-term post-LTx). MR imaging measured the volume of ventricles (VV), an indirect index of brain volume and volume of focal white matter lesions (FWML), an index of small vessel cerebrovascular disease. Neuropsychologic tests evaluated attention (Symbol digit), motor function (Grooved Pegboard), executive function (Hooper) and memory (Auditory Verbal Learning).

**Results**
1) Short-term post-LTx (short post-LTx vs pre-LTx): The VV (cm\(^3\)) increased by 14.8%. Fourteen patients exhibited FWML that decreased the volume by 36.6%, which can be explained by reversible brain edema in these areas. Neuropsychologic tests improved indicating reversal of minimal hepatic encephalopathy. No association was found.
between change in VV and HE prior to LTx. In contrast, the decrease in FWML showed a tendency to be higher in those with prior HE. 2) Long-term post-LTx (long vs short post-LTx): The VV increased by 23.4% and the volume of FWML increased by 80.6%. Neuropsychologic tests remained stable, except for memory that showed deterioration. Among patients with larger changes in FWML (>15%) pharmacologic treatment for arterial hypertension was more common (88% vs 33%, p=0.05) and creatinine tended to be higher (1.37±0.21 vs 1.19±0.15 mg/dl, p=0.06).

CONCLUSION
Following LTx patients develop a decrease in brain volume despite a successful outcome of liver function. The initial decrease probably reflects disappearance of brain edema related to HE. The decrease at long term is part of a degenerative process in part caused by small vessel cerebrovascular disease. Adequate control of vascular risk factors appears critical to prevent neurologic deterioration following LTx.

KEY WORDS: Hepatic encephalopathy

Thursday Afternoon
1:30 PM – 3:00 PM
Room 1

(52d) Pediatric: Developmental/ Congenital Malformations
(Scientific Papers 476 – 486)

See also Parallel Sessions
(52a) Head & Neck: Temporal Bone & Skull Base
(52b) Adult Brain: Cerebrovascular Occlusive Disease II
(52c) Adult Brain: Degenerative/Demyelinating/ Metabolic Diseases II

Moderators: Orit A. Glenn, MD
Linda A. Heier, MD

Paper 476 Starting at 1:30 PM, Ending at 1:38 PM
Intracranial Abnormalities Detected by Magnetic Resonance Imaging in Prader-Willi Syndrome and Early-Onset Morbid Obesity

Schmaffuss, I. M. • Miller, J. L. • Liu, Y. • Guojun, H. • Couch, J. A. • Driscoll, D. J.
University of Florida
Gainesville, FL
SENRS Winner

Introduction: Childhood obesity has become an epidemic with more than 30% of children in the United States being overweight. Only a minority of patients suffer from a well-defined, genetic disorder causing childhood obesity such as Prader-Willi Syndrome (PWS). In the majority of patients, the etiology of the early onset morbid obesity is unknown (EMO).

Method: Three-dimension T1 and conventional FLAIR weighted MR images of 17 PWS patients (7 months to 39 years) were compared with 18 age and gender matched individuals with EMO and 21 normal weight siblings of both groups. The interpreters of the scans were blinded to the diagnosis.

Results: MR findings observed in individuals with PWS included white matter lesions, pituitary gland abnormalities, parieto-occipital lobe atrophy and Sylvian fissure polymicrogyria. In contrast, EMO patients had only white matter lesions and pituitary gland abnormalities, while none of the normal weight controls had any of these findings. Some of these findings were already present in the youngest patients while others (parieto-occipital lobe atrophy and white matter lesions) were only observed in older patients. A trend was seen between severity of obesity and development of white matter lesions.

Conclusion: The frequent and delayed occurrence of parieto-occipital lobe atrophy in the PWS patients and of white matter lesions in both groups may represent accelerated changes of brain aging starting as early as 3 years of age in case of parieto-occipital lobe atrophy and 12 years of age in case of white matter lesions. The trend seen between severity of obesity and early development of white matter lesions is heightening the public health concerns of the obesity epidemic in childhood.

KEY WORDS:
cortical ribbon distortion, by two pediatric neuroradiologists in consensus. Gestational age ranged between 21 and 24 weeks (average 22.3, sd 1.07 weeks). In 11 cases postnatal MR imaging, MR autopsy, or pathology follow up was available, while in 11 cases no follow-up data on brain structure could be collected (mostly because impossibility to collect the brain after pregnancy termination); in one of the latter cases molecular genetic analysis confirmed the diagnosis of tuberous sclerosis.

RESULTS
We identified four basic patterns of cortical rim anomaly: “wart-like” (8 cases), “saw-tooth” (6 cases), major aberrant invaginating sulci/i (6 cases), and single or multiple bumps (3 cases). All anomalies already were detectable when the brain was still smooth (“physiologic lissencephaly”). The “wart-like” and “saw-tooth” patterns were confirmed to be focal polymicrogyria when follow up was available. In “wart-like” and in aberrant sulci cases the anomaly became more complex along with gyration process. A bump anomaly turned to be a cortical tuber at very early stage of development. All cases were associated with additional brain anomalies: callosal agenesis, focal parenchyma volume reduction, septum pellucidum agenesis, periventricular nodular heterotopias, focal thinning of subplate layer or intermediate layer, germinal matrix-ganglionic eminence hypertrophy, cerebellar hypoplasia, micro or macrocephaly, borderline ventriculomegaly. Four cases were probably on genetic basis, four very probably of hypoxic-ischemic and infective (3) origin; 11 cases were of unknown cause.

CONCLUSION
The present cohort shows how focal cortical gyration anomalies can be detected even at very early sulcation process stage. Most of these cases presented similarities to rat model of experimental polymicrogyria. Moreover, these cases showed how polymicrogyria and aberrant sulci grow along with brain maturation. Finally, the thinning of the subplate and of intermediate layer of cerebral mantle, noticed in some fetuses, suggests that failure in the framework sustaining the cortical plate may be also relevant in the pathophysiology.

KEY WORDS: fetal MRI, cortical malformation, brain development

Paper 478 Starting at 1:46 PM, Ending at 1:54 PM
Diffusion Tensor Imaging Detection of Alterations in Tissue Microstructure Adjacent to Focal Cortical Dysplasia

Widjaja, E. · Zarei Mahmoodabadi, S. · Otsubo, H. · Snead, O. · Holowka, S. · Bells, S. · Raybaud, C.
Hospital for Sick Children
Toronto, ON, CANADA

PURPOSE
Malformations affecting the cortex are likely to affect the underlying white matter. The aims of this study were to determine whether diffusion tensor imaging (DTI) changes were present in the (a) subcortical white matter subjacent to MR visible focal cortical dysplasia (FCD), (b) subcortical white matter beyond the MR visible abnormality but subjacent to magnetoencephalography (MEG) dipole cluster and (c) deep white matter tracts.

MATERIALS & METHODS
Fifteen children consisting of six boys and nine girls, mean age of 11.6 years (range 3.6 - 18.3 years), with MR diagnosis of FCD and intractable epilepsy had DTI and MEG. The axial T2-weighted images were first coregistered onto b=0 images. Subsequently, the MEG spike sources that were transposed onto axial 3D T1 images then were coregistered onto T2-weighted images. MEG clustered dipoles previously have been shown to correspond to the epileptogenic zone and therefore were used to determine the extent of electrophysiologic abnormality of FCD. Regions of interest were placed in the (a) subcortical white matter subjacent to MR visible abnormality and contralateral side, (b) subcortical white matter beyond the MR visible abnormality but subjacent to MEG dipole cluster and contralateral side, and (c) deep white matter projecting to/from the MR visible FCD and contralateral side. The fractional anisotropy (FA), mean diffusivity (MD) and eigenvalues (λ1, λ2, λ3) in the subcortical white matter and deep white matter tracts, and fiber density index (FDI) of the deep white matter tracts were assessed.

RESULTS
Eleven of 15 children had MEG dipole clusters and four children had MEG scatter. None of the patients had clusters contralateral to the MR visible FCD. (a) There was a significant reduction in FA, elevated MD, and elevated λ2 and λ3 but no significant difference in λ1 of the subcortical white matter subjacent to the MR visible FCD compared to contralateral normal side. (b) There was also a significant reduction in FA, elevated MD, and elevated λ2 and λ3 but no significant difference in λ1 of the subcortical white matter beyond the MR visible FCD but subjacent to MEG dipole cluster compared to contralateral side. (c) There was a significant reduction in FA, elevated MD, elevated λ2 and λ3 of the deep white matter tracts projecting to/from the MR visible FCD compared to contralateral side. However, there were no significant differences in the λ1 or FDI of the deep white matter tracts projecting to/from the MR visible FCD.

CONCLUSION
We found abnormalities on DTI indices both within and beyond the MR visible FCD in a population of children with intractable epilepsy. Since surgical outcome is dependent on resecting the MR visible lesion as well as the MR occult areas within the epileptogenic zone, such findings may have implications in presurgical detection of the true extent of FCD using DTI and hence seizure outcome following surgical resection.

KEY WORDS: Focal cortical dysplasia, diffusion tensor imaging, magnetoencephalography
Developmental Differences of the Major Forebrain Commissures in Lissencephalies

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1University of California San Francisco, San Francisco, CA, 2Acibadem University, Istanbul, TURKEY

PURPOSE
The brain requires interhemispheric connections to coordinate activity between the cerebral hemispheres. In the forebrain, these connections are principally in the form of three commissures: the corpus callosum, the hippocampal commissure and the anterior commissure. The aim of the study was to investigate the developmental differences of forebrain commissural development in a large group of patients with varying types of lissencephaly, in order to find correlations between the type of cortical malformation and the size and shape of the commissures.

MATERIALS & METHODS
MR scans or portions of MR scans of 124 patients were reviewed retrospectively. The cortical imaging characteristics of the cerebrum were classified in all patients as classic lissencephaly (cLIS, composed of lissencephalies with 4 layer cortex and cell-sparse zones, most commonly associated with LIS1 or DCX mutations), variant lissencephaly (vLIS, composed of lissencephalies with no cell-sparse zone, 2-layer lissencephaly or lissencephaly caused by or presumably caused by ARX, RELN, or VLDLR) or cobblestone lissencephaly (also called dystroglycanopathy, with imaging findings of cobblestone complex, CBSC). The locations of abnormal cortex were noted. Patients with proved genetic diagnoses were classified accordingly. Those without genetic diagnoses were given presumed (p) diagnoses, when possible, based on imaging characteristics. Abnormalities of the corpus callosum were categorized based on shape and which of the components (rostrum, genu, body, splenium) were present. Anterior and hippocampal commissures were classified as absent, small, enlarged, or normal. Inadequately imaged commissures were classified as nonassessed. Associations of commissural abnormalities with cortical patterns then were investigated using “chi-square” tests.

RESULTS
Most patients were classified as classic (59.8%) or variant (36.1%) lissencephaly, with the remaining 4.1% classified as CBSC. In the most common callosal conformation (called hypogenetic), the rostrum was absent, inferior part of genu was small, and the splenium was small or abnormally shaped. Classic lissencephaly cases had a “hockey stick” shape (flat body with vertical splenium) more often than variant lissencephaly group. ACC was common in vLIS and (p)vLIS cases. The absence of the anterior commissure was common in vLIS, while enlargement was detected in ARX cases. Enlarged hippocampal commissures were seen mostly in vLIS and (p)vLIS. Diminished white matter volume and delayed myelination were much more common in the vLIS than the cLIS group.

CONCLUSION
Certain types of commissural anomalies tend to predominate in specific types of lissencephalies. Abnormalities were detected more often in the corpus callosum than in the anterior and hippocampal commissures. The appearance of corpus callosum and developmental differences of commissural structures can be used to help to differentiate among the different types of malformations and may give insight into the processes that cause these malformations.

KEY WORDS: Lissencephaly, commissure

MR Imaging and Diffusion Weighted Imaging Analysis of Normal Appearing White and Gray Matter in Children with Tuberous Sclerosis Complex

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Johns Hopkins University
Baltimore, MD

PURPOSE
To (a) compare the apparent diffusion coefficient (ADC) values of the normal appearing white matter (NAWM) and gray matter of patients with tuberous sclerosis complex (TSC) with previously published normative data and (b) to correlate the ADC values of the NAWM of patients with TSC with the severity of neurologic symptoms.

MATERIALS & METHODS
Twenty-one TSC patients who underwent MR imaging/DWI between January 2000 and August 2008 were included in this study (11 males, 10 females, mean age 12.4 years). Conventional MR imaging and ADC maps were available for image and ADC analysis. Regions of interest (ROIs) included the frontal white matter (FWM), parietal white matter (PWM), occipital white matter (OWM), pons and basal ganglia. All measurements were performed bilaterally. Care was given to exclude focal TSC lesions in the ROI positioning. Apparent diffusion coefficient data were compared with previously published, age-matched normative data (1, 2). The neurologic severity was scored according to the study by Chou et al. One sample t-test, linear and logistic regression were used in data analysis.

RESULTS
Supratentorial NAWM ADC values were higher in TSC patients compared with normative data. A statistically significant increase in ADC values was found in the left OWM and bilateral pons, in the 48-96 months age group (n=5); in the bilateral FWM and bilateral pons in the 96-144 months age group (n=4); and in the bilateral FWM, PWM, OWM and pons in the age group of > 144 months (n=10). There was no significant change in neurologic severity score per unit increase in ADC measurement. Conventional MR imaging showed cerebellar lesions in six (28.6%) of the studied patients. There was a significant increase in the odds of autism with increase in the number of involved lobes and total tuber count.

CONCLUSION
Apparent diffusion coefficient values of normal appearing white matter are increased significantly in TSC, especially with increasing child’s age. Our data indicate that the myelination of the supratentorial brain may be delayed/ altered in TSC patients. This could explain the more global neurocog-
nitive deficits in TSC patients. There was no correlation between the ADC values of the NAWM of TSC patients and severity of neurologic symptoms. Larger studies, including DTI are necessary to validate our results.

**REFERENCES**


**KEY WORDS:** Brain, tuberous sclerosis, apparent diffusion coefficient

**Paper 481 Starting at 2:10 PM, Ending at 2:18 PM**

**Pulsed Arterial Spin-Labeled MR Imaging Evaluation of Tuberous Sclerosis**

Pollock, J. M.¹ · Whitlow, C. T.² · Tan, H.² · Kraft, R. A.² · Burdette, J. H.² · Maldjian, J. A.²

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**PURPOSE**

Tuberous sclerosis presents with characteristic cortical hamartomas and subependymal nodules associated with seizures. The purpose of this study was to use pulsed arterial spin labeling (PASL) to quantify the perfusion of the cortical hamartomas and correlate the perfusion values with seizure frequency.

**MATERIALS & METHODS**

A retrospective search yielded 16 MR examinations including conventional MR imaging and PASL perfusion performed in 13 patients with a history of tuberous sclerosis ranging in age from 7 months to 23 years. The mean perfusion of each cortical hamartoma greater than 5 mm in size localized with conventional MR sequences was obtained using manually drawn regions of interest. Cortical hamartomas were classified as normal, hyperperfused, or hypoperfused based on the mean and standard deviation of the unaffected cortex. Correlation was made between perfusion imaging, conventional imaging, and clinical history.

**RESULTS**

Of the 245 cortical hamartomas, 227 (92.7%) were hypoperfused, 10 (4.1%) were hyperperfused, and 8 (3.3%) were unchanged relative to the mean gray matter. One patient had a subependymal giant cell astrocytoma with a mean perfusion of 93.5 mL/100g tissue/min. There was a statistically significant positive correlation between seizure frequency and number of hyperperfused cortical tubers (r=.51, n=16, p=.04), with higher seizure frequency associated with greater number of hyperperfused cortical tubers. There was no significant correlation, however, between seizure frequency and overall number of cortical tubers (r=.20, n=16, p=.47).

**CONCLUSION**

Pulsed arterial spin labeling can assess and quantify the perfusion characteristics of a cortical hamartoma. The majority of lesions are hypoperfused; however, both normally perfused and hyperperfused lesions occur. The presence of hyperperfused cortical tubers was associated with increased seizure frequency.

**KEY WORDS:** Arterial spin labeled, tuberous sclerosis, perfusion

**Paper 482 Starting at 2:18 PM, Ending at 2:26 PM**

**Analysis and Classification of Cerebrovascular Abnormalities in PHACE Syndrome**

Hess, C. P.¹ · Fullerton, H. J.¹ · Metry, D. W.² · Drolet, B. A.³ · Siegel, D. H.⁴ · Auguste, K. I.¹ · Gupta, N.¹ · Frieden, I. J.¹ · Barkovich, A. J.¹

¹University of California San Francisco, San Francisco, CA, ²Baylor Texas Children’s Hospital, Houston, TX, ³Medical College of Wisconsin, Madison, WI, ⁴Oregon Health & Sciences University, Portland, OR

**PURPOSE**

PHACE (OMIM #606519) describes the association of facial infantile hemangiomas with abnormalities of the posterior cranial fossa, intracranial and cervical arteries, cardiac system and eye (1). The cerebrovascular manifestations of PHACE have been enumerated through small case series and larger retrospective literature reviews (2,3), but to date a systematic review of neuroradiologic findings has not been undertaken. We retrospectively reviewed imaging from 72 patients with PHACE to identify characteristic arterial anomalies and insights they may provide into pathogenesis.

**MATERIALS & METHODS**

CT and/or MR angiographic examinations from 72 patients with PHACE, recruited through three pediatric dermatology referral centers and a registry, all of whom had structural brain and/or cerebrovascular abnormalities, were reviewed retrospectively by two neuroradiologists. Anomalies were grouped into five categories: circle of Willis variants, dysplasia, anomalous course or origin, narrowing or occlusion, and persistent embryonic connections. Anomalies were further characterized by laterality with respect to the hemangioma, distribution of the hemangioma (4), and whether the anterior, posterior, or both circulations were involved.

**RESULTS**

Demographics of patients in this cohort were concordant with the literature (5), with a strong female predominance (9:1) and more common involvement of the S1 segment (81%) than other segments (47% S2, 51% S3 and 16% S4). Structural brain anomalies were seen in 52% of patients, most commonly in the posterior fossa (36%). Among arterial anomalies, dysplasia (looping, kinking, saccular or fusiform aneurysms and/or dolichoectasia) was most common (53%). Narrowing and occlusion (including hypoplasia and agenesis) were nearly as common (50%), followed by aberrant course or origin (42%). Two patients had large-vessel infarcts. Persistent fetal arteries were observed in 21%, with persistent trigeminal being the most common (16%). Aneurysms were found in 13%, underscoring the need for long-term follow up for late aneurysm development and hemorrhage. Overall, arteries within the anterior circulation were involved more frequently than in the posterior circula-
tion (89% versus 31%), and abnormalities were typically ipsilateral to the hemangioma (61%) or bilateral (29%). Of note, variants in the anterior circle of Willis were more common (29%) among this cohort than has been reported in the literature for a normal population (14%).

**CONCLUSION**

Various hypotheses have been proposed to explain the pathogenesis and phenotypic variation of anomalies encountered in PHACE, with neural cristopathy and elaboration of vasoactive mediators by hemangiomas being the most popular. The present work points to an underlying disorder in the arterial media and/or intima of susceptible vessels, leading to changes in arterial caliber (narrowing or widening), occlusions, and development of collaterals and inhibition of fetal vessel regression to sustain flow at different points during vasculogenesis. This hypothesis is corroborated by the observation that structural brain anomalies in PHACE, such as unilateral cerebellar hypoplasia and polymicrogyria, are often the sequelae of in utero ischemia.

**REFERENCES**


**KEY WORDS:** PHACE, cerebrovascular, neurocutaneous

**Paper 483 Starting at 2:26 PM, Ending at 2:34 PM**

**Evaluation of Skull Base Synchondroses in Syndromic and Nonsyndromic Craniosynostoses**

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**PURPOSE**

Patients with craniosynostosis syndromes have complex craniofacial abnormalities involving the cranial vault, orbits, and midface. The interrelationship of skull base growth and craniosynostosis is one that frequently is not taken into account in the surgical management of patients with craniosynostosis. Often the abnormalities of the calvarial unit are stressed and the abnormalities of the skull base portion of the skull are not taken into account. There are now various hypotheses and scattered empirical observations of the relationship between skull base growth and the pathophysiology of syndromic craniosynostoses. In this study we sought out to determine the rate of closure of two important skull base synchondroses, the sphen-ethmoidal and sphen-occipital synchondroses in patients with syndromic craniosynostosis and compare them to patients without syndromic craniosynostosis.

**MATERIALS & METHODS**

A retrospective review of thin-section craniofacial CT scan images from 73 patients were reviewed. They included 44 patients with syndromic craniosynostosis (Apert, Crouzon, Saethre-Chotzen, and Pfeiffer syndromes), nine patients with nonsyndromic bicornoral synostosis, and 20 patients without craniosynostosis. A total of 142 CT time points were reviewed and analyzed according to patient age in days. Grading systems for assessment of the closure of the sphen-ethmoidal and sphen-occipital synchondroses were developed. The images were transferred to a dedicated 3D workstation and reviewed in multiple planes. They were reviewed and graded by two pediatric neuroradiologists via concensus. Comparison of the degree of synchondrosis closure in the various groups was performed via analysis of variance.

**RESULTS**

The degree of closure of the sphen-ethmoidal synchondrosis was significantly different and earlier in groups with syndromic craniosynostoses compared to patients without syndromic craniosynostosis (p<0.05). The degree of closure of the sphen-occipital synchondrosis was significantly different and earlier in groups with syndromic craniosynostoses compared to patients without syndromic craniosynostosis (p<0.05).

**CONCLUSION**

This study for the first time demonstrates in vivo the abnormal closure pattern and potential role of the sphen-ethmoidal and sphen-occipital synchondroses in patients with syndromic craniosynostosis. Better understanding of the growth pattern of the skull base in normal and craniosynostoic children may assist our approach to surgical treatment, and specifically the potential role of anterior skull base expansive surgery.

**KEY WORDS:** Craniosynostosis, skull base synchondroses
**Paper 484 Starting at 2:34 PM, Ending at 2:42 PM**

**Imaging Features of Anterior Pyriform Aperture Stenosis and Central Incisor Syndrome**

Monsalve, J. · Branson, H · Papsin, B. · Blaser, S.
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Toronto, ON, CANADA.

**PURPOSE**
Congenital pyriform aperture stenosis (CPAS), an unusual but well described entity, constitutes one of the causes of nasal obstruction in young infants. Congenital pyriform aperture stenosis is also known as “central incisor syndrome” due to its frequent association with a single central megaincisor (SCMI). Reported intracranial abnormalities are holoprosencephaly and absent or posterior pituitary ectopia (PPE). Additional imaging findings include cleft palate, hypoplastic maxillary sinus, ocular coloboma and microphthalmia. Clinical features are pituitary hormone deficiency, cardiac defects, developmental delay, and multiple congenital anomaly syndromes such as VACTERL, CHARGE and 22q11DS.

**MATERIALS & METHODS**
Retrospective evaluation of 31 patients diagnosed with CPAS at a tertiary pediatric referral center during the period between 1993 to 2008. We assess nasal pyriform aperture (NPA) size and posterior choanal width (PCW), associated intra and extracranial associated anomalies. We also sought features of labyrinthine dysplasia.

**RESULTS**
Fifteen males/16 females were diagnosed with CPAS. Seventeen underwent CT and MR imaging (one fetus), eight patients just had CT and six patients (one additional fetus) only MR imaging. Important features were: SCMI in 67.8%, two crowded incisors in 32.2%, decreased NPA (3.9 - 12.1 mm) in 97.7%, triangular palate in 93.5% and prominent midline palatal ridge in 96.8%. Typical features of PPE (13%) and holoprosencephaly (9.7%) were identified. Additionally, we found lateral semicircular canal dysplasia, including persistent LSCC anlage with absent bone window or hypoplastic bone window in 25% of 62 ears. Additional inner ear anomalies included stenotic internal auditory canal, small cochlear nerve canal and enlarged vestibular aqueduct in several patients.

**CONCLUSION**
New features of CPAS include crowded central incisors when SCMI was not present and labyrinthine dysplasia, predominantly involving the LSCC.

**KEY WORDS:** Anterior pyriform aperture stenosis, central incisor syndrome

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**Paper 485 Starting at 2:42 PM, Ending at 2:50 PM**

**Craniofacial CT: Altering Patient Position, Radiographic Technique and Clinical Practice to Minimize Effective Radiation Dose in Children**

Bardo, D. M. E. · Didier, R. · Anderson, J. · Selden, N. · Guillaume, D. · Klein, A. · Chang, A. · Pollock, J. · Yutan, E. · Kuang, A.
Oregon Health and Science University
Portland, OR.

**PURPOSE**
Children with craniofacial malformations and traumatic injury undergo CT of the face and head as part of their work up for diagnosis prior to and after surgical repair. Many children also undergo follow-up CT examinations as staged reconstruction proceeds and for late follow-up assessment. We sought to reduce effective radiation dose for these patients by altering our method of scanning and through reassessing the anatomical expectations and needs of our neurosurgery and plastic surgery clinicians.

**MATERIALS & METHODS**
Craniofacial CT examination quality and scan technique were reviewed in order to visually assess image noise and spatial resolution of the facial bones, skull base, calvaria, and brain parenchyma anatomy in 15 children of all ages, on a 5-point scale. Anatomical coverage, effective radiation dose and clinical data were noted. Images were used as age-matched controls for comparison of image quality and radiation dose as we adjusted our imaging protocol. Head position was changed to allow full extension of the neck such that the occiput and mental process of the mandible were aligned parallel to the CT gantry, eliminating the cervical spine and thyroid gland from the FOV. The scan technique was altered by reducing tube voltage (kV) from 120 to 80-90 and maintaining tube current (mA) at 150-180; other scan parameters remained fixed for visualization of osseous structures. Postprocessing with a smoothing filter was employed to optimize the appearance of intracranial and orbital structures. Visual assessment of image noise and spatial resolution of the facial bones, skull base, calvaria, and brain parenchyma anatomy in children of all ages was reevaluated on a 5-point scale after scan protocol and position changes were instituted.

**RESULTS**
The effective radiation dose for craniofacial CT was reduced by 50-67% [i.e., in an 18-month-old child, decreasing 7.3 mSv to 3.12 mSv (57%)]. The image quality of the osseous structures has been improved or maintained in all age groups. Postprocessing with a smoothing filter provides diagnostic quality images of the intracranial and orbital structures. An unexpected benefit has been faster and easier postprocessing of 3D and specialized views.
CONCLUSION
Marked reduction of effective radiation dose with superior image quality is achievable with craniofacial CT without loss of diagnostic image quality. New head position procedure and scan technique reductions should be taught and practiced. Benefits also include decreased radiation dose to the thyroid gland, a tissue known to be susceptible to radiation exposure.

KEY WORDS: Craniofacial CT, effective radiation dose

Paper 486 Starting at 2:50 PM, Ending at 2:58 PM

Intracranial MR Imaging Findings in Children with Sensorineural Hearing Loss: Spectrum of Brain Abnormalities

Huang, B. Y. · Castillo, M. · Roche, J. P. · Adunka, O. F. · Buchman, C. A.
University of North Carolina
Chapel Hill, NC.

PURPOSE
To characterize and to determine the prevalence of the spectrum of intracranial abnormalities in a select population of children with sensorineural hearing loss (SNHL) undergoing MR imaging evaluation of the brain.

MATERIALS & METHODS
A retrospective review was performed using two clinical databases of children identified at our institution with a diagnosis of SNHL. Patients in the study population either had a diagnosis of auditory neuropathy (n=140) or had hearing loss and underwent Guthrie blood spot PCR screening for cytomegalovirus (CMV) infection (n=115, of whom 13 were determined to have CMV). Patients in these two groups who underwent MR imaging of the brain and inner ear using a dedicated high-resolution eighth cranial nerve (CN8) protocol were included for analysis. The imaging protocol included axial and sagittal T1-weighted images and axial T2-weighted and fluid attenuated inversion recovery (FLAIR) images through the brain, as well as axial 3D constructive imaging in the steady state (3D CISS) images through the temporal bones. The MR studies were reviewed by two neuroradiologists, and abnormalities of the cerebral hemispheres, cerebellum, and brainstem were described and tabulated in a consensus reading. Inner ear abnormalities, including labyrinthine dysplasias and anomalies of the facial or vestibulocochlear nerves (absence or hypoplasia) also were noted.

RESULTS
A total of 186 patients, who ranged in age from 3 weeks to 16 years (median age 1 year) at the time of MR imaging were identified for review. Forty-nine patients (26.3%) demonstrated brain abnormalities. Of these patients, 16 (8.6%) showed abnormalities both above and below the tentorium; 27 (14.5%) had only supratentorial abnormalities; and 6 (3.2%) showed only infratentorial abnormalities. The most common supratentorial abnormality was confluent or patchy non-specific hyperintensity involving white matter on T2-weighted and FLAIR images, seen in 28 (15.1%) patients. Seven patients demonstrated a cortical dysplasia or gray matter heterotopia, and six patients had findings consistent with the sequelae of periventricular leukomalacia (PVL). Seven patients had callosal abnormalities ranging from a small or thin corpus callosum to complete callosal agenesis. Among infratentorial findings, the most common abnormality was pontine hypoplasia (in isolation or in combination with other brainstem findings), seen in 14 (7.3%) patients. The most common finding involving the cerebellum was hypoplasia of the vermis or hemispheres, seen in 12 (6.5%) patients. Patients with brain abnormalities demonstrated inner ear or cranial nerve abnormalities in 22.4% (11/49) of cases, compared to 26.3% (36/137) patients without obvious brain abnormalities. Inner ear/cranial nerve anomalies were seen in 4/27 (14.8%) patients with only supratentorial abnormalities, in 3/6 (50.0%) patients with only infratentorial abnormalities, and in 4/16 (25.0%) patients with both supra and infratentorial abnormalities; these differences were not statistically significant.

CONCLUSION
Abnormalities of the brain and brainstem are common in select populations of children with SNHL and should be carefully sought out, as they may impact treatment and prognosis of these patients.

KEY WORDS: Sensorineural hearing loss, congenital hearing loss
Thursday Afternoon
3:00 PM – 5:00 PM
Ballroom A

(53) (ASPNR) Vascular Malformations of the Head and Neck

(487) PHACES and Vascular Malformations in Children: A Clinical Perspective of Vascular Anomalies of the Head and Neck

– Denise Adams, MD

(488) The Role of the Interventional Radiologist in the Treatment of Vascular Malformations in Children

– Ahmad I. Alomari, MD

(489) Imaging of the Pediatric Head and Neck Vascular Malformations

– Caroline D. Robson, MD, MB, ChB

Moderator: TBD

PHACES and Vascular Malformations in Children: A Clinical Perspective of Vascular Anomalies of the Head and Neck

Denise Adams, MD

LEARNING OBJECTIVES
Upon completion of this presentation, participants will be able to:
1) Describe the classification system of vascular anomalies.
2) Define the criteria of PHACE Syndrome.
3) Describe treatment options for vascular anomalies in the head and neck

PRESENTATION SUMMARY
Vascular anomalies are a diverse group of disorders classified as either malformations or tumors. Both disorders are common in the head and neck area. There is limited knowledge regarding the pathophysiology of these disorders and thus standard of care and treatment options are sparse. Multidisciplinary centers have emerged to care for these patients and future investigational studies are in development. The classification system of vascular anomalies will be reviewed and discussion of PHACE syndrome and other vascular lesions in regard to their diagnosis and treatment will follow.

REFERENCES

Role of the Interventional Radiologist in the Treatment of Vascular Malformations

Ahmad I. Alomari, MD

LEARNING OBJECTIVES
Upon completion of this presentation, participants will be able to:
1) Discuss treatment for vascular anomalies of the head and neck.

PRESENTATION SUMMARY
Role of the Interventional Radiologist in the Treatment of Vascular Malformations in Children

Imaging of the Pediatric Head and Neck Vascular Malformations

Caroline D. Robson, MD, MB, ChB

LEARNING OBJECTIVES
Upon completion of this presentation, participants will be able to:
1) Recognize and differentiate between the imaging characteristics of the commonly encountered head and neck vascular anomalies.
2) Detect CNS anomalies that can be associated with vascular anomalies.
3) Recognize syndromic forms of vascular anomalies

PRESENTATION SUMMARY
The characteristic imaging appearance for head and neck vascular anomalies is reviewed. These include true tumors such as hemangioma, and vascular malformations such as venous malformation (VM), lymphatic malformation (LM) and combined malformations. Associated abnormalities will be illustrated. HEMANGIOMA. Hemangioma is a common vascular tumor and arises in infants. Hemangiomas are characterized by proliferation during the first year of life, followed by involution. Proliferation, results in prominent vascularity: Involution causes decreased vascularity and size. Congenital hemangioma are rare. PHACES is the association of: posterior fossa malformations, hemangiomas, arterial anomalies, coarctation of the aorta and cardiac defects, eye abnormalities, and sternal malformations. Absence/hypoplasia of the internal carotid and/or vertebral arteries and persistent trigeminal artery can occur. Progressive cerebrovascular occlusive changes and vascular tortuosity occasionally occur. Proliferating hemangiomas are well circumscribed, lobulated, and enhance rapidly and intensely following the admin-
istration of contrast, with prominent vascularity. Proliferating hemangiomas are moderately hyperintense on T2-weighted images. Involuting hemangiomas are present at birth, and gradually expands. Symptoms include swelling and pain. Clinical examination reveals skin discoloration and a soft, spongy, compressible mass. Venous malformation expands with valsalva or dependent positioning. Phleboliths are pathognomonic. Familial forms include Blue-rubber bleb nevus syndrome. Midline facial VM can be associated with intracranial developmental venous anomalies and sinus pericranii. Mafucci syndrome is multiple enchondromas with VMs. Phleboliths are characteristic of VMs. Fluid within VMs is venous blood which enhances, unlike LMs. Enhancement is heterogeneous at first, becoming more homogeneous over time. Venous malformations are cystic and septated with markedly hyperintense fluid on long TR MR imaging. High-flow vascularity is not a feature. MR venography may reveal dilated or anomalous veins. LYMPHATIC MALFORMATION. Lymphatic malformation (LM) consists of endothelial-lined lymphatic channels filled with lymph. Lymphatic malformations are detected antenatally, at birth or in infancy. Previously occult LM may present with increase in size from hemorrhage or infection. Lymphatic malformation presents as a mass and/or alteration of function. Lymphatic malformations are characterized as microcystic (<1 cm cysts), macrocystic or mixed. Lymphatic malformation manifests as a cystic or spongy mass, or diffuse infiltration. Progressive osteolysis with LM is termed Gorham-Stout syndrome. Syndromic associations include Turner and Noonan syndrome, and trisomies 21, 13 and 18. There is an association between periorbital LM and intracranial developmental venous anomalies with dural AVF. The imaging appearance depends on the size of spaces and presence of hemorrhage or infection. Lymphatic malformation tends to involve multiple fascial compartments, and is cystic and septated. Fluid-fluid levels are characteristic. Anomalous venous channels often are seen. Fluid characteristics vary with protein and blood content. Cyst walls/septations enhance, but not contained fluid. Infection produces stranding of subcutaneous fat. High-flow vascularity is not a feature. The differential diagnosis includes teratoma and VM.

Table: Combining Vascular Malformations

<table>
<thead>
<tr>
<th>Malformation Type</th>
<th>Pathological Features</th>
</tr>
</thead>
<tbody>
<tr>
<td>Venous Malformation (VM)</td>
<td>Consists of dysplastic venous channels.</td>
</tr>
<tr>
<td>Lymphatic Malformation (LM)</td>
<td>Consists of endothelial-lined lymphatic channels filled with lymph.</td>
</tr>
<tr>
<td>Combined Vascular Malformation</td>
<td>Consist of combinations of lymphatic, venous, capillary or arterial malformations with imaging features reflecting the various components.</td>
</tr>
</tbody>
</table>

REFERENCES


Thursday Afternoon

3:30 PM – 5:00 PM

Hall A

(54) (ASHNR) Head and Neck Oncology: Evaluation of Newly Diagnosed Cancer

Audience Response Plus (AR+)*

Self Assessment Module (SAM)**

*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.

**Programming is currently under review for qualification as a Self Assessment Module (SAM) through the American Board of Radiology (ABR).

(490) Oral Cavity and Oropharyngeal Cancer

– *Suresh K. Mukherji, MD*

(491) Nasopharyngeal Cancer and Patterns of Spread

– *Nancy J. Fischbein, MD*

(492) Evaluation of Salivary Tumors

– *Kristine M. Mosier, DMD, PhD*

Moderator: Nancy J. Fischbein, MD

Learning Objectives

Upon completion of this presentation, participants will be able to:

1. Review the Anatomy of the Oral Cavity (OC) & Oropharynx (OP).
2. Review common sites of HNSCCA in the OC & OP.
3. Review information that needs to be conveyed to referring physicians.

Oral Cavity and Oropharyngeal Cancer

*Suresh K. Mukherji, MD*
PRESENTATION SUMMARY
The intent of this presentation is to review the anatomy of the oral cavity and oropharynx and common sites of SCCA that arise in these regions. We also review the information that needs to be conveyed to referring physicians that will make a difference in treatment.

Nasopharyngeal Cancer and Patterns of Spread
Nancy J. Fischbein, MD

LEARNING OBJECTIVES
Upon completion of this presentation, participants will be able to:
1) Review the appearance of nasopharyngeal carcinoma.
2) Describe patterns of local spread of disease.
3) Discuss patterns of regional and distant spread of disease.

PRESENTATION SUMMARY
Nasopharyngeal carcinoma (NPC) is a malignant epithelial carcinoma that is associated with the Epstein-Barr virus (EBV) in the majority of cases. The World Health Organization classifies NPC into three histologic subtypes: type III is the undifferentiated carcinoma associated with EBV and is most prevalent, type II is nonkeratinizing squamous cell carcinoma, and type I is keratinizing squamous cell carcinoma. A variety of clinical presentations are associated with NPC. Most common is a neck mass (present in 70% to 90% of cases), followed by nasal obstruction or bleeding, hearing loss/otitis/otalgia, headache, and/or cranial neuropathy. Nasopharyngeal carcinoma typically is treated with external beam radiation therapy, with chemotherapy added for treatment of all but the earliest stages of disease. Despite the advances made in treatment, the 5-year overall survival rate of ~75% underscores opportunities for improvement, particularly for patients with advanced disease, where survival rates decline to <60. Late radiation toxicity is also an issue. Surgery has a limited role in the management of NPC patients. Imaging plays an important role in all aspects of diagnosis, staging, treatment planning and follow up of patients with NPC. MR is the imaging study of choice, as CT does not give adequate information regarding skull base and intracranial extent of disease. Complete assessment of NPC requires an understanding of the complex anatomy of the central skull base, as extension to skull base and neural foramina is common. Nasopharyngeal carcinoma may extend to the pterygopalatine fossa (PPF), and from there they may access multiple regions by direct or perineural extension. Nasopharyngeal carcinoma also may extend to foramen lacerum superiorly, and to foramen ovale superolaterally. To some degree, the tough pharyngobasilar fascia limits extension to foramen ovale. MR imaging for assessment of NPC should include three planes of pregadolinium T1-weighted images, an axial and/or coronal T2-weighted image with fat saturation, and at least two planes, usually axial and coronal, of postgadolinium T1-weighted images with fat saturation. MR imaging should include the neck to at least the sternal notch in order to adequately stage lymph node involvement. Parotid nodes and supraclavicular nodes can be seen with NPC, so imaging must include these regions. Distant metastases are assessed with FDG PET/CT scans. PET/CT is useful not only for initial staging of disease, but also increasingly for treatment planning, and certainly for assessment of residual/recurrent disease following therapy and ongoing assessment for the development of distant metastases.

Evaluation of Salivary Tumors
Kristine M. Mosier, DMD, PhD

LEARNING OBJECTIVES
Upon completion of this presentation, participants will be able to:
1) Identify the CT and MRI appearance and patterns spread in salivary gland tumors.
2) Discuss the application and limitations of other modalities including spectroscopy and DWI in the evaluation of salivary gland tumors.
3) Discuss the indications for PET in the evaluation of salivary gland tumors.

PRESENTATION SUMMARY
The common and uncommon CT and MR imaging appearance of benign and malignant disease affecting salivary tissues will be addressed. The appearance of benign and malignant tumors involving the major and minor salivary glands in the head and neck as well as tumor mimics will be covered. Patterns of spread from malignant disease and nodal involvement will be reviewed. Applications and the limitations of other imaging modalities including spectroscopy and diffusion-weighted imaging (DWI) in the evaluation of salivary neoplasms will be discussed. The indications for pretreatment and posttreatment evaluation of salivary tumors with positron emission tomography (PET) will be reviewed.

REFERENCES
Molecular Imaging: Neuro Applications

Dima A. Hammoud, MD

LEARNING OBJECTIVES
Upon completion of this presentation, participants will be able to:
1) Summarize the properties of the CNS that reflect on molecular imaging applications.
2) Explain the role of small animal molecular neuroimaging prior to human applications.
3) Discuss the concept of translational molecular imaging in the CNS.
4) Cite multiple examples of translational molecular imaging applications in different CNS pathologies such as neurodegeneration, neuroinflammation and brain tumors.

PRESENTATION SUMMARY
Introduction. Unlike other organ systems, the central nervous system (CNS) has two special characteristics that reflect on molecular imaging applications: 1. Highly selective blood-brain barrier (BBB). 2. Complex cellular network of neurotransmitters. Small animal molecular neuroimaging. 1. Generally used for testing and optimization of molecular imaging agents before human use: first step towards eventual clinical applications. 2. Allows the performance of longitudinal studies: potential for follow up, therapeutic/prognostic usefulness. 3. Became possible due to the availability of high-resolution multimodality devices for animal imaging (micro-PET, micro-SPECT, micro-MR imaging and micro-CT) and the development of many relevant animal models of human diseases, such as Alzheimer dementia, stroke, glioma and Parkinson disease.

Translation of molecular imaging. Translational molecular imaging brings promising experimental therapies and diagnostic tests to the clinic, after extensive evaluation in experimental models. Frequently used modalities include nuclear medicine techniques such as PET and SPECT, as well as few MR imaging applications. Optical techniques and ultrasound applications remain of limited use in humans. Perhaps the most commonly used techniques in translational molecular imaging in the CNS are nuclear medicine techniques, namely PET and SPECT, as they provide a very high sensitivity (~10^-6 M), which is suitable for detection of CNS molecular concentrations. However, the successful development of CNS molecular imaging agents depends significantly on the agents’ potential for BBB penetration. Thus, when evaluating a molecular imaging agent in the CNS, many factors need to be taken into account including appropriate lipophilicity, low molecular weight, high affinity and suitable metabolism, among others. Examples of translational molecular imaging applications in different CNS pathologies and corresponding molecular imaging targets: 1. Alzheimer dementia: targets include neuronal death/regeneration, pathologic associates (Amyloid-β and Tau proteins) and inflammation. 2. Neuroinflammation: main target is the upregulated translocator protein expression in the mitochondrial membrane of activated microglia. 3. Parkinson disease: targets include different components of the dopaminergic system. 4. Brain tumors: targets include increased glucose metabolism (e.g., 18F-FDG), increased amino acid transport (e.g., 11C-methionine), cellular proliferation (e.g., 18F-fluorothymidine), and hypoxia (e.g., 18F-MISO).

Hyper-Polarized Metabolism: Neuro Applications

Brian D. Ross, MD, PhD

LEARNING OBJECTIVES
Upon completion of this presentation, participants will be able to:
1) Define nuclear polarization, Bolzman distribution, hyperpolarization and unique MR properties of each.
2) Review the rudiments of neurochemistry to understand the goals of hyperpolarized metabolic neuroimaging.
3) Describe multiple HD-MRI hyperpolarization techniques, their advantages and disadvantages.
4) Identify current research goals and ‘killer’ applications of HD-MRI to clinical brain problems.

PRESENTATION SUMMARY
What is HD-MRI? Hyperpolarization is the general term for a method of enhancing the spin-polarization difference of populations of nuclei in a magnetic field. No less than five distinct techniques (DNP; PHIP-PASADENA; xenon/helium polarization transfer; Brute-Force; 1H hyperpolarized water) are currently under exhaustive investigation as means of amplifying the intrinsically (a few ppm) weak signal used in conventional MR neuroimaging and spectroscopy. While only gaseous MRI of xenon and helium have reached the clinic, the term HD-MRI is used to indicate that, with up to 100,000 fold signal enhancement, images and spectra will indeed be “high-definition”. Beyond structural
imaging lies Hyperpolarized Metabolism. As predicted by Forsen and Hoffman (1) magnetization transfer will result in HD-MRI of any metabolic product which arises from that reagent for the duration of hyperpolarization. It is as a metabolic imaging tool that much of the interest in HD-MRI arises. Can hyperpolarized metabolism be demonstrated in vivo; in brain; in human patients? These questions are to be addressed in this and the accompanying presentation. HD-MR metabolism in vivo. Most successful to date has been DNP, where 'C pyruvic acid has shown many applications (2) (to be discussed by Dr. Petersson). PHIP-PASADENA with 'C succinate shows HD-MR metabolism in vivo in tumor-bearing mice of several types, entering TCA-cycle for ultra-fast detection with 'C MRI, MRS and CSI. Neuro-Applications. Five promising but “embryonic” preclinical studies of HD-MRI in brain will be discussed; 'C succinate PHIP in brain tumor (3); 'C ethylpyruvate DNP (4) and 'C acetate (5) DNP in rodent brain; 'C succinate PHIP (6) and 'H hyperpolarized water (7) vs Gd imaging of stroke, and last but not least, the possibility of HD-MRI via hyperpolarized 'C-glucose (8). In all of these, 'C-T1 (T1 < 1 minute) presents a serious limitation given the relatively slow transport across intact blood-brain barrier (BBB). We and others are exploring 'N choline DNP/PHIP, 'N glutamine and 'N glutamate (T1 2 - 7 minutes) for long-lived HD-MRI of the brain in vivo (9). Barriers to clinical Neuro-Applications. Apart from T1, BBB and the identification of clinical targets for HD-MRI, there remain issues of toxicity, sterility and cost of this new generation of MR molecular imaging agents. The success of diagnostic 'C neurospectroscopy in relatively large numbers of patients (10, 11) encourages us to overcome the remaining barriers to clinical HD-MRI.

REFERENCES
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Acknowledgment: Pratip Bhattacharya, Henry Chan, Shawn Wagner, Eduard Chekmenev, Kent Harris, William Perman, Thao Tran, Lawrence Robertson and Napapon Sailasuta thank the Rudi Schulte Research Institute (RSRI) for initiating and sustaining the Enhanced (“PASADENA”) MR Unit at HMRI.

Neuro-MR Imaging: Do We Need New Contrast Agents?
Peter Caravan, PhD

Dr. Caravan is Assistant Professor in Radiology at Harvard Medical School and Massachusetts General Hospital. Dr. Caravan has more than 15 years industrial and academic experience in the development, characterization, and application of gadolinium-based contrast agents. Dr. Caravan is an inventor on 15 granted or pending patents related to new MR imaging contrast agents and methods for their use. He has authored or co-authored over 35 peer-reviewed journal articles on original research in this field, along with numerous conference abstracts. Dr. Caravan also has contributed seven book chapters and six review articles on the chemistry, properties, and uses of MR contrast agents. His research interests lie broadly in the development of new molecular (MR, PET, multimodal) imaging probes.

LEARNING OBJECTIVES
Upon completion of this presentation, participants will be able to:
1) Differentiate the approved gadolinium contrast agents with respect to their function and physicochemical properties.
2) List recently approved MR contrast agents and describe how they may be used in neuroradiology.
3) Identify emerging molecular MR imaging agents being developed for neuroimaging applications

PRESENTATION SUMMARY
The emergence of nephrogenic systemic fibrosis (NSF) and its link to gadolinium (Gd)-based contrast media has led to broad concern about the use of Gd-based contrast. Historically different preparations of Gd that are chemically distinct but functionally equivalent are used interchangeably, and collectively referred to as “gadolinium”. Chemical differences among these compounds may impact their relative safety with respect to NSF. Recently approved Gd-based contrast are both chemically and functionally different than conventional “gadolinium” offering new opportunities for neuroimaging. This presentation will provide a brief overview of the differences among contrast agents with respect to chemistry and function and then focus on two recently approved contrast agents with some potential applications in neuroradiology. In addition to approved agents, emerging molecular MR imaging probes for neuroimaging also will be surveyed.
Notes
Scientific Poster 1

Imaging Findings in Retinal Vasculopathy and Cerebral Leukodystrophy in Patients with TREX1 Mutation

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PURPOSE
Retinal vasculopathy and cerebral leukodystrophy (RVCL), a rare multisystem vasculopathy affecting cerebral white matter, was described initially by Grand et al in 1988 as cerebroretinal vasculopathy (CRV) with white matter lesions and pseudotumors, associated with retinal microvasculopathy. Recently, an autosomal dominant frameshift mutation in the TREX1 gene has been linked to RVCL, allowing identification of affected patients and their families. It is important for radiologists to be aware of this diagnosis and its imaging features. Incorrect diagnosis as demyelinating disease or malignancy may lead to potentially harmful interventions such as biopsy. A retrospective review of patients diagnosed with RVCL with a TREX1 mutation was performed. Our goal was to characterize a pattern of imaging findings, enabling the radiologist to suggest this diagnosis. This would allow patients to receive proper clinical evaluation and prevent unnecessary and potentially harmful diagnostic procedures.

MATERIALS & METHODS
Two neuroradiologists retrospectively reviewed 19 MR examinations of five patients performed at varying institutions from 2001 to 2008. Only patients with TREX1 mutations were included. For each patient, the study that had the greatest number of lesions was used for classification. White matter lesions were counted and classified according to their location as subcortical, periventricular, or infratentorial. The lesions were classified additionally according to whether they had abnormal FLAIR signal only versus abnormal FLAIR signal with enhancement. Pseudotumor lesions were defined as having enhancement, abnormal FLAIR signal, and mass effect.

RESULTS
All lesions were seen on FLAIR images. Of the white matter lesions with abnormal FLAIR signal without enhancement, 24 were subcortical, 27 were periventricular, and only one was infratentorial. Of the lesions which also enhanced, 13 were subcortical, 14 were periventricular, and four were infratentorial. No lesions were identified in the corpus callosum. A total of six pseudotumors were identified in the five patients. The pseudotumor lesions ranged in size from 5.8 x 3.3 cm to 1.7 x 0.7 cm. Fifty percent of the pseudotumors involved the right frontal lobe and one involved the left frontal lobe. Two of the patients had only pseudotumor lesions without additional lesions. Of note, diffusion restriction was present in four of the six pseudotumors. One patient had diffusion restriction in multiple nonpseudotumor lesions.

CONCLUSION
Imaging findings in RVCL can mimic other white matter disorders. We reviewed MR images of five patients with TREX1 mutations and characterized their lesions revealing patterns which may be helpful to radiologists when considering this diagnosis. Most lesions were supratentorial and equally distributed in the periventricular and subcortical areas. No corpus callosum lesions were seen. It is interesting that the majority of pseudotumors affected the frontal lobes consistent with prior reported data on similar patients. In order to prevent unnecessary procedures such as biopsy, radiologists need to be aware of this diagnosis and include it in the differential for patients with white matter lesions and/or superimposed focal pseudotumor.

KEY WORDS: Retinal vasculopathy and cerebral leukodystrophy, cerebroretinal vasculopathy, TREX1

Scientific Poster 2

“De Novo” Aneurysms: Radiologic and Clinical Analysis of Our Ten Years Experience

Di Lella, G. M. · Gaudino, S. · Maira, G. · Tirkakova, B. · Albanese, A. · Colosimo, C.
Catholic University of Sacred Heart
Rome, ITALY

PURPOSE
To evaluate frequency, risk factors and epidemiology of de novo aneurysms in our series of patients previously treated for intracranial aneurysms in the last 10 years.
Scientific Poster 3

Effect of Hyperdynamic Therapy on Cerebral Perfusion in Subarachnoid Hemorrhage Patients With and Without Delayed Cerebral Ischemia: A Systematic Review

Dankbaar, J. W. · Slooter, A. J. C. · Rinkel, G. J. E. · van der Schaaf, I. C.

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Utrecht, NETHERLANDS

PURPOSE

Hyperdynamic therapy (hemodilution, hypervolemia, hypertension, Triple-H) is used to treat and prevent delayed cerebral ischemia (DCI) (which is preceded by hypoperfusion) after subarachnoid hemorrhage (SAH). Hyperdynamic therapy should increase cerebral perfusion in order to achieve better neurologic outcome. It is not clear, however, whether hyperdynamic therapy has this effect on cerebral perfusion. To clarify this issue we did a systematic review of the literature on research about the effect of prophylactic and therapeutic hyperdynamic therapy on cerebral perfusion in SAH patients.

MATERIALS & METHODS

Recent clinical evidence suggest that patients successfully treated for aneurysmal rupture should be considered at risk to develop new lesions adjacent to the former aneurysm (regrowth), or in a new site (de novo), where no pathology was found in previous neuroradiologic studies. We retrospectively reviewed 297 patients with 315 aneurysms (F/M=3:2, mean age 54.8 years) treated both with surgery (224 patients, 238 lesions) or by endovascular approach (73 patients, 77 aneurysms).

RESULTS

Nine patients (6 F, 3 M, mean age 44.1 years) developed 11 de novo lesions with an average interval of 13 years. All but one of the patients were under 40 years of age at the diagnosis of the first aneurysm. Four patients were smokers, while three had hypertension. Only one patient, a young female, had a familiar history of brain aneurysm, while another female developed multiple lesions. Two patients, both with SH at the time of first diagnosis, had new hemorrhage. Our results are in accordance with the literature, regarding the higher female prevalence, younger age of discovery of the first aneurysm and incidence of risk factors in de novo lesions, while hypertension was found only in three cases.

CONCLUSION

Our data, in accordance with the literature, suggest that SH from brain aneurysms may not be a “one time” event. Patients treated have a higher risk to develop a new lesion and, if 45 years or younger at the time of first treatment, should be evaluated by CT or MR angiography, depending on the surgical or endovascular procedure, one year after the surgery and subsequently every two years. The type and incidence of risk factors suggest a genetic influence: dedicated genetic studies, in our institution, are trying to find patients with higher risk of aneurysm development and those, between them, with higher rupture risk.

KEY WORDS: Aneurysm, CT angiography

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* significant change; † RCT

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MATERIALS & METHODS

An online literature search was performed in PubMed to identify all randomized controlled trials (RCT), cohort studies, and case series on hyperdynamic treatment in human patients older than 18 years with SAH to prevent or treat DCI, and in which treatment effect was evaluated by means of a cerebral perfusion measurement. Study design, patient characteristics and treatment characteristics were evaluated and differences in cerebral blood flow (CBF in ml/100g/min), before and after hyperdynamic therapy were calculated per study with 95% confidence intervals from reported mean values and standard deviations.

RESULTS

Thirteen studies met the selection criteria (number of included patients: 4 to 51; age: 42 - 59 years). Nine studies were prospective. Two studies were randomized controlled trials (prophylactic hypervolemia and prophylactic Triple H). Different types of hyperdynamic therapy were used (some studies used several): hypervolemia (8, of which three with hemodilution), isovolemic hemodilution (1), induced hypertension (5), and Triple-H (3). Five studies applied hyperdynamic therapy as prophylactic treatment, 7 as therapeutic treatment, and 1 both. CBF was measured with: external scintillation counter (5), SPECT (2), Xenon-CT (5), PET (1). CBF change could not be calculated for two studies (of which one RCT showing no significant CBF increase after prophylactic Triple H). Weighted total effects could not be calculated due to the large heterogeneity of study methodology. Significant increases only were seen within 24 hours after the start of hypertensive therapy (prophylactic and therapeutic treatment) and Triple H (prophylactic treatment), and within 5-7 days after hypervolemia (therapeutic) (Tables 1 and 2). None of these results were from RCTS.

CONCLUSION

There is no strong evidence for a positive effect of hyperdynamic therapy on CBF. In this review, only two studies were randomized control trials (giving hypervolemic and Triple H therapy).
therapy), both without a significant increase in CBF. Significant CBF increase, is seen in uncontrolled studies on prophylactic and therapeutic hypertensive therapy and prophylactic Triple H therapy.

**KEY WORDS:** Subarachnoid hemorrhage, hyperdynamic therapy, ischemia

**Scientific Poster 4**

**Triple Rule-Out for Stroke Patients: Brain, Aorta and Its Carotid Branches, and Heart**

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San Francisco, CA

**PURPOSE**

Most ischemic strokes result from carotid atherosclerosis or are of cardiac origin. Patients with carotid atherosclerosis are more likely to have coronary artery atherosclerotic disease. The purpose of this study was to evaluate the image quality of a novel stroke imaging protocol that expands the standard CT angiogram coverage to include all four chambers of the heart and the full extent of the coronary arteries, allowing assessment of the brain, carotid arteries, aorta, cardiac chambers and coronary arteries in a single study.

**MATERIALS & METHODS**

Ninety patients consecutively admitted to the emergency department with suspected cerebrovascular ischemia receiving a standard-of-care CT angiogram (CTA) of the brain and neck were enrolled prospectively in our study. An original, tailored acquisition protocol employing a 64-slice CT scanner was used, consisting of a dual-phase, intravenous injection of iodinated contrast and saline flush, in parallel with a dual-phase, helical CT acquisition, from the top of the aortic arch up to the vertex of the head, and then from the top of the aortic arch down to the diaphragm. The second CT acquisition phase was performed during a breath hold and was ECG-gated. No beta blockers were administered to the patients. The overall image quality, attenuation, and signal-to-noise ratio of the contrast-enhanced blood flow in the carotid and coronary arteries, as well as in the aorta were assessed. The adequacy of contrast opacification of the left cardiac chambers also was evaluated. The influence of patient size and heart rate on the image quality was calculated.

**RESULTS**

The patient population characteristics were as follows: mean age 64.4, mean body mass index (BMI) 25.6 (±3.7), and mean heart rate 70.2 (±13.3, range 41-102) bpm. The best reconstruction phase of the cardiac cycle for the right coronary artery (RCA), left anterior descending coronary artery (LAD) and the left circumflex coronary artery (LCX) was 75%. Carotid and vertebral artery image quality was 100% diagnostic (rated good or excellent) in all patients. Coronary artery image quality was diagnostic in 57% of RCA segments, 72% of LAD segments, and 62% of LCX segments. When considering proximal segments only, the diagnostic quality rose to: 70% in the RCA, 82% in the LAD, and 73% in the LCX. Mean attenuation in the RCA was 363.7 HU (±74.4 HU), in the LAD 355.7 HU (±91.2 HU), and in the LCX 351.6 HU (±84.4 HU). Mean attenuation in the cardiac chambers was: right atrium 198.5 HU (±104.1 HU), right ventricle 222.1 HU (±84.6 HU), left atrium 360.7 HU (±97.7 HU), and left ventricle 371.2 HU (±101.3).

**CONCLUSION**

The proposed stroke protocol achieved excellent opacification of the left heart chambers, the cervical arteries and each coronary vessel, in addition to adequate carotid and coronary artery image quality in a consecutive series of patients suspected of cerebrovascular ischemia without use of beta-blockers. This protocol holds promise in terms of a single study allowing comprehensive assessment of cerebrovascular patients including intracranial vascular occlusion, burden of carotid, aortic and coronary atherosclerosis, and possible cardiac clots.

**KEY WORDS:** Stroke, atherosclerosis, CT angiography

**Scientific Poster 5**

**Carotid Artery Stenosis: Brain Perfusion Before and After Stent Treatment**

Tenneo, B. · Bjornerud, A. · Nedregaard, B. · Hald, J. K.
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Oslo, NORWAY

**PURPOSE**

Carotid artery stenosis is a common source of cerebral emboli. Cerebral hyperperfusion and hemodynamic infarction may be another effect of stenosis. The circle of Willis and collaterals protect against ischemia. The purpose of this study was to evaluate brain perfusion in patients with internal carotid artery stenosis, and assess the effect of stent treatment.

**MATERIALS & METHODS**

Dynamic susceptibility contrast perfusion MR imaging (DSC MR) was performed before (1-4 days) and after (1-2 days) stent treatment in 10 patients with unilateral carotid artery stenosis. Patients with contralateral high-grade carotid artery stenosis (> 50%, NASCET method) or occlusion were excluded from the study. The dynamic first-pass response was analyzed using established tracer kinetic models to produce color maps representing cerebral blood volume (CBV), cerebral blood flow (CBF), mean transit time (MTT) and bolus delay. Arterial input function (AIF) was defined semi-automatically in the middle cerebral artery contralateral to the artery stenosis. CBF and MTT were estimated using block-circulant singular value decomposition (cSVD) to correct for bolus delays relative to the AIF. Image processing was performed in nordicICE (NordicImagingLab). Two neuroradiologists interpreted the color maps visually. Stenting (Precise, Cordis) was performed in 11 proximal internal carotid stenoses (6 left and 5 right side) in 6 males and 4 females (one patient treated twice), with mean age 64.1 years (52 to 74 years). Seven stenoses were symptomatic and four asymptomatic. Grade of stenosis was measured from digital subtraction angiography images just before and after stent placement. Prior to treatment the stenoses ranged from 50% to 73%, mean 63%.
RESULTS
Before treatment the perfusion was symmetric and normal in 6/11 cases, in these patients the stenosis ranged from 50% to 71%, mean 59.8%. Five of 11 cases showed asymmetric perfusion with increased MTT and/or perfusion delay ipsilateral to the stenosis. In these cases the stenosis ranged from 59% to 73%, mean 66.8%. One of these patients also showed increased CBV and CBF ipsilateral to the stenosis. After stenting there was no residual stenosis in 9/11, while two cases showed residual stenosis of 21% and 44% respectively. The six cases with normal perfusion prior to treatment, also were normal after, including the two cases with residual stenosis. Three of 5 cases with abnormal perfusion before treatment normalized after stenting. One case showed unchanged perfusion delay, and one case showed normalization of perfusion delay, but still increased MTT, CBV and CBF.

CONCLUSION
High-grade carotid artery stenosis does not necessarily affect brain perfusion, due to significant collateral flow. In cases where carotid artery stenosis does affect brain perfusion, stent treatment may normalize perfusion. DSC MR imaging may highlight patients with small collateral reserves.

KEY WORDS: Carotid artery, stenosis, perfusion

Scientific Poster 6
Image Quality and Dosimetric Comparison of Clinical Neuro-CTAs Acquired Using Dual Energy and Digital Subtraction Angiographic Modes on the Same Dual Source MDCT Scanner

Hedge, A. · Illyas, M. · Ng, K. · Tan, L. · Wan, C. · Tan, J. · Lim, W. · Chan, L.
Singapore General Hospital
Singapore, SINGAPORE

PURPOSE
The application of dual energy CT (DECT) technology in CT angiographic (CTA) studies for bone removal is fairly novel. The purpose of this study is to compare (1) the image quality of bone removal on 3D MIP images created from DECTAs with the subtracted 3D MIP images created from conventional CT digital subtraction angiographic (DSA) studies, and (2) dosimetric differences between the 2 modes of acquisition, in clinical neuroangiographic studies obtained on the same scanner.

MATERIALS & METHODS
Fifty-five neuro-CTAs acquired on a Somatom Definition (Siemens, Germany) over a 9-month period were included in this study. Of these, 22 intracranial (COW) and/or 7 extracranial (carotid) CTAs were acquired in the DECTA mode, and 17 intracranial (COW) and/or 9 extracranial (carotid) CTAs in the DSA mode. 3D rotational MIP images were created from the bone removed DECTA and subtracted DSA images using commercially available taskcards. These are read by two independent raters who assessed image quality based on a 5-point diagnostic confidence scale (1 = poor image quality rendering study nondiagnostic; 5 = excellent image quality allowing confident diagnosis) for the presence of aneurysms and significant vascular stenoses. The presence of artifacts resulting from the bone removal/subtraction process also was assessed. The mean DLP reading at the end of each CTA study also is compared between the DECT and DSA acquisitions.

RESULTS
The median age of the patients was 55 years (20 - 85 years). Image quality assessment of the second rater is incomplete at the time of abstract submission. Mean diagnostic confidence scores from the first rater for (a) presence of aneurysms on DECTA and DSA: 3.9 versus 3.9; (b) presence of significant stenosis on DECTA and DSA: 4.3 versus 3.9. Twenty-seven of 29 (93%) DECTAs versus 21/26 (81%) DSA CTAs showed presence of postprocessing artifacts. These will be compared with those from the second rater and interobserver variability assessed. The mean DLP (mGy.cm) from (a) COW alone and (b) COW and carotid studies, on DECTA versus DSA are: (a) 376 (310 - 569) and (b) 780 (700 - 1023) versus (a) 951 (734 - 1318) and (b) 1143 (936 - 1291) respectively.

CONCLUSION
Image quality of bone removal and subtracted 3D MIP CTA images are comparable, but the mean dose delivered is significantly lower using the DECTA than the DSA mode.

KEY WORDS: Dual energy CT, neuroangiography, image quality

Scientific Poster 7
High-Resolution MR Imaging of Lactate Derangement in Traumatic Brain Injury

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PURPOSE
Traumatic brain injury (TBI) accounts for ~ 500,000 hospital admissions and 17,500 deaths per year in the United States, with a high incidence of significant morbidity in survivors (1). Cerebral microdialysis studies show that increased lactate and increased lactate/pyruvate ratios can predict poor outcome in TBI prior to development of imaging abnormalities (2,3). Protein-dependent saturation transfer techniques developed in our lab enable high-resolution lactate mapping in brain, resolved within the low micromolar range. We evaluated the ability of this technique to map lactate derangement in the setting of diffuse TBI.

MATERIALS & METHODS
Using an established mouse diffuse TBI model (4), five C57 black mice were imaged immediately following TBI, 1 reimaged at 5 days, and compared to six preinjury controls. MR imaging was performed on a 7 T Bruker Biospec horizontal bore system. Lactate mapping sequence: 10 gaussian saturation pulses (flip angle 30°, RF power 2μT, 150 Hz bandwidth, MT module duration 183 ms) at offsets of +/- 3.4 ppm (1020 Hz, corresponding to lactate methyl protons) from the bulk water peak; FLASH acquisition (2.4 FOV, matrix 128 x 128, slice thickness 1 mm, flip angle 20°, TR/TE 400/2.2
ms); identical acquisitions without MT prepulse train. MTR(lactate) images were created by \{1 - [Msat(-3.4ppm)/No MT]\}%.

RESULTS

Lactate contrast throughout brain at baseline is low and most prominent in the basal ganglia, consistent with our understanding of baseline metabolism in these regions. After TBI, lactate contrast increased by 24% in corpus callosum with respect to overlying cortex as compared to controls. Increases also were seen in cortex underlying impact zone and in areas of expected contracoup injury, with preliminary evidence of delayed lactate derangement in hippocampus.

CONCLUSION

High-resolution MR lactate imaging noninvasively detects micromolar changes in lactate following TBI, and shows promise for detecting subtle traumatic injury, probing disease pathology and following novel treatment strategies. Preliminary evidence suggests lactate as a marker of the neuronal toxicity known to occur in the hippocampus after TBI.

REFERENCES


KEY WORDS: TBI, lactate, magnetization transfer

Scientific Poster 8

Whole-Brain Proton Metabolite Changes Detected by MR Spectroscopy Imaging Following Mild-to-Moderate Traumatic Injury

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PURPOSE

Traumatic brain injury (TBI) is one of the most common causes of long-term disability. It has been shown that TBI can present as a focal process (contusions, hematomas) and/or a diffuse process (diffuse axonal injury). Neuropathologic correlates of long-term cognitive deficits in approximately 30% of mild traumatic brain injury patients remain uncorroborated by clinical and conventional neuroimaging findings. It is hypothesized that there may be diffuse metabolic alterations with or without tissue structural damages detectable by conventional neuroimaging methods. Whole-brain MR spectroscopic (MRSI) acquisition was used to quantitate metabolite alterations as a consequence of mild-to-moderate closed head injury and metabolite changes were correlated with clinical and neuropsychological measures.

MATERIALS & METHODS

MR imaging (FLAIR, T1-, T2- and diffusion-weighted) and MRSI data were acquired at 3T from 19 subjects with TBI (Glasgow coma scale: 9-15, age: 18 - 33), between 1 and 11 weeks of injury, and from 51 age-matched controls. The MRSI data were acquired using a volumetric EPI sequence and processed using the MIDAS software (1). Data processing included signal intensity normalization using the tissue water signal and spatial registration to a brain T1-MR image with atlas delineations for the eight hemispheric lobes and the cerebellum images for N-acetyl aspartate (NAA), total-creatine (Cr), and total-choline (Cho), and their ratios were obtained. Images were derived by calculating the difference between the individual-subject metabolite images and the mean of the corresponding metabolite images from controls and scaling by the standard deviation of the control group. Comparison of metabolite values calculated for each of the hemispheric lobes and cerebellum by tissue-types (gray matter and white matter) also was performed. Associations between the metabolite values/ ratios and clinical and neuropsychologic evaluation scores were determined. Unpaired-t and linear regression tests were used, with significance limit set at p ≤0.05.

RESULTS

1) Individual-subject Cho/NAA images showed widespread changes (≥3 SDs of the control-group mean) in five of eight moderate TBI and six of 11 mild TBI, mostly in the white matter. 2) The p-values of the lobar-level tissue-type analysis provided in the Table indicate significant (p ≤0.05) metabolite alterations in all the brain regions, except the cerebellum. 3) Metabolite values/ratios showed significant correlations with neuropsychologic test scores.

<table>
<thead>
<tr>
<th>Region</th>
<th>NAA</th>
<th>V</th>
<th>L</th>
<th>GM</th>
<th>WM</th>
<th>NAA/1</th>
<th>Cho</th>
<th>NAA/1</th>
<th>Cho</th>
</tr>
</thead>
<tbody>
<tr>
<td>R-Frontal</td>
<td>0.94</td>
<td>-0.01</td>
<td>0.04</td>
<td>0.76</td>
<td>0.01</td>
<td>0.04</td>
<td>-0.01 ± 0.01</td>
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<td>0.04 ± 0.01</td>
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<tr>
<td>L-Frontal</td>
<td>0.46</td>
<td>-0.01</td>
<td>-0.01</td>
<td>0.94</td>
<td>-0.01</td>
<td>0.04</td>
<td>-0.01 ± 0.01</td>
<td>0.01</td>
<td>-0.01 ± 0.01</td>
</tr>
<tr>
<td>R-Temporal</td>
<td>0.10</td>
<td>0.04</td>
<td>-0.01</td>
<td>0.14</td>
<td>0.01</td>
<td>0.04</td>
<td>0.01 ± 0.01</td>
<td>0.01</td>
<td>0.04 ± 0.01</td>
</tr>
<tr>
<td>L-Temporal</td>
<td>0.36</td>
<td>0.07</td>
<td>-0.01</td>
<td>0.22</td>
<td>0.06</td>
<td>0.01</td>
<td>-0.01 ± 0.01</td>
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<td>-0.01 ± 0.01</td>
</tr>
<tr>
<td>R-Occipital</td>
<td>&lt;0.01</td>
<td>0.01</td>
<td>0.01</td>
<td>0.17</td>
<td>0.01</td>
<td>0.02</td>
<td>0.04 ± 0.01</td>
<td>0.01</td>
<td>0.04 ± 0.01</td>
</tr>
<tr>
<td>L-Occipital</td>
<td>&lt;0.01</td>
<td>0.01</td>
<td>&lt;0.01</td>
<td>0.73</td>
<td>0.01</td>
<td>0.10</td>
<td>&lt;0.01 ± 0.01</td>
<td>0.01</td>
<td>&lt;0.01 ± 0.01</td>
</tr>
<tr>
<td>R-Parietal</td>
<td>&lt;0.01</td>
<td>0.01</td>
<td>&lt;0.01</td>
<td>0.82</td>
<td>0.02</td>
<td>0.44</td>
<td>0.17 ± 0.01</td>
<td>0.13</td>
<td>&lt;0.01 ± 0.01</td>
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<tr>
<td>L-Parietal</td>
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<td>0.01</td>
<td>&lt;0.01</td>
<td>0.86</td>
<td>0.02</td>
<td>0.69</td>
<td>0.06 ± 0.01</td>
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<td>&lt;0.01 ± 0.01</td>
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<td>R-Cerebellum</td>
<td>0.48</td>
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<td>0.01</td>
<td>0.89</td>
<td>0.01</td>
<td>0.66</td>
<td>0.06 ± 0.01</td>
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<td>0.09 ± 0.02</td>
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<tr>
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<td>0.01</td>
<td>0.16</td>
<td>0.17</td>
<td>0.01</td>
<td>0.01</td>
<td>0.12 ± 0.01</td>
<td>0.01</td>
<td>0.16 ± 0.01</td>
</tr>
</tbody>
</table>

CONCLUSION

This study demonstrates the potential of whole-brain MRSI for detection of diffuse metabolite alterations following mild-to-moderate TBI. Metabolite values/ratios showed significant correlations with neuropsychologic test scores. These findings could serve as a baseline for longitudinal studies to evaluate temporal evolution of these imaging measures.

REFERENCES

Scientific Poster 9

Diffusion Tensor Imaging Evaluation of Military Traumatic Brain Injury Patients

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PURPOSE
The National Capital Area serves as the major stop over point for injured soldiers returning from the conflicts in Iraq and Afghanistan. Over 2000 traumatic brain injury (TBI) patients have been evaluated at Walter Reed and National Navy, with about 80% of them carrying the diagnosis of mild TBI. We sought to evaluate a subset of these patients utilizing the advance neuroimaging technique diffusion tensor imaging (DTI).

MATERIALS & METHODS
Seventy-six TBI subjects were examined with MRI and DTI. TBI severity included 50 mild, 15 moderate, and 11 severe patients. Of the 76 subjects, 68 were male and 8 were female (mean age 29.7). These subjects were a mixture of blast and nonblast (MVA, fall, assault) injured patients. The mean time from injury and was 5.02 months (span 4 days to 24 months). Twelve controls were also examined (11 males, 1 female; mean age 24.7). MR image acquisition was obtained on a 1.5T GE MRI. The imaging protocol consisted of routine neuroimaging with a gradient-echo sequence and a DTI scan employing 25 diffusion directions and gradient strength-b-1000 s/mm2, with the following parameters; TE/TR= 90/7000ms, 5mm slices, image matrix 128x128, and 1 NEX. DTI images were postprocessed offline with fractional anisotropy (FA) maps generated for each patient. To avoid confounders associated with spatial normalization, a manual region of interest (ROI) methodology was utilized to delineate specific white matter tracks within selected regions of the brain. Measurements were performed by one investigator who was blinded to TBI severity. For each patient a standardized elliptical ROI volume (48-52 mm2) was copied manually and pasted within nine predetermined white matter track locations. The nine ROIs measured in this study included: left and right inferior temporal lobe white matter; left and right anterior frontal lobe white matter; genu, body, and splenium of the corpus callosum; and left and right posterior internal capsule.

RESULTS
Grouped data analysis demonstrated statically significant changes (p<0.05) in the DTI FA of moderate and severe TBI patients. In comparison to controls the severe TBI patients showed decreased FA in the frontal white matter tracks and in the genu and body of the corpus callosum. The moderate TBI patients demonstrated decreased FA in the splenium, and frontal white matter. The grouped analysis for the mild TBI patients demonstrated no statically significant changes in the ROIs in comparison to controls. However an analysis of the individual patients ROIs using a 2xSD threshold beyond the normal mean, demonstrated that 14 of the 50 mild TBI patients had one or more regions of DTI abnormality in the white matter. The majority of the DTI abnormalities were in the posterior limb of the internal capsule and the splenium of the corpus callosum.

CONCLUSION
Grouped analysis demonstrated DTI changes in moderate and severe TBI, but not in mild. Due to the variable nature of TBI, certain tracts may be damaged to different degrees, while others may be relatively spared. Grouped analysis of the data can lead to an averaging of these changes especially in mild TBI.

KEY WORDS: Trauma, DTI, TBI

Scientific Poster 10

Changes in Cavernous Sinus and Meckel's Cave in Pseudotumor Cerebri

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PURPOSE
Pseudotumor cerebri (PTC) is caused by increased pressure within the brain and is associated with headache, nausea, vomiting, papilledema and may lead to blindness if not properly diagnosed. However, conventional measurements of ventricular size on CT or MR imaging have low predictive value for this disease. This study examines additional neuroimaging findings that may provide greater accuracy in the noninvasive diagnosis of PTC, and in particular, the role of the cavernous sinus and Meckel's cave.

MATERIALS & METHODS
Patients presenting with possible PTC were evaluated retrospectively (n = 16). The clinical presentation included classical symptoms of PTC, and lumbar punctures showed elevated CSF pressures. All patients had brain MR scans and MR venograms (MRV) also were performed. MR images were examined for various parameters related to changes in intracranial pressure, including ventricular size, prominence of optic nerve sheaths, stenosis of venous sinuses, as well as the size of pituitary gland, Meckel's cave and cavernous sinuses.

RESULTS
The size of the cavernous sinuses and Meckel's caves was decreased in all cases. Abnormalities also included empty sellas (n = 13) and optic nerve sheath prominence (n = 14). The ventricular system was slightly small in most patients (n = 4), but did not generally show classical slit-like narrowed ventricles. Abnormalities of the venous sinuses were detected in all patients, with diffuse or focal narrowing that could be seen not only on MRVs, but also on conventional MR images.

CONCLUSION
Pseudotumor cerebri can be associated with various neuroimaging findings on brain MR imaging that can be used in the noninvasive evaluation of this disease. These include...
empty sella, optic nerve sheath prominence, narrowing of the venous sinuses, and a decrease in size of Meckel's caves and cavernous sinuses. The latter finding is probably due to mass effect from increased intracranial pressure and may relate to symptoms such as cranial nerve palsies. Improperly diagnosed PTC can lead to continued symptoms and eventually possibly to blindness. Careful evaluation of the above imaging parameters is therefore important to augment diagnostic accuracy of PTC in the appropriate clinical setting.

**KEY WORDS:** Pseudotumor cerebri, intracranial hypertension, cavernous sinus

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**Scientific Poster 11**

**Magnetic Resonance Imaging Study on Acute Carbon Monoxide Poisoning in Rat Brain**

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**PURPOSE**

Our purpose was to establish a new radiologic model about acute carbon monoxide poisoning in the rat brain and determine its MR imaging features to facilitate imaging study on acute carbon monoxide poisoning in rat brain.

**MATERIALS & METHODS**

Left common cervical artery in 52 male Sprague Dawley (SD) rats weighing approximately 280 grams was ligated. Twenty hours after that, 41 rats selected from them as experimental group were put into an animal hyperbaric capsule which was ventilated with 2900 ppm CO-containing air for 1 hour. The remaining 11 as control group also were put into the animal capsule which was ventilated with air for 1 hour. Shortly after they were taken out, one rat was selected from each group at random for electronic microscope examination. Five time points, namely 1 hour, 3 hours, 6 hours, 12 hours and 24 hours after poisoning were established. The remaining rats in both groups were equally divided into five subgroups accordingly. All the rats underwent brain MR examination using clinical MR scanner equipped with specially-made coil at above-mentioned time points. Apparent diffusion coefficient value in the lesions were measured in each subgroup rats. The lesion volumes in ADC maps, triphényltetrazolium chloride (TTC)-stained coronal sections, and contrasted lesion volume on MR imaging acquired 5 minutes after contrast injection were calculated using Image J software. To facilitate the comparison of lesion sizes between animals and imaging methods, the relative lesion size (RLS) was calculated with the formula RLS = lesion volume/brain volume × 100%. Numerical data were reported as means ± standard deviations (S.D.). Statistical analysis was carried out with the SPSS for windows software package (release 13.0, SPSS Inc., Chicago, IL). Analysis of variance and Q test were applied for comparison of lesion size between different techniques. A significant difference was considered if the P-value was less than 0.05.

**RESULTS**

All rats survived the procedures. The rat brain in the control group revealed nothing abnormal while the brain lesion in the experimental group was similar to that of ischemic stroke in microscopy. Apparent diffusion coefficient value in lesions decreased from 1 hour to 3 hours (p < 0.001) and kept unchanged until 24 hours (p > 0.05). The relative lesion size in ADC maps increased from 1 hour to 6 hours (p < 0.001) and kept unchanged at the intervals between 6 hours to 12 hours (p > 0.05) and further decreased from 12 hours to 24 hours (p < 0.001). The relative lesion size neared that in TTC between 6 hours to 12 hours (p > 0.05). The relative contrasted lesion size unchanged markedly (p > 0.05).

**CONCLUSION**

Our investigation demonstrates that it is feasible to investigate acute CO poisoning in rat brain with clinical MR scanner and it reveals their changing features with time.

**KEY WORDS:** Carbon monoxide, poisoning, rat

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**Scientific Poster 12**

**Effectiveness of Novalis Radiosurgery in Patients with Trigeminal Neuralgia**

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¹University of Missouri Kansas City, Kansas City, MO, ²Saint Luke's Hospital, Kansas City, MO

**PURPOSE**

To evaluate the effectiveness of Novalis radiosurgery in patients with trigeminal neuralgia.

**MATERIALS & METHODS**

From August 2006 to December 2008, 19 patients with trigeminal neuralgia underwent Novalis treatment. Eleven females patients and eight male patients, aged 48 to 90 (median 78). Median symptom duration 15 years. Four patients with left trigeminal neuralgia and 15 patients with right trigeminal neuralgia. All failed medical therapy (narcotics, neuropathic medications) and/or failed interventions (microvascular decompression, glycerol rhizotomy, nerve block, ablation, and balloon microcompression). One patient exhibited suicidal ideation from severe trigeminal neuralgia. Using Barrow Neurological Institute (BNI) Pain Intensity Scoring Criteria, 19 patients were designated according to severity of trigeminal neuralgia pre and post Novalis intervention. Follow-up periods up to 6 months were assessed using BNI Pain Intensity Scoring Criteria and for any post-treatment complication. Prior to Novalis treatment, patients received MRI with MRI trigeminal nerve protocol for localization and assessment of trigeminal nerve. MRI trigeminal nerve protocol consisted of: three plane localizer with Sagittal T1, Ax T1 3D SPGR 1.5mm, Ax T2 2D FRFSE 1.5 mm, and Ax 3D Fiesta 2.0mm. Novalis radiosurgery (shaped beam surgery) is noninvasive treatment, which employs a highly focused beam of radiation with highest level of accuracy. Due to beam shaping capabilities, a radiation beam can be tailored to the treatment area, thereby protecting healthy brain tissue from unnecessary irradiation.
RESULTS
Nineteen patients who underwent Novalis radiosurgery for trigeminal neuralgia, 17 (89%) patients were designated with preintervention BNI IV (some pain, not adequately controlled with medications) and two patients (10%) were designated with preintervention BNI V (severe pain, no relief). Of the 19 patients, 18 patients (95%) resulted in symptomatic improvements and one patient (5%) resulted in no symptomatic improvement, six patients improved from BNI IV to BNI I (no trigeminal pain), nine patients improved from BNI IV to BNI II (occasional pain, no need medication), one patient improved from BNI IV to BNI III (some pain, adequate control with medication), one patient improved from BNI V to BNI III, one patient improved from BNI V to BNI II, and one patient resulted in no change pre and post Novalis intervention, BNI score IV. All 19 patients reported no clinical complications post Novalis intervention.

CONCLUSION
Novalis radiosurgery is a highly successful intervention with significant improvement in BNI Pain Intensity Score for the treatment in patients with severe trigeminal neuralgia and carries a minimal treatment complication.

KEY WORDS: Trigeminal, novalis

Scientific Poster 13

Evaluating Antiangiogenic Therapy Response in Patients with Glioblastoma Multiforme Using Hemodynamic Response Imaging

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1Functional Brain Center, Tel Aviv Sourasky Medical Center, Tel Aviv, ISRAEL, 2Tel Aviv University - Sackler Faculty of Medicine, Tel Aviv, ISRAEL, 3Tel Aviv Sourasky Medical Center, Tel Aviv, ISRAEL, 4Goldyne Savad Institute of Gene Therapy, Hadassah University Medical Center, Jerusalem, ISRAEL

PURPOSE
One of the main characteristics of malignant phenotype of a lesion is formation of new and abnormal blood vessels (angiogenesis). Close correlation between angiogenic processes and poorer prognosis have led, during recent years, to new strategies utilizing combinations of antiangiogenic and chemotherapies. Yet, methods for monitoring vasculature changes under such therapies are limited. We previously have presented a novel fMRI method [hemodynamic response imaging (HRI)], using hyperoxia and hypercapnia for detection of vascular functionality and maturation, both in animal models as well as in human brain tumors (1,2). This method has been shown to facilitate detection of mature vessels resistant to antiangiogenic therapy in animal models (3), and to differentiate between various tissue types with high sensitivity in humans (2). The aim of this study was to evaluate the sensitivity of HRI to assess therapy response of patients with glioblastoma multiforme(GBM) who received antiangiogenic therapy.

MATERIALS & METHODS
Three patients with recurrent GBM treated with a combination of anti VEGF and cytotoxic chemotherapy were scanned several times during course of therapy with conventional MRI methods and proposed method (HRI), at intervals of 2-8 weeks (total of 10 MR examinations). MRI was performed on a 3T GE-scanner. For the HRI method, gradient-echo EPI sequence was used with TR=5000msec and TE=35msec. Two separate scans were performed, each using block design paradigm with inhalation of either 95% O2 + 5% CO2 or 95% air + 5% CO2 and 100% air. Statistical maps of the signal intensity changes were analyzed using Matlab package SPM5.

RESULTS
At baseline scan (before therapy), HRI demonstrates areas that respond to O2 within the enhanced lesion and show no response to CO2. After 2 weeks of therapy, partial response was detected based on T1-weighted images postgadolinum. Using HRI method, a response to CO2 became visible within the enhanced tumor area. This vascular response to CO2 might indicate the existence of smooth muscles within the blood vessels, demonstrating a process of “vessel normalization” as a result of antiangiogenic therapy. Such a mechanism previously has been proposed to occur with anti-VEGF therapies (4).

CONCLUSION
HRI is a novel noninvasive method for vascular assessment which provides additional information regarding vessel permeability and maturation. This method shows high sensitivity for evaluating therapy response and might have added value in clinical management.

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KEY WORDS: Antiangiogenic, hemodynamic, GBM
High-Resolution MR Imaging of Brain Lactate Using Selective Saturation Transfer

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PURPOSE
Lactate, an important metabolic biomarker for various neurologic disease states, now is recognized also as an essential substrate of neuronal metabolism (1). MR spectroscopic (MRS) methods have been used previously to measure brain lactate concentrations but have limited temporal and spatial resolution. We investigated whether magnetic coupling between lactate methyl and water protons previously reported in MRS studies (2) and in phantoms (3) could be exploited to generate lactate-specific MRI contrast.

MATERIALS & METHODS
MR imaging was performed on a 7T Bruker Biospec horizontal bore system. We imaged phantoms of varying lactate concentrations combined with 20% heat cross-linked bovine serum albumin (BSA) (pH 7.0, temperature 30-35°C), and two C57 black mouse models: normal mice before and after intraperitoneal glucose injection, and mice undergoing transient middle cerebral artery occlusion (MCAO). Lactate imaging sequence: 10 gaussian saturation pulses (flip angle 30°, RF power 2 μT, 150Hz bandwidth, MT module duration 183 ms) at offsets of +/- 3.4 ppm (1020 Hz, corresponding to lactate methyl protons) from the bulk water peak; FLASH acquisition (2.4 FOV, matrix 128 x 128, slice thickness 1mm, flip angle 20°, TR/TE 400/2.2ms); identical acquisitions without MT (magnetization transfer) prepulse train. -3.4 ppm images subtracted from +3.4 ppm images create final MT subtraction images. MT ratio (MTR) images were created by digital division of +/- 3.4 ppm images into the non-MT image.

RESULTS
MTR images demonstrate micromolar sensitivity for lactate in vitro (Figure 1). In brain, baseline lactate is low (mean MTR 3.7 +/- 1.2) and most prominent in the basal ganglia. MTR imaging demonstrated a global increase in lactate accumulation following i.p glucose (mean MTR 6.0 +/- 0.9 at 90 minutes) most pronounced in the basal ganglia. In stroke, lactate images demonstrate significant lactate accumulation in the MCA territory during occlusion and preceding DWI abnormality, near complete washout of lactate following reperfusion, and persistence in region of stroke extension on DWI at 24 hours.

Figure 1. Lactate detection in BSA phantoms.

CONCLUSION
Changes in lactate readily can be detected at concentrations at least one to two orders of magnitude lower than MRS and at higher spatial resolution using a saturation transfer sequence, allowing for high-resolution mapping of lactate change in vivo. Extension to humans would allow noninvasive imaging of lactate in normal brain function and disease.

REFERENCES
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KEY WORDS: Lactate, saturation transfer, MR
CONCLUSION
In summary, this study described our current experience with ASL based on the clinical sample. Arterial spin-labeling perfusion imaging can be implemented successfully into a routine clinical neuroimaging protocol and can accurately demonstrate alterations in brain perfusion.

KEY WORDS: Arterial spin-labeling

Scientific Poster 16
Perfusion MR Imaging: New Doors Open for Glial Neoplasm

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PURPOSE
To investigate the efficiency of perfusion MR imaging in discrimination of high- and low-grade gliomas. To compare baseline relative cerebral blood volume (rCBV) with histopathology and tumor progression and examine whether rCBV measurements can be used to predict clinical outcome in patients with low-grade gliomas.

MATERIALS & METHODS
Dynamic susceptibility contrast-enhanced MR imaging and determinations of maximal rCBV were performed in 88 subjects with histopathologically confirmed diffuse gliomas. The study included 51 male patients and 37 female patients (median age 53.4 years; range 19 to 75 years). Tumors were divided according to the WHO 2007 classification of tumors of the central nervous system into low- (grade II) and high-grade (grade III and IV) lesions. To avoid potential diagnostic error with biopsy samples, we studied the differences of rCBV in patients grouped in clinical response categories (complete or stable response versus progressive or death). Low-grade tumors showing progression during the first year follow up were reclassified into high-grade tumors. Comparison of rCBV between high- and low-grade gliomas was obtained, considering separately the histologic diagnosis and clinical diagnosis (histologic diagnosis corrected by clinical follow up). P values <0.05 were considered significant. The mean values of rCBV were compared by means of the student’s t-test. Receiver operator characteristic (ROC) curves were determined for parameters with high sensitivity and specificity in order to identify threshold values to separate high- from low-grade lesions.

RESULTS
According to histologic criteria alone, in low- and high-grade gliomas mean rCBV was measured as 2.58 ± 1.46 and 5.31 ± 2.69 (mean ± SD), respectively (p<0.001). If we consider patients grouped in different response categories (clinical behavior r considered for the diagnosis of low- and high-grade gliomas), the difference was even greater, with a rCBV value of 1.93 ± 0.94 for low-grade versus 5.04 ± 2.62 for high-grade lesions (p<0.001). Six patients with biopsy-proved grade II tumors (8% of low-grade gliomas) showed increased rCBV suggesting a higher grade than the grade diagnosed at pathology. Clinical worsening at 1-year follow up as well as increasing enhancement confirmed the diagnosis of high-grade tumor proposed on the initial perfusion MRI. ROC curves for the most significant parameter rCBV tumor/normal tissue ratio were determined. Threshold value was 2.4 (sensitivity = 73.5%; specificity = 78.9%) for rCBV tumor/normal tissue ratio.

CONCLUSION
Relative cerebral blood volume values significantly correlate with tumor grade in diffuse gliomas. Dynamic susceptibility contrast-enhanced perfusion MR imaging can be used to predict clinical outcome in patients with low-grade gliomas, independent of pathologic findings. In fact, high rCBV values in tumors histologically classified as low-grade lesions can help to predict an aggressive clinical course. From the ROC curves, a high probability for a neoplasm to be a high-grade lesion was associated with a rCBV of > 2.4.

KEY WORDS: Brain tumor, gliomas, perfusion MR imaging

Scientific Poster 17
Influence of the Stupp Scheme in High-Grade Glioma: Perfusion Analysis Using Dynamic Susceptibility Contrast MR Imaging (DSC-MRI) in a Brain Tumor Model

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PURPOSE
Significant long-term survival in glioblastomas is found in patients with complete resection and also the so-called Stupp scheme, which has become the gold standard of care. After resection of the lesion patients undergo radiation and receive cycles of chemotherapy using temozolomide. Glioblastomas demonstrate neovascularization and proliferation and thus increased perfusion. Dynamic susceptibility contrast MR imaging (DSC-MRI) commonly is used preoperatively for differential diagnosis of brain tumors. The purpose of this study was to assess perfusion changes caused by brachytherapy combined with a cycle of temozolomide in a malignant brain tumor model.

MATERIALS & METHODS
A C6-glioma model was used in 13 Wistar rats stereotactically injecting 106 glioma cells into the basal ganglia. This induces a rapid aggressive tumor growth resembling the human glioblastoma multiforme. Sixteen days after injection of the cells MR imaging was performed using a 3T scanner and a dedicated solenoid coil (Philips, Best, The Netherlands) including T1- and T2-weighted sequences to define tumor size prior to therapy. Six rats received both 20 mg/kg/d temozolomide i.p. and brachytherapy using HDR afterloading remote machine (VarioSource IX, Varian Medical Systems, Charlottesvile, Inc., VA, USA) for 5 days (2 Gy per fraction) followed by another MR image including a DSC-MRI using a T2*-weighted EPI PRESTO sequence (TR/TE = 30/14 ms, matrix 64 x 64, FOV 90 mm; slice thickness of 1.5mm). Ratios of rCBV and rCBF were creat-
ed using the Nordicsee Software (NordicNeuroLab, Bergen, Norway). As rats have an increased metabolism the applied dose of temozolomide was corrected accordingly.

RESULTS
Compared to control animals, the Stupp scheme led to a significant reduction of the cerebral blood volume in the tumor (rCBV; t= 2.09, p = 0.03, one-tailed t-test). The cerebral blood flow with and without therapy did not differ significantly. Tumor size also did not differ between therapy and control.

CONCLUSION
After one cycle of therapy with temozolomide and combined brachytherapy we found a significant reduction of cerebral blood volume within the lesion. It is surprising to find these changes as early as 5 days after beginning of therapy. Prior to tumor shrinkage perfusion is reduced that might influence cleavage and thus tumor growth by decreasing nutrition and oxygen supply. In humans temozolomide is given for 5 days in a 4-week cycle after radiation is completed. Dynamic susceptibility contrast MR imaging is a powerful tool in assessing response to treatment and should become a mainstay of follow-up MRI exams. Further studies are needed to understand response to treatment, but DSC-MRI has proven to be a sensitive method to depict changes in cerebral perfusion immediately after the beginning of the therapy.

KEY WORDS: Stupp scheme, DSC-MRI, tumor model

Scientific Poster 18

Early 11C-Methionine PET Changes for Monitoring Therapeutic Response Following Simultaneous Integrated Boost Technique by Helical Tomotherapy with Chemotherapy for Glioblastoma Multiforme

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PURPOSE
We developed simultaneous integrated boost technique (SIB) by helical tomotherapy (HT) planned by 11C-methionine (MET)-PET, and quantified the effect of MET-PET in defining tumor volume and in monitoring the tumor's response to radiation for SIB with chemotherapy.

MATERIALS & METHODS
We performed SIB in 17 patients with glioblastoma multiforme (GBM) with subtotal resection. GTV-1 was defined as the area of intensive MET uptake, including the surgical resection surface. GTV-2 was defined as the area of abnormal MET uptake relative to normal brain tissue around the resection cavity. PTV-1 encompassed GTV-1 plus 5 mm margin, and PTV-2 encompassed GTV-2 plus 2 mm margin. Simultaneous integrated boost technique was performed in eight fractions, planning the dose for GTV-1 at 68 Gy, PTV-1 at 56 Gy and PTV-2 at 40 Gy with concurrent temozolomide (TMZ) at a dose of 75mg/m², then adjuvant TMZ at a dose of 150mg/m². Each patient underwent a series of MET-PET exams: baseline prior to SIB, 3 months following SIB and 6 months following SIB. In each patient, the change of uptake value of MET in the PTV-1 and PTV-2 (PTVs) after SIB was investigated quantitatively, and the emergence of new abnormal MET uptake after SIB was examined qualitatively.

RESULTS
In the acute phase, no severe acute toxicity was observed, and radiation necrosis did not develop in any of the patients. Among our patients, MET-PET exams were performed in all 17 patients 3 months after SIB and in 10 patients 6 months after SIB. At 3 months following SIB, MET uptake value in the PTV-1 was reduced in all 17 patients (average 32.3%), compared to baseline. The uptake value in the PTV-2 at 3 months following SIB was reduced in 14 of 17 patients (average 22.8%), and increased in three patients (average 14.6%). In one of those three patients, new abnormal MET uptake was seen at the edge of the PTVs. At 6 months following SIB, the uptake value in the PTV-1 was reduced in all 10 patients (average 35.4%), compared to baseline. The uptake value in the PTV-2 at 6 months following SIB also was reduced in all 10 patients (average 25.3%). However, in three of those 10 patients, new abnormal MET uptake at the outside of PTVs was seen.

CONCLUSION
The SIB technique with TMZ planned by MET-PET demonstrated significant efficacy in control of the regional tumor in the early phase of the disease, and appeared to have no severe side effects or neurologic toxicity. Preliminary results demonstrated that the uptake value of MET decreases after SIB at the PTV-2 of 40 Gy, as well as at the PTV-1 of 56 Gy in the majority of patients. In some cases, however, it is still difficult to prevent tumor recurrence at the outside of PTVs, even if the original tumor was well controlled.

KEY WORDS: Glioblastoma multiforme, 11C-methionine PET, simultaneous integrated boost technique

Scientific Poster 19

Central Nervous System Involvement in Patients with Multiple Myeloma

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PURPOSE
Multiple myeloma usually is restricted to the bone marrow. Central nervous system involvement is uncommon and can be observed in approximately 1% of the multiple myeloma patients. We aimed to demonstrate brain magnetic resonance patterns in patients with multiple myeloma with neurologic symptoms and the literature is reviewed.

KEY WORDS: Multiple myeloma, Central nervous system involvement, 11C-Methionine PET, simutaneous integrated boost technique
MATERIALS & METHODS
We retrospectively studied 39 patients with multiple myeloma with neurologic symptoms. All the patients underwent classic and contrast-enhanced brain MR examination.

RESULTS
Patients presented with the following symptoms: impaired consciousness (n = 8, 20.5%), headache (n = 6, 15.3%), hemiparesis (n = 2, 5.1%), aphasia (n = 6, 15.3%), scalp swelling (n = 2, 5.1%), visual loss (n = 1, 2.5%), seizure (n = 2, 5.1%), vertigo (n = 4, 10.2%), ophthalmoplegia (n = 4, 10.2%), meningeal irritation findings (n = 2, 5.1%), and orientation disorder (n = 2, 5.1%). Among 39 patients with multiple myeloma, 14 (35.8%) had ischemic lesions, 14 (35.8%) had calvarial diploic metastases, 5 (12.8%) had dura mater mass, 4 (10.2%) had dura mater involvement, 2 (5.1%) had sinusosal mass, 1 had cavernous sinus and orbital apex mass, 1 (2.5%) had leptomeningeval involvement, 1 (2.5%) had intraorbital mass, 3 (7.6%) had clivus mass, 1 (2.5%) had optic neuritis, 1 (2.5%) had central pontine myelinolysis and 2 (5.1%) had meningitis. Examination of the cerebrospinal fluid was performed in six patients. Cerebrospinal fluid studies showed malignant plasma cells in one patient with leptomeningeval contrast enhancement. Despite serial cerebrospinal fluid examination, plasma cells in cerebrospinal fluid were not showed in two patients with dura mater involvement. Two patients had menengitis.

CONCLUSION
Involvement of the central nervous system in multiple myeloma is very uncommon. The occurrence of neurologic symptoms in a patient with myeloma requires an accurate evaluation with MR and lumbar puncture to detect a possible meningeal or cerebral involvement, when metabolic factors (hypercalcemia, uremia), hyperviscosity, or medullary compression can be excluded.

KEY WORDS: Central nervous system, multiple myeloma, MR imaging

Scientific Poster 20
Glioblastoma Treatment with Bevacizumab: MR Imaging with Pathologic Correlation in Human Specimens and Animal Models
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PURPOSE
Tumor progression following treatment of high-grade gliomas with the monoclonal antibody to vascular endothelial growth factor (VEGF) bevacizumab is extremely difficult to treat. Patients with high-grade glioma treated with bevacizumab alone or in combination with cytotoxic chemotherapy such as Irinotecan (CPT-11) have demonstrated impressive reductions in enhancement and vasogenic edema by MR imaging, which correlates with a decrease in vascular permeability. Following an initial response to the regimen as defined by a reduction of the contrast-enhancing tumor, some patients fail this treatment regimen, which can be observed by MR imaging as an increase in the nonenhancing or infiltrative tumor. To date, there have been no reports of paired MR imaging and tumor samples correlating the pathologic features of this aggressive tumor phenotype.

MATERIALS & METHODS
We provide three illustrative cases of patients with high-grade gliomas that demonstrate an apparent phenotypic shift of tumor progression after treatment with bevacizumab to a predominantly infiltrative pattern of failure. In an attempt to better understand this complication of anti-VEGF therapy, we forced a highly angiogenic, noninvasive tumor into an infiltrative tumor in a murine orthotopic glioma xenograft model by treatment with bevacizumab.

RESULT
Pathologic examination of tumor infiltration revealed areas of thin-walled blood vessels suggesting vascular “normalization” adjacent to areas of necrosis. High levels of IGFBP1 and MMP2 expression were seen within infiltrating tumor. This model mimicked the histopathologic findings from the human cases.

CONCLUSION
We demonstrate illustrative cases of neuroimaging with pathologic correlates of failure to bevacizumab therapy and mimicked aspects of this pattern of treatment failure in an orthotopic xenograft model. This model demonstrates the role of anti-VEGF therapy in the promotion of infiltrative tumor progression and will allow the discovery of alternative or additive therapies to prevent these types of tumor recurrences in clinical practice.

REFERENCES

KEY WORDS: Bevacizumab, glioblastoma, MR Imaging
Cerebral Tumor-Like Chagas' Disease: Conventional Spin-Echo and Advanced MR Imaging Findings

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PURPOSE

Chagas' disease is caused by infection by the parasite Trypanosoma cruzi and is endemic in many Latin American countries. Cerebral tumor-like lesions are an uncommon complication of the disease and has thus far been observed only in immunosuppressed patients. The aim of this study is to describe the characteristic imaging findings using conventional and advanced MR imaging techniques in two pathologically proved cases of intracranial Chagas' disease. Both patients had a previous history of kidney transplantation.

MATERIALS & METHODS

We report two patients, 26 and 23 years of age respectively, who developed progressive focal neurologic signs and intracranial hypertension 3 years after kidney transplantation. Conventional spin-echo sequences, diffusion-weighted imaging (DWI), perfusion-weighted imaging (PWI) and MR spectroscopy (MRS) were performed with a 1.5 T MR imaging scanner. Both patients had no previous history of myocardiitis or systemic Chagas' disease and both went to surgery.

RESULTS

In both patients, neuroimaging depicted an expansive intraaxial mass in the left frontal lobe with a similar and characteristic pattern of findings. The lesions had a central solid portion with low signal on T2WI and a striking globular pattern of enhancement. Small areas of intrinsic hyperintensity on precontrast T1WI were observed as well. The larger lesion reached approximately 4 cm in greatest diameter. The lesions also were surrounded by a large area of hyperintensity on T2WI probably representing vasogenic edema. No areas of restricted diffusion were observed. Absence of areas of high capillary density on PWI suggested an inflammatory process. Conventional and advanced MR imaging techniques in two pathologically proved cases of intracranial Chagas' disease. Both patients had a previous history of kidney transplantation.

CONCLUSION

Intracranial Chagas' disease may present as an expansive mass that in our two cases had similar findings: a) central low signal on T2WI, b) globular solid pattern of enhancement, c) no areas of restricted diffusion, d) no areas of high capillary density on PWI, e) Low NAA peaks and an elevated choline to creatine ratio on MRS. Intracranial Chagas' disease should be considered in cases of cerebral tumor-like lesions having these imaging findings in immunocompromised patients from endemic regions even without a history of infection by T. cruzi. DWI, PWI and MRS may have an important role in distinguishing Chagas' disease and additional studies may be needed.

KEY WORDS: Chagas' disease, inflammatory

Characteristic MR Imaging Findings of Acute and Chronic Progressive Neuro-Behçet's Disease

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PURPOSE

Recent studies describe acute, and chronic progressive forms of neuro-Behçet's disease (NB), their different clinical courses, prognosis and effective treatments. Acute NB patients have an onset of meningoencephalitis accompanied by fever. They are treatable with steroids and their neurologic prognosis is favorable. On the other hand, chronic progressive NB patients frequently have onsets of gait disturbance and dysarthria. Neurologic disturbances develop gradually without neurologic attacks and the neurologic prognosis is quite poor. We reviewed 38 Japanese NB patients to determine MR image characteristics of each form.

MATERIALS & METHODS

We retrospectively reviewed MR images of 38 NB patients (acute NB; 19, chronic progressive NB; 19), investigated between 1994 and 2008. We also measured the area of thepons and midbrain of 23 of the patients (acute NB; 8, chronic progressive NB; 15) on mid-sagittal T1WI, and compared 142 control subjects.

RESULTS

In acute NB, two patients presented thickened meninges and abnormal meningeal enhancement. T2 prolonged lesions were observed in the brainstem (n = 6), thalamus (n = 4), basal ganglia (n = 4) and cerebral deep white matter (n = 5). No significant differences were observed in the pons and midbrain of patients and controls. In chronic progressive NB, T2 prolonged lesions were observed in the brainstem (n = 7), thalamus (n = 1), basal ganglia (n = 3) and cerebral deep white matter (n = 5). Cerebellar atrophy was seen in 12 patients. Visually apparent atrophy of the brainstem was seen in 13 patients and the area of the pons and midbrain was significantly smaller than in controls.

CONCLUSION

In chronic progressive NB, brainstem atrophy is treatable with steroids and the neurologic prognosis is favorable. On the other hand, chronic progressive NB patients are treatable with steroids and their neurologic prognosis is favorable. On the other hand, chronic progressive NB patients frequently have onsets of gait disturbance and dysarthria. Neurologic disturbances develop gradually without neurologic attacks and the neurologic prognosis is quite poor. We reviewed 38 Japanese NB patients to determine MR image characteristics of each form.
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‘H-MR Spectroscopy Utilizing a 1T Open MR System: Multisite Clinical Test Results

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PURPOSE
Proton MR spectroscopy (‘H-MRS) has been long established for the study and diagnosis of neurologic disorders. In a recent study, 1.0T spectra acquired on patients with normal brain chemistry demonstrated metabolic sensitivity comparable to spectra collected at 1.5T and 3.0T(1). We initiated a multisite clinical test to evaluate whether clinically useful metabolic information can be obtained on patients with brain pathology within three different clinical practices.

MATERIALS & METHODS
Water-suppressed single voxel ‘H-MRS (SVS) and 2D spectroscopic imaging (2D-SI) of the brain were performed with point resolved spectroscopy (PRESS) localization on a 1.0T open whole-body MR system (Panorama HFO, Philips Healthcare). PRESS SVS and/or 2D-SI localized spectra were added to standard brain protocols for patients undergoing MR brain imaging. Both SVS and 2D-SI used TR/TE 1500/144 msec, with total scan times of 5:15 (min:sec) for the SVS, and 5:44 for 2D PRESS, which utilized SENSE to reduce scan time by a factor of 2.

RESULTS
Figures 1a and b show typical SVS spectra from the 1.0T open MR system. The spectra were obtained within a thalamic astrocytoma (a) and the subsequent transformation to a glioblastoma multiforme (GBM) (b) in a 66-year-old female. The astrocytoma spectrum shows elevated choline with significantly reduced NAA, an inverted lactate doublet, and elevated myoinositol (mI), all consistent with a grade III astrocytoma. Spectrum (b), with the absence of myoinositol, represents a GBM. The simulated 1.0T TE 144 PRESS spectrum of myoinositol has a distinct singlet-like peak at 3.54 ppm, which is not the case at higher field strengths. This is consistent with recent publications which concluded that not all predicted spectroscopic gains at higher field strength can be realized(2,3).

CONCLUSION
This study demonstrates high quality ‘H-MRS spectra acquired in a high field open magnet. With habitus-limited radiology studies increasing due to rising numbers of obese patients (4), as well as the potential for performing MR radiation therapy planning (5,6), a 1.0T open MR system has become a valuable tool in the diagnosis and treatment of a variety of disease processes.

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KEY WORDS: Spectroscopy, neoplasm, radiotherapy

Scientific Poster 24

A Novel High-Resolution Brain SPECT and Its Applications in Functional Neuroimaging

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PURPOSE
Chronic neurologic diseases such as epilepsy, Parkinson and Alzheimer are difficult to study with traditional “physical” 3D neuroimaging. These diseases are involved more often with subtle disturbances of functional and/or molecular processes in the brain such as neurotransmission. The development of radiopharmaceuticals that can specifically target these disease processes has caused an emergence of SPECT and PET neuroimaging. However these conventional systems whose basic principles have been around since the 60s suffer from poor spatial and contrast resolution. This has led to the term “fuzzy” imaging which generally are known to have no better than 5-10 mm resolution in any one axis. This poster will present an entirely new method of SPECT detection, acquisition, and reconstruction which has been conceived to approach 2-3 mm resolution. This is felt to be absolutely necessary to make the qualitative and quantitative measurements necessary to determine the presence or absence of disease given the discrete anatomical structures that are typically affected.

MATERIALS & METHODS
This paper will describe a novel design which utilizes focusing collimators in a raster process similar to scanning electron microscopy. A portable device of this type has been designed and built and is undergoing clinical and regulatory testing. Scans of patients with intractable epilepsy and Parkinson disease have been imaged in comparison with conventional SPECT and PET.

RESULTS
This focused SPECT method has been shown to separate the caudate nucleus and putamen and differentially quantify the uptake of a dopamine radio-ligand. Conventional SPECT has been incapable of this separation and quantification. Comparison images are provided in Figure 1.
CONCLUSION

Functional imaging is likely to add to the repertoire of diagnostic imaging. However, neuroimaging places higher demand on spatial and contrast resolution. An entirely new type of SPECT imaging has been conceived that could play a key role in diseases such as epilepsy, Parkinson and Alzheimer. Comparison to conventional SPECT shows greater than an order of magnitude improvement in quantitative brain imaging.

KEY WORDS: SPECT high resolution, functional imaging, brain

Scientific Poster 25

Diagnostic Value of Susceptibility-Weighted Imaging in Diffuse Axonal Injury

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PURPOSE
To study the diagnostic value of susceptibility-weighted imaging (SWI) in diffuse axonal injury (DAI) and the relationship between SWI and clinical prognosis.

MATERIALS & METHODS
Twenty patients (15 males and 5 females) with DAI were included in this study. Routine sequences (T1WI, T2WI and FLAIR) and SWI were performed on 3.0 T MR imaging system. The average age of all patients was 34 years old. The injuries were caused by traffic accident in 16 cases, fall in two cases, heavy pound in one case and beating in one case. There were eight cases whose Glasgow score Scale (GCS) ranged from 3 to 5, four cases from 6 to 8 and eight from 9 to 12. The interval time between injury and examination were between 3 hours to 20 days. The number and volume of lesions observed in SWI and routine sequence were compared.

RESULTS
Routine MR imaging scan found a total of 78 lesions, while SWI sequence detected 424 lesions. The number of the lesions found in SWI sequence was higher than that of conventional MRI (u = -15.447, P < 0.01). The total volume of the lesions measured in routine MR imaging and SWI were 19.340 mm³ and 38.042 mm³, respectively. The total volume measured in SWI was bigger than that in routine MR (t = 5.870, P < 0.01). The number and volume of all lesions were negatively correlated with GCS (r = -0.802, P < 0.01 and r = -0.767, P < 0.01).

CONCLUSION
Susceptibility-weighted imaging sequence can find more bleeding lesions than the routine MR imaging sequences. The number and the volume of the lesions were related closely to GCS. Susceptibility-weighted imaging shows high value in diagnosis and prognosis of the DAI.

KEY WORDS: Susceptibility-weighted imaging, diffuse axonal injury, diagnosis

Scientific Poster 26

Optic Tracts in Blind Humans: Evaluation with Diffusion Tensor Imaging

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PURPOSE
Plasticity of primary and secondary visual cortical regions in blind humans has been demonstrated in different studies. In contrast to the known changes in the cortical organization, it still remains unknown, in how far blindness affects the organization of the visual white matter tracts. The aim of this study is to qualitatively and quantitatively compare optical tracts in visually impaired and healthy subjects by means of diffusion tensor imaging.

MATERIALS & METHODS
A total of 41 blind (27 congenital, 14 acquired) and 26 healthy subjects were enrolled in this study following an institutional review board approval and written informed consent. All imaging was performed using a 1.5 T scanner (GE SIGNA Excite, Wisconsin, Illinois) and an 8-channel head coil. The imaging protocol included T1-, T2-, diffusion-weighted images in the axial plane, 3D spoiled gradient-echo images and diffusion tensor images (DTI). Diffusion tensor images were obtained employing spin-echo EPI sequence with two b values (0 and 1000 s/mm²) along 25 different gradient axes with the following parameters; TR:6500 ms, TE: 95 ms, FOV: 28x28 cm, matrix: 160x128, slice thickness: 6 mm, interslice gap: 1 mm. Fractional anisotropy (FA) and relative anisotropy (RA) maps derived from these data sets were compared visually for both groups. For quantitative assessment FA and RA values from the lateral geniculate ganglion, Meyer's loop, optic radiata were measured using a circular ROI placed under the guidance of thin section 3D images on both sides. Same values also were measured from the corticospinal tracts for control purposes. Student's t tests were used for statistical analysis.
RESULTS
Visual inspection of FA and RA maps failed to show any differences between two groups. Bilateral FA and RA values of the lateral geniculate nucleus in the blind subjects were statistically significantly lower than those of the corresponding anatomical sites in the normal subjects. Fractional anisotropy and RA values measured from the optic radiata, Meyer's loop and control localizations failed to show any statistically significant difference between those two groups.

CONCLUSION
Low FA and RA values measured over the lateral geniculate nucleus indicated a loss of integrity which failed to extend more distally in the optic pathways of blind humans. This information might be of importance in selecting patients for future retinal implants, since a functional transmission of the information delivered by these implants to the primary visual regions of the brain needs an intact optic radiation.

KEY WORDS: Blindness, DTI

Scientific Poster 27

Predicting Acute Ischemic Stroke by Measuring the Degree of Ocular Gaze Deviation (Prévost’s Sign) on CT

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BACKGROUND AND PURPOSE
Ocular gaze deviation (OGD) is a well-known clinical observation (Prevost’s sign) in patients with acute cerebral ischemic stroke. Although OGD has been observed on computerized tomography (CT) in acute stroke, no investigation has quantified the degree of OGD in acute stroke.

MATERIALS & METHODS
We performed a blinded, prospective, comparison of two groups of adult patients who underwent computerized tomography (CT) of the brain. Group 1 enrolled patients with acute hemiplegia or hemiparesis due to middle cerebral artery ischemic stroke. Group 2 enlisted ambulatory outpatients with a history of headache but no clinical neurologic signs or cerebral pathology on CT. We cropped the CT images to only show the orbital contents. A neuroradiologist, who was blinded to the clinical data, then measured the OGD for both groups. The OGD was quantified using the axial planes of the lenses relative to the nasal midline structures and the bilateral OGD average was calculated. We also evaluated both groups for conjugate or disconjugate gaze. We analyzed the results with the Fisher’s Exact test.

RESULTS
Ten of 70 patients in Group 1 and 15 of 46 patients in Group 2 were eligible for analysis. The frequency of conjugate and disconjugate gaze was similar in the two groups (p=0.596). An averaged OGD of >14 degrees and an OGD >18 degrees in either globe was predictive of the presence of acute stroke (p=0.0166).

CONCLUSION
Measurement of OGD is useful in predicting the presence of acute ischemic stroke.

KEY WORDS: Ocular gaze deviation, stroke, computerized tomography

Scientific Poster 28

Impaired Microstructural White Matter Integrity in Treatment-Resistant Unipolar Depression

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PURPOSE
Treatment-resistant unipolar depression (TRD) is relatively common, but its neurobiologic basis is poorly understood. Disruption in the integrity of fronto-striatal neural circuits has been suggested in depressive patients (1), but its association with treatment resistance has not been well established. Diffusion tensor imaging (DTI) is an MR imaging technique which is highly sensitive to the microstructural white matter abnormalities, not detectable by routine MR imaging sequences (2). This study evaluated the integrity of microstructural white matter of patients with TRD, using DTI.

MATERIALS & METHODS
Diffusion tensor imaging was performed in 13 patients with TRD (9 men and 4 women; mean age = 42 ± 11 years), nine patients with non-TRD (5 men and 4 women; mean age = 52 ± 11 years), and 22 normal healthy subjects (14 men and 8 women; mean age = 46 ± 12 years). For all patients, DTI was performed at the initial visit to depression clinic. Fractional anisotropy (FA) and mean diffusivity (D) values were compared voxel-by-voxel, using one-way analysis of variance (ANOVA) and post-hoc t-tests. False discovery rate (FDR)-corrected p<0.05 and cluster size of >100 voxels were considered significant. Significant alterations of FA and D, if any, were correlated with the Global Assessment of Functioning (GAF) scales, obtained at the time of DTI. For this purpose, Pearson’s product moment correlation analysis was used, and p<0.05 was considered significant.
RESULTS
Significant FA decrease was observed in the bilateral frontal white matter of patients with TRD (Figure), which correlated significantly with GFA scales (r = 0.48). No significant FA abnormality was observed in the non-TRD patients. There were no voxels with significant FA increase or D alterations, in both patient groups.

CONCLUSION
Diffusion tensor imaging revealed the impaired integrity of bilateral frontal white matter in patients with TRD. These findings may suggest the involvement of fronto- striatal neural circuits in TRD, and support the hypothesis that the neuroanatomical circuit abnormality is a key factor in the functional anatomy of TRD. Further investigations still are needed for clearer understanding about the white matter abnormalities in TRD.

REFERENCES

KEY WORDS: Unipolar depression, diffusion tensor imaging, frontal white matter

Scientific Poster 29
Restricted Diffusion in the Thalamus in Patients with Seizures

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PURPOSE
We present five patients who manifested restricted diffusion in the thalamus in addition to other classically described locations on MR imaging following documented seizures. In these cases, the thalamic involvement allows a more confident diagnosis of seizure-related neuronal injury rather than Herpes Simplex encephalitis, which would be an important consideration given the hippocampal involvement. Also, we will summarize current opinion on the role of the thalamus in seizures.
MATERIALS & METHODS
We examined thickness and volumetric measures of atrophy, derived from automated software, in 34 neocortical and non-neocortical regions using high-resolution, T1-weighted MR imaging scans of 313 individuals from two independent cohorts. The first cohort included 49 older controls (OC) and 48 individuals with MCI while the second cohort included 94 OC and 57 MCI. Sixty-five patients with probable AD also were included for comparison.

RESULTS
For discrimination of MCI, entorhinal cortex thickness, hippocampal volume, and supramarginal gyrus thickness demonstrated an area under the curve (AUC) of 0.91 for the first cohort and an AUC of 0.95 for the second cohort. For the discrimination of AD, these three measures demonstrated an AUC of 1.0. The three MR imaging measures demonstrated significant correlations with clinical and neuropsychologic assessments as well as with cerebrospinal fluid levels of tau, hyperphosphorylated tau, and Abeta 42 proteins.

CONCLUSION
These automated MR imaging measures can serve as an in vivo surrogate for disease severity, underlying neuropathology and potentially as a noninvasive diagnostic method for identifying individuals with mild cognitive impairment and Alzheimer disease.

KEY WORDS: Alzheimer disease, mild cognitive impairment, computational morphometry, biomarker

Scientific Poster 31
Fiber-Tracking Through Multiple Sclerosis Lesions Using Probabilistic Fiber-Tracking Algorithm

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PURPOSE
We hypothesized that MS plaques can cause not only local but also pathway-specific damage. Therefore, sensitive pathway-specific measures of axonal integrity of through-lesion tracks are useful to assess disease burden. Diffusion tensor imaging is an attractive method for track evaluation; however, deterministic methods often fail when encountering crossing fibers or regions of low anisotropy. We present results of through-lesion tracking using a probabilistic algorithm combined with nontensor fiber orientation distribution estimation methods. We hypothesized that probabilistic tracking can propagate tracks through isotropic anomalies such as MS lesions.

MATERIALS & METHODS
Six MS patients at Cleveland Clinic's Mellen Center, whose T2 and FLAIR showed MS lesions along one corticospinal track (CST) but not along contralateral CST, underwent whole-brain 71-direction DWI scan on a Siemens 3T MRI scanner equipped with 12-channel receive-only head array. The number of tracks intersecting a given voxel reflected the connectivity between that voxel and seed/target regions. The first fiber-tracking pass between the lesion and the entire pial surface revealed two tracks connecting the lesion to the pial surface and to the cerebral peduncle. These locations formed the seed and target for the second tracking pass that was observed to approximate the lesion. The seed and target were adjusted to ensure through-lesion propagation. Using homologous targets and seeds, contralateral control CST tracks were computed. Whole-brain diffusion-tensor maps of fractional anisotropy, mean diffusivity, longitudinal and transverse diffusivities were calculated by first least-squares fitting 71 diffusion profiles to six independent tensor elements. Convolution of these maps with tracks provided track-specific quantitative measures.

RESULTS
In Figure 1, voxels representing fibers crossing the MS lesion overlay the lesion, indicating a match. In Figure 2, the voxel counts for lesion-crossing fibers and for fibers crossing the homologous lesion-free contralateral region appear similar throughout the tracks. Therefore, the lesion does not significantly alter tracking as might be expected in the case

Figure 1: Three-dimensional representations of all 34 ROIs examined in the current study (only right hemisphere is shown).
of termination or deflection of fibers near the lesion. Figure 3 shows transverse diffusivities (TD) for the through-lesion tracks and tracks propagating through the homologous contralateral region. It shows elevated TD in the vicinity of the lesion, possibly indicating demyelination. The smaller peak shows TD elevation due to encountering crossing fibers.

CONCLUSION
This study shows the robustness of probabilistic tracking in propagating fibers through MS lesions. Using probabilistic methods, the integrity of WM fibers can be interrogated along their entire lengths, and clinically relevant parameters of WM integrity can be quantitatively evaluated.

KEY WORDS: Multiple sclerosis, DTI fiber-tracking, probabilistic

Scientific Poster 32
Assessment of the Diversity of Cortical and Subcortical Multiple Sclerosis Pathology and Lesions Revealed by 7 T MR Imaging

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PURPOSE
MR imaging is well established as the standard for the diagnosis of MS and its response to therapy. Improvements in sensitivity and spatial resolution accruing with increasing field strengths have provided corresponding improvements in the conspicuity of lesions (1). The eventual introduction of clinical 7T scanners is expected to further improve sensitivity, and also may yield novel information regarding MS pathology in vivo (2). While MS classically is viewed as an inflammatory demyelinating disease of white matter (WM), gray matter (GM) atrophy and cortical lesions are also hallmarks of the disease (3,4), and GM pathology may contribute significantly to clinical disability (5). Similarly, there is strong neuropathologic evidence that WM lesions originate from perivascular inflammatory foci (2), suggesting that small perivascular lesions may represent early biomarkers of relapse and/or response to therapy. Both GM and small perivascular WM lesions are poorly visualized at 1.5 or 3T. This study assesses 7T neuroimaging of MS, emphasizing improved conspicuity of MS pathology.

MATERIALS & METHODS
Using a protocol approved by the Vanderbilt University Medical Center IRB, MS patients were scanned at 7T (Philips Healthcare, Cleveland, OH). This protocol included: FLAIR (TR/TI/TE = 15000/2800/44ms; 0.6x0.6x2.5mm voxel; imaging time = 6:30 min), T1W 3D turbo-field echo (TFE) (TR/TE = 9.1/4.5ms; FA = 10o; 0.72x0.72x1.75mm voxel; time = 4:35 min), multi-echo 3D fast-field echo (FFE) (TR/TE1/ΔTE = 22/12/2ms; FA = 10o; 0.72x0.72x1.75mm voxel; time = 4:04 min), and a T2*W-3D FFE (TR/TE = 22/14.80ms; FA = 12o; 0.5x0.5x1.0mm voxel; time = 4:02 min).

RESULTS
Cortical GM pathologies were evident as focal hypointensities on high-resolution 3D FFE images (Figure1A). High-resolution T2*W images revealed perivascular lesions that appear to form cuffs around deep medullary veins (Figure1B).
CONCLUSION
The course of MS is highly variable and better markers of disease activity and treatment response are needed. Ultra-high field MR imaging reveals cortical and perivascular MS lesions that reflect different aspects of MS neuropathology than previously seen at lower field.

REFERENCES

KEY WORDS: Multiple sclerosis, 7 T, MR imaging

Scientific Poster 33
Quantitative Measure of Distal Medulla Oblongata Correlates with Disease Progression in Multiple Sclerosis
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PURPOSE
To determine which segment of the medulla oblongata best correlates with disease progression in multiple sclerosis (MS). Multiple sclerosis is the most common autoimmune inflammatory disease affecting the central nervous system (CNS). It is a multifactorial disease with a strong neurodegenerative component with progressive atrophy of the brain and spinal cord. Atrophy can cause both motor dysfunction and neuropsychologic impairment, which can be assessed in patients using the Expanded Disability Status Scale (EDSS) and Ambulation Index (AI). Brain parenchymal fraction is the “gold standard” atrophy metric. We recently have demonstrated that medulla oblongata volume (MOV) is associated with disability in MS and is a readily deployed biomarker for MS disease progression.

MATERIALS & METHODS
For this retrospective analysis, 45 patients were selected from the Comprehensive Longitudinal Investigation of Multiple Sclerosis at the Brigham and Women’s Hospital study at the Partners MS Center. The study group was composed of 32 relapsing-remitting, 8 secondary progressive, and 5 primary progressive MS patients. Medulla oblongata volume was determined from axial T2-weighted spin-echo images. The entire medulla oblongata was outlined beginning from the pontomedullary junction to the level of the foramen magnum, and segmented into anterior vs posterior and right vs left. Parcellation was performed on 2 segments of the proximal medulla using the retro-olivary groove as a landmark to distinguish anterior from posterior. These two points were averaged to create a plane to separate the entire medulla into anterior vs posterior portion. Similar segmentation techniques were used to parcellate the medulla into right and left portions.

RESULTS
The distal 3 slices of MOV demonstrate the highest correlations with both clinical measures: EDSS and AI (Tables 1 and 2). Although we hypothesized the anterior portion of the medulla containing the cortical spinal tracts would have the most atrophy and therefore correlate better disease progression, our results show otherwise.

CONCLUSION
We propose a readily obtainable, reproducible and robust method to indirectly detect MS spinal cord and brain disease burden. It can be applied to routine clinical MS brain surveillance images. The high T2 contrast of the medullary cistern facilitates segmented MOV determination, which correlates closely with disease progression of MS patients. One limitation of our study is the resolution of the images, which make it difficult to segment the distal medulla. With higher resolution images, new parcellation techniques could be developed on the distal three slices of the medulla to better approximate anterior from posterior medulla.

KEY WORDS: Multiple sclerosis, neuroimaging, medulla oblongata
Scientific Poster 34

Entorhinal Cortex Volume Differentiates Alzheimer Disease from Dementia with Lewy Bodies: MR Imaging with Automatic Voxel-Based Morphometry Study

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PURPOSE Dementia with Lewy Bodies (DLB) appears to be the second most common form of dementia, accounting for about one in five cases. Diagnostic criteria of DLB have not been listed in the Diagnostic and Statistical Manual of Mental Disorders, 4th edition criteria (DSM-4) or the International Statistical Classification of Diseases and Related Health Problems 10th Revision (ICD-10). Recently, DLB has been recognized increasingly and understood with greater clarity, following publication of the 2003 consensus guidelines after the international workshop of the consortium on DLB. Symptoms of DLB can be similar to those of Alzheimer disease (AD), making diagnosis difficult. Presence of AD pathology modifies the clinical features of DLB, making it harder to distinguish DLB from AD clinically. Dementia with Lewy Bodies is characterized by fluctuating cognitive impairment, spontaneous parkinsonism, and recurrent visual hallucinations. Clinical diagnostic criteria for DLB can result in failure to identify up to 50% of cases. The newest diagnostic criteria recommend including relative preservation of medial temporal lobe structures on CT/MR scan as a supportive feature. This new criteria has not been proved to have diagnostic specificity. “VSRAD” is an automatic voxel-based morphometry analysis system for detecting atrophy of the entorhinal cortex (EC). The purpose of this study was to assess patterns of cerebral atrophy in cases of DLB compared with cases of AD using a VSRAD system.

MATERIALS & METHODS Nine outpatients with a clinical diagnosis of probable DLB (mean age: 75 +/- 4.4 years; mean Mini-Mental State Examination (MMSE) score: 23.3 +/- 5.8) were individually matched with respect to gender and age with nine patients with probable AD (mean age: 75 +/- 4.8 years; mean MMSE: 20.7 +/- 4.1) in our memory clinic. Each subject underwent 1.5T MR imaging within 3 months of the first visit. The diagnosis of dementia was based on the “DSM-4,” the “National Institute of Neurological and Communicative Disorders and Stroke,” and the “Alzheimer's Disease and Related Disorders Association (NINCDS-ADRDA) criteria,” as well as “Diagnosis and management of dementia with Lewy bodies: third report of the DLB consortium.” The EC volume, whole brain volume, and entorhinal/whole brain ratio were determined using a VSRAD system.

RESULTS Dementia with Lewy Bodies patients exhibit symptoms including “hallucinations in other modalities,” “disproportionately severe visuocognitive and visuoperceptual disturbances,” “transitory alterations in consciousness with reduplication phenomena,” “misidentification delusions,” and “systematized delusions.” EC volumes were significantly smaller in the AD patients than in the DLB patients (p < 0.0001). The percent volume reduction of the EC was 47.32% for AD and 0.76% for DLB, respectively. Whole-brain atrophy rates were almost the same for both AD and DLB groups. The EC/whole brain atrophy ratio was 9.44 for AD and 0.25 for DLB, respectively.

CONCLUSION Patients with core clinical features of DLB have preserved EC volume. MR imaging with VSRAD analysis, a simple clinical diagnostic system, allows DLB to be distinguished from AD in a clinical setting. The correct diagnosis of DLB is important for adequate treatment, avoiding adverse effects with neuroleptic drugs, and establishing precise prognoses.

KEY WORDS: Dementia with Lewy bodies (DLB), MR imaging, voxel-based morphometry

Scientific Poster 35

Case Control MR Imaging and 3D-TOF MR Angiography Study of Gait Disorders

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PURPOSE “Lower body” or vascular parkinsonism (VP) is a heterogeneous entity. Both cerebral vascular disease, VP and idiopathic Parkinson disease (PD) are common among the elderly. The exact role of imaging in differentiating VP and PD has yet to be clarified fully. The clinical utility of MR imaging and MR angiography in patients who present with predominant lower body parkinsonism has yet to be evaluated systematically. In a case control study, we compared the advanced MRI/A features in subjects who presented with predominant gait problems suggestive of VP and PD with healthy controls to determine for any differentiating imaging characteristics between VP and PD.

MATERIALS & METHODS This study was approved by the institutional ethics review board. Consecutive subjects who presented with predominant lower gait parkinsonism initially were recruited from a tertiary referral center. These subjects were divided into possible VP and PD based on their levodopa responsiveness. In addition, age and gender matched healthy controls with no gait problems were recruited. All subjects underwent standardized clinical evaluation by an experienced neurologist. The following rating scales were administered; the United Parkinson's Disease rating Scale and Tinetti Gait Scale. The VP and PD groups were matched for Tinetti Gait Score. All subjects underwent a standardized MR study on a 3.0 T unit, including T2-weighted, FLAIR, susceptibility-weighted (SWI) and 3D time of flight MRA sequences.

RESULTS A total of 60 subjects (20 PD, 20 PD, 20 controls, mean age 70 years, 65% males) who satisfied the inclusion criteria were recruited. The frequency of lacunar infarcts (subcortical, brainstem) in VP was higher compared to PD (65% vs 20%) (p = 0.01, odds ratio 7.43, 95%CI 1.8-30), and controls (65% vs 25%) (p = 0.02, odds ratio 5.9, 95%CI 1.5-22.0).
There was a higher trend of microbleeds in VP compared to the other two groups (40% vs 20% (p = 0.2, odds ratio 3.3, 95% CI 0.8-12.6). However the presence of large or medial vessel stenosis on MRA was not different between VP, PD and controls. Presence of vascular risk factors such as hypertension, diabetes, hyperlipidemia and coronary artery disease was found to be similar in all 3 groups (85% vs 75% vs 65%). A multivariate analysis also revealed that infarct on MR was a predictor of VP.

CONCLUSION
Our case control study demonstrated that noninvasive MR imaging and MR angiography is a useful tool in differentiating VP from PD and controls. The higher presence of lacunar infarcts and microbleeds suggest small vessel involvement in the pathophysiology of VP.

KEY WORDS: Gait disorder, MR imaging, brain

Scientific Poster 36

Thrombus Location Matters: Infarct Growth in Acute Proximal Middle Cerebral Artery Occlusion

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PURPOSE
In an attempt to standardize the effect of thrombus location on tissue outcome, the purpose of this study was to characterize a carefully selected group of patients presenting with acute stroke exclusively due to M1-middle cerebral artery (MCA) thrombus.

MATERIALS & METHODS
Patients with new onset acute stroke symptoms were screened consecutively between April 2003 and April 2008 for presence of unilateral M1-MCA occlusion on CTA. Cases with occlusion or stenosis of any other cerebral arteries, or the common and internal carotid arteries were excluded. Only cases with available acute diffusion images (DWI) (<9h, mean 5h) and follow-up MR or CT imaging (>48h, mean 7d) were included to measure volumes of acute infarct core and growth. Patients were ranked by volume of acute infarct core and dichotomized by median growth (50 percentile) into high and low growth infarction. Student's t-test was used to compare differences of means of admission National Institutes of Health Stroke Scale (NIHSS), edema index, collateral score, DWI signal intensity, and ASPECTS were significantly different between high and low growth infarcts; however, MR-perfusion-diffusion mismatch was not (Table 1).

Characteristics of acute M1-occlusive MCA strokes with acute infarction volume 2-90 ml dichotomized by growth

<table>
<thead>
<tr>
<th>low infarct (n=20)</th>
<th>high infarct (n=20)</th>
<th>t</th>
<th>p (t-test, one tailed,paired)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Admission parameters:</td>
<td>(mean)</td>
<td>(mean)</td>
<td></td>
</tr>
<tr>
<td>DWI lesion volume (ml)</td>
<td>22.8</td>
<td>20.5</td>
<td>15.8</td>
</tr>
<tr>
<td>onset to imaging time (h)</td>
<td>4.1</td>
<td>1.9</td>
<td>5.2</td>
</tr>
<tr>
<td>NIHSS</td>
<td>18.7</td>
<td>6.1</td>
<td>11.4</td>
</tr>
<tr>
<td>Edema index</td>
<td>1.047</td>
<td>0.036</td>
<td>1.044</td>
</tr>
<tr>
<td>DWI signal intensity</td>
<td>1.73</td>
<td>0.25</td>
<td>1.60</td>
</tr>
<tr>
<td>ASPECTS</td>
<td>5.5</td>
<td>1.6</td>
<td>6.8</td>
</tr>
<tr>
<td>Collateral score</td>
<td>2.6</td>
<td>0.9</td>
<td>3.7</td>
</tr>
<tr>
<td>MR-P-DWI mismatch (%)</td>
<td>82.4</td>
<td>14.5</td>
<td>86.3</td>
</tr>
</tbody>
</table>

Follow up parameters:
| ASPECTS | 2.1 | 1.3 | 5.8 | 2.0 | <0.0001 |
| Final infarct volume (ml) | 123.7 | 90.2 | 29.5 | 24.1 | <0.0001 |
| mRS at 3 months | 3.8 | 2.4 | 2.3 | 2.0 | 0.0264 |

CONCLUSION
Tissue outcome in acute strokes exclusively due to M1-MCA occlusion is highly variable. A multivariate model to predict infarct growth should incorporate NIHSS, edema index, and collateral score.

KEY WORDS: Tissue outcome, middle cerebral artery, occlusion
**Scientific Poster 37**

**Prediction of Hemorrhagic Transformation Following Thrombolytic Therapy for Acute Ischemic Stroke: Role of CT Permeability Mapping**

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**PURPOSE**
Animal studies suggest that increases in blood-brain barrier permeability may predispose to hemorrhage in the setting of acute brain ischemia. Our purpose was to determine whether increased permeability calculated from CT perfusion (CTP) data obtained within 6 hours of acute ischemic stroke could predict the risk for subsequent hemorrhage in patients treated with thrombolytic therapy.

**MATERIALS & METHODS**
We retrospectively evaluated the pretreatment CTP data of 22 patients who presented with acute ischemic stroke and received thrombolytic therapy within 6 hours of symptom onset. A group of 6 patients who underwent CTP but did not receive thrombolitics or show evidence of ischemic stroke on follow-up imaging served as negative controls. Color permeability maps were generated from first pass dynamic CT data. The perfusion findings of the patients with hemorrhage then were compared to the negative control group and those patients with proved ischemic stroke who did not develop hemorrhagic transformation.

**RESULTS**
Hemorrhage occurred within the area of infarction in 7 patients. Permeability abnormalities were seen in all (22/22) patients who developed stroke. There was no evidence of increased permeability in patients without infarction. The distribution and area of increased permeability closely matched the region of infarcted tissue as demonstrated by follow-up CT or diffusion MR. There was suggestion that abnormal permeability findings were better predictors of regional tissue infarction than cerebral blood volumes. In patients with hemorrhagic transformation, region of interest analysis showed focal areas of increased permeability approximately 40-50% greater than those seen within the adjacent ischemic tissue. These focal areas of permeability abnormality closely matched areas of hemorrhage seen on subsequent imaging. Seven of nine patients with focally elevated permeability developed subsequent infarction: 7 true positives and 2 false positives for hemorrhage prediction. There were 13 true negatives: no regions of focal permeability elevation, and no hemorrhage and no false negatives.

**CONCLUSION**
Our findings support the hypothesis that increased permeability may serve as a predictor of hemorrhage in the setting of acute ischemic stroke. In addition, the study showed the potential of increased permeability to predict the volume of infarcted tissue. Such knowledge may be useful for guiding therapeutic strategies and risk versus benefit analysis. Larger studies are needed to assess the validity of these predictions.

**KEY WORDS:** CT permeability, TPA, stroke

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**Scientific Poster 38**

**Evaluation of a Work-in-Progress Pulse Sequence, Permitting a Marked Reduction in TE, in Diffusion-Weighted Imaging of Stroke Patients at 3 T**

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**PURPOSE**
To evaluate a work-in-progress (WIP) unipolar diffusion gradient pulsing scheme that achieves a markedly shorter TE by diffusion encoding during the entire time between the two required radiofrequency pulses. This scheme was compared to a conventional EPI DWI sequence with bipolar diffusion gradients in respect to SNR, bulk susceptibility artifact, geometrical distortion, and overall diagnostic quality. Geometric distortion was quantified using a novel technique.

**MATERIALS & METHODS**
Ten patients with acute stroke on MR imaging were evaluated with four different 3 T scan sequences: a conventional bipolar gradient spin-echo (SE) EPI DWI parallel imaging factor 2 (p2), and unipolar short TE (sTE) SE EPI DWI using parallel imaging factors of 2, 3, and 4. Signal-to-noise ratio (SNR) was quantified by the subtraction method at the level of the anterior forceps (white matter) and pons. A novel technique was employed for quantifying geometric distortion: for the sTE p2 and p4 scans, additional images were obtained using phase encoding gradients of opposite polarity. The difference in the AP dimension of the pons between these scans and their nonreversed counterparts was used to quantify geometric distortion. Seventeen healthy volunteers were evaluated in the same manner as above. A blinded reader ranked the healthy volunteer scans in terms of bulk susceptibility artifact and overall preference.

**RESULTS**
Calculated SNRs in the stroke patients were not significantly different among the sTE p2 (4.96), p3 (4.56), and p4 (4.61) scans due to compensation by number of scan averages (NSA = 2, 3 and 6 respectively). Conventional TE SNR (4.58) also was not statistically different, despite using twice the number of scan averages (NSA = 4) as the sTE p2. sTE p4 scans lessened geometric distortions compared with the sTE p2 scans ( p4). The blinded reader preferred the sTE p4 scan overall. There was no difference in preference for the sTE p2 and p3, while conventional TE scans were always least preferred.

**CONCLUSION**
The new unipolar DWI pulsing scheme allows for a substantial reduction in TE, thus markedly improving SNR, as demonstrated. The gain in SNR permits the use of a higher parallel imaging factor (p4), the latter to reduce bulk susceptibility, within a reasonable scan time. As demonstrated in stroke patients and healthy volunteers, this sTE sequence, slated to be FDA approved and in general use by mid-2009, provides a marked improvement at 3 T in bulk susceptibility.
artifact, geometric distortion, and overall image quality, which was confirmed by reader preference, over conventional EPI DWI.

**KEY WORDS:** DWI, short TE WIP, stroke

**Scientific Poster 39**

CT Evaluation of Intracranial Stents: An in Vitro Study

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**PURPOSE**
To determine whether an optimized CTA protocol is adequate for evaluating intracranial stents using a phantom, and comparing this method with angiographic CT.

**MATERIALS & METHODS**
A silicone vessel model (approximately 4 mm in luminal diameter) was placed into a cadaveric skull, and filled with dilute contrast (0.8 mL Omnipaque 300 diluted with saline to a total volume of 10 mL) to simulate a vessel density similar to that of CTA. We then placed two intracranial stents into the phantom (Neuroform3, 4.0 x 30 mm; Wingspan 4.0 x 20 mm; both produced by Boston Scientific). On a Siemens Definition dual-energy CT scanner, a routine helical acquisition scan was performed using our standard CTA protocol (kV, 120; mA, 350; section collimation, 0.75 mm; pitch, 0.9; reconstruction interval, 0.6 mm). We then repeated the CTA utilizing CT parameters comparable to those previously reported as optimal for imaging of intracranial clips (kV, 140; mA, 314; section collimation, 0.75 mm; pitch, 0.9; reconstruction interval, 0.6 mm). Finally, we performed a scan utilizing our dual-energy CTA protocol (Tube A: kV, 80; mA, 560; Tube B: kV, 140; mA, 128; all other parameters unchanged). Images from all scans were inspected visually for subjective image quality and stent-related artifacts. The images then were analyzed using commercially available 3D imaging and vessel analysis software (TerraRecon, Inc.), to determine its capability for semiautomated vessel evaluation. The phantom then was scanned using angiographic CT technique (InSpace DR protocol, Siemens AXIOM Artis Bi-plane angiography unit). Images were reconstructed and viewed in multiplanar format on a Leonardo workstation.

**RESULTS**
There was no significant difference in imaging characteristics between the Neuroform and Wingspan stents on any of the scans. Blooming artifact involving the struts made evaluation of the lumen at the ends of the stents nearly impossible. The remainder of the stent lumen was well visualized, and appeared widely patent on all scans as expected. Density measurements within the lumen of the stents were not significantly different than in the corresponding unstented vessel segments on each scan. The third party vessel analysis software performed poorly in evaluation of the stented vessel segments. Threshold levels were set based on the density measurements within the unstented vessel segments for each scan. These correlated well with vessel diameter in the unstented segments. When these thresholds were applied to the stented segments, however, the software was unable to identify the vessel lumen, and instead overestimated the size of the vessel. In contrast, the blooming effect of the stent struts caused the software to significantly overestimate the degree of luminal narrowing at the stent ends. Findings were similar on all three scans. Angiographic CT resulted in an improvement in the blooming artifact of the stent struts, thereby making the lumen of the ends of the stents more visible.

**CONCLUSION**
Optimized CTA protocols are inadequate in thoroughly evaluating intracranial stents. Angiographic CT is a promising technology providing good visualization of the stent lumen, and should be investigated further.

**KEY WORDS:** Intracranial stents, angiographic CT

**Scientific Poster 40**

Characterizing Neural Substrates of Stroke Recovery Utilizing Functional MR Imaging, Diffusion Tensor Imaging, Cortical Thinning and Stroke Imaging

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**PURPOSE**
While numerous prior studies have investigated functional mapping changes following infarction, which involves irreversible structural changes, few studies have examined the functional mapping changes related to chronic hypoperfusion, which is potentially reversible through therapeutic interventions. The purpose of this research is to understand the influence of chronic hypoperfusion on neural network changes which are associated with functional recovery after stroke (Figure 1).

**MATERIALS & METHODS**
Stroke patients (n=12) with cortical hypoperfusion of the middle cerebral artery (MCA) territory and transient ischemic attack (TIA) controls (n=12) with normal perfusion but with transient MCA distribution symptoms were enrolled
in this study. The stroke and TIA patients were evaluated in terms of microstructural, functional mapping within a few days after their symptom onset (acute) and approximately 6 months following their index event (chronic). The experiments proposed here will include the use of magnetic resonance imaging (MRI) (e.g. functional MRI, DTI, cortical thinning, other standard stroke imaging sequences) to monitor the human brain after stroke. A cognitive task, specifically the verbal fluency task, known to reliably activate MCA distribution regions as demonstrated by blood oxygen level dependent (BOLD) functional MR imaging (fMRI) was employed to characterize cognitive mapping changes in the brain. Perfusion MR methods was employed to characterize regions of hypoperfusion in the brain. Diffusion tensor imaging (DTI) and cortical thinning were used to characterize microstructural integrity in the brain. Analyses: Statistical testing was done to assess whether regions of chronic hypoperfusion, when compared to normally perfused regions in TIA controls, will lead to functional (cognitive) mapping changes as measured by fMRI and microstructural changes as assessed by cortical thinning and DTI methods.

RESULTS
Areas of chronic hypoperfusion led to decrease in fMRI activity in ipsilateral regions with increase in fMRI activity in contralateral homologous regions. Cortical thickness changes appear to mirror BOLD fMRI activity changes with decrease in ipsilateral regions and increase in contralateral homologous areas. Similarly areas of hypoperfusion led to decrease in white matter integrity in ipsilateral regions with increase in white matter integrity in contralateral homologous regions.

CONCLUSION
Overall, fMRI provided an assessment of functional (cognitive) mapping changes, cortical thinning and DTI measures provided an assessment of microstructural changes after stroke (hypoperfusion) with ipsilateral regions showing decrease and contralateral regions showing increase in fMRI activity and microstructural changes. This provides evidence that stroke-related dysfunction in ipsilateral regions may be compensated by plasticity changes in contralateral brain regions.

KEY WORDS: Stroke, FMRI, DTI

Scientific Poster 41
Evaluation of Cerebral Perfusion from Bypass Arteries Using MR Regional Perfusion Imaging in Patients with Moyamoya Disease
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PURPOSE
To determine whether cerebral perfusion from bypass arteries can be demonstrated by using MR regional perfusion imaging (RPI) which is an arterial spin labeling (ASL) technique and to compare the distribution of cerebral perfusion on RPI with that on digital subtraction angiography (DSA) in patients with moyamoya disease who underwent extracranial bypass surgery.

MATERIALS & METHODS
Regional perfusion imaging examinations were performed at a 3 T MR scanner in 13 patients who underwent extracranial bypass surgery for moyamoya disease. Six vessel studies of DSA were performed in all cases. According to MR angiographic findings, a selective labeling slab was placed on the external carotid artery bypassed on RPI studies. Two neuroradiologists graded the volume of cerebral perfusion in the middle cerebral artery (MCA) territories from bypass arteries on RPI and DSA using a 4-point grading system: grade 1, the volume of the cerebral perfusion was less than 20% of MCA territory; grade 2, the volume of the cerebral perfusion was 20 -50%; grade 3, the volume of the cerebral perfusion was more than 50%. They also assessed the location of the cerebral perfusion on RPI and DSA which was divided into three regions: anterior, posterior, and both portions of the MCA territory. Kappa analysis was used to determine the agreement of the assessment for the volume and location of cerebral perfusion from bypass arteries between RPI and DSA.

RESULTS
Cerebral perfusion from bypass arteries was evaluated in 20 hemispheres and regional cerebral perfusion was observed on RPI in all cases. The agreement of the grading for the volume of cerebral perfusion from bypass arteries between RPI and DSA was good (kappa = 0.63). The agreement for the location of cerebral perfusion from bypass arteries between RPI and DSA was good (kappa = 0.71).

Figure. Regional perfusion imaging with selective labeling on right external carotid artery shows regional perfusion distributed more than 50% in right MCA territory in patient who underwent right STA-MCA anastomosis.
CONCLUSION
Regional perfusion imaging can demonstrate the cerebral perfusion from the bypass arteries. Regional perfusion imaging is a useful tool for the evaluation of distribution of cerebral perfusion from bypass arteries in patients who underwent arterial bypass surgery for moyamoya disease.

KEY WORDS: Regional perfusion imaging, moyamoya disease, arterial spin labeling

Scientific Poster 42

Central Nervous System Superficial Siderosis Associated with Chronic Subdural Hematoma: T2-Weighted MR Imaging at 3 T

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PURPOSE
Superficial siderosis (SS) of the central nervous system is caused by repeated hemorrhage into the subarachnoid space with resultant hemosiderin deposition in the subpial layers of the brain and spinal cord. During our work, we noticed that a SS-like finding was sometimes observed on T2-weighted images at 3 T in patients with a presence or history of subdural hematoma (SDH), and thus hypothesized that a SDH may be a risk factor for the development of SS. The purpose of this study is to evaluate the frequency and MR imaging characteristics of SS in patients with presence or history of subdural hematoma (SS-SDH) by comparing those with a history of aneurysmal subarachnoid hemorrhage.

MATERIALS & METHODS
A computerized search of the radiology database for a 4-year period revealed data for patients in whom the diagnosis in the radiologic reports were SDH. From these patients, we further selected 47 patients who underwent a brain MR examination at 3 T MR system after diagnosis of SDH. Two neuroradiologists evaluated the T2-weighted images for the presence or absence of SS, and the MR imaging characteristics of SS-SDH by comparing the patients with a history of aneurysmal subarachnoid hemorrhage (SS-SAH). The SS were classified into three types: a. dural pattern, SS at the top of the surface of gyrus of cerebral hemisphere; b. pial pattern, SS surrounding gyrus; c. mixed pattern.

RESULTS
Of 47 patients with presence or history of SDH, 13 (27.7%) patients showed SS on T2-weighted images. All 13 SS-SDH were found in the cerebral hemispheres unilaterally, but not in the cerebellar hemisphere or brainstem. In 12 (92.3%) of 13 patients, the SS was observed in the cerebral hemisphere ipsilateral to the side of the SDH and was found to accumulate preferentially in areas near the SDH (Figure; arrows). All 13 SS-SDH demonstrated the dural pattern, whereas 13 SS-SAH were scored as pial pattern in 9 (69.2%) and mixed pattern in 4 (30.8%). All 13 SS-SDH were accompanied by the thinning of apices of the cerebral cortex, which were seen more frequently in SS-SDH than in SS-SAH.

CONCLUSION
Subdural hematoma occasionally causes the SS-like MR finding. Because the MR findings were not similar between SS-SDH and SS-SAH, the pathogenesis of SS-SDH may be different from that of SS-SAH.

KEY WORDS: 3T MRI, superficial siderosis, subdural hematoma

Scientific Poster 43

Correlation of Neuroimaging and Neurosurgical Findings in Microvascular Decompression of Vth Cranial Nerve

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PURPOSE
To compare neuroimaging and neurosurgical findings in patients suffering from drug-resistant pain of the Vth cranial nerve.

MATERIALS & METHODS
Twenty-five patients underwent microvascular decompression of the Vth cranial nerve. Brain MR imaging included axial proton density, T2-weighted and FLAIR, T1-weighted sequences in three planes before and after iv administration Gd-chelate (0.2 ml /kg body weight), as well as 3D constructive interference steady state sequence (CISS - 0.5 mm slice thickness) in the posterior cranial fossa. All of the patients had a video tape during the neurosurgical approach. Comparison of the MR imaging and surgical findings followed.
RESULTS
Two patients had meningioma of the cerebellopontine angle, one patient arachnoid cyst and one patient epidermoid. From the 21 patients left, 12 had compression of the Vth cranial nerve by the superior cerebellar artery, six showed compression by veins and three demonstrated unusual compression of the Vth cranial nerve by the ipsilateral vertebral artery, the basilar artery and the contralateral superior cerebellar artery. In five of six cases (83.33%) with compression of the Vth cranial nerve by veins MR imaging was negative. MR imaging was accurate in 14/15 patients (93.33%) with compression of the Vth cranial nerve by arterial branches.

CONCLUSION
The presurgical neuroimaging control using CISS sequence in patients suffering from drug-resistant pain of the Vth cranial nerve is mandatory.

KEY WORDS: Vth cranial nerve, microvascular decompression, MRI

Scientific Poster 44
High-Field High-Resolution MR Venography: How Does the Method Benefit from High-Relaxivity Contrast Media?

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High-resolution susceptibility-weighted imaging (SWI) is a three-dimensional venographic method for visualizing of small and ultra-small cerebral vascular structures in high spatial resolution and detail. The technique has been applied thus far to the imaging of cerebral tumors, vascular malformations, trauma, stroke, microhemorrhages, and as a functional imaging method. Methods to improve the applicability and usefulness of this promising technique are the use of 3T and the use of T1-shortening paramagnetic contrast agents (contrast-enhanced, susceptibility-weighted imaging [CE-SWI]). In this study we present our data of 85 subjects examined with SWI pre and post contrast application of a 3T system.

Patients examined included 23 glioma patients, 20 AVM patients and 42 patients suffering from a mental decline. SWI was performed prior and after application of 0.1mmol/kg BW of gadobenate dimeglumine (MultiHance, Bracco, Princeton). The imaging date were analysed based qualitatively using a five point scale for vessel patency and quantitatively using a ROI analysis. A substantially improved vessel patency was described by both readers on the contrast enhanced SWI scans (Figure 1). Especially small tumor vessels and a more detailed description of the AVM nidus was noticed (Figure 2). In the quantitative analysis the susceptibility effect was significantly improved with a stronger signal drop. 3Tesla contrast enhanced SWI using the high relaxivity contrast agent gadobenat dimeglumine (MultiHance®) allowed a significant improvement in displaying small vascular structures, while preserving adequate signal-to-noise ratio with higher spatial resolution. The method enabled to assess vascular structures in and around brain tumors, the depiction of AVM angioarchitecture. The role in imaging patients with mental decline has to be further evaluated.

KEY WORDS: Susceptibility-weighted MRI, contrast media, lesion

Scientific Poster 45
Withdrawn

Scientific Poster 46
High Temporal and Spatial Resolution Dynamic Contrast Enhanced MRA in Patients with Cerebral Arteriovenous Malformations

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PURPOSE
Cerebral arteriovenous malformations (AVMs) are congenital vascular malformations that result in direct arteriovenous shunts. While some of the AVM symptoms are directly related to the angioarchitecture of the malformations, newer studies have shown that especially the risk of bleeding and the results to radiosurgical treatment are mainly related to the hemodynamics. Currently there are two approaches to assess the hemodynamics non invasively: 1st a non contrast enhanced time resolved 2D thick slab MRA based on blood bolus tagging and 2nd contrast enhanced 4D techniques based on parallel imaging and time-resolved imaging with stochastic trajectories (TWIST). The second offers combined anatomic and hemodynamic information. The aim of the current study was to assess the morphology and hemodynamic characteristics of using both described methods.
MATERIALS & METHODS
In an ongoing prospective protocol we examined 20 patients with AVMs in an intraindividual comparison. The dMRA sequence is based on the 2D time resolved spin labeling sequence (STAR), a technique acquiring a thick slab projection. The time resolution was 100ms for each volume. The 3D time resolved TWIST angiography is based on the injection of 0.1mmol of Gd-BOPTA (MultiHance, Bracco, Princeton, USA) which allows for a time resolution of 250ms and spatial resolution of 1x1x1 mm³. To compare the two methods independent readers were asked to assess the visibility of the vascular components of the malformation and the hemodynamics by calculating an AVM shunt-time defined as time between feeding arteries and draining veins.

RESULTS
Both methods were able to assess hemodynamics of the AVM (Figure 1-2). The tagging method with high temporal resolution could prove our concept that smaller AVMs generally showed shorter shunt-times, however, a short shunt-time was associated with a higher risk of bleeding, independent of the AVM size. In the direct comparison the tagging method was due to the lack of spatial resolution substantially inferior in the assessment of the angioarchitecture and could show significantly less feeding arteries (p<0.05). The current temporal resolution of the TWIST angio was sufficient to assess large AVMs, however if the shunt time was too short one could not calculate an AVM shunt time at the used temporal resolution.

CONCLUSION
The combined evaluation of the angioarchitecture and hemodynamics of cerebral AVMs is best possible with a CE TWIST MRA. However the calculation of hemodynamic parameters is best with the dMRA based on the tagging technique, however, the techniques lack of sufficient spatial resolution.

KEY WORDS: TWIST MRA, arterio venous malformations, contrast media

Scientific Poster 47
Quantitative MR Perfusion and Intracranial Arteriovenous Malformations: Characterization of Vascular Steal Using Spin-Echo Acquisition Sequences

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PURPOSE
Recently, T₁-weighted spin-echo (SE) EPI acquisitions for quantitative MR perfusion combined with parallel imaging have been equated to GRE-EPI images but were higher quality. Higher quality quantitative MR perfusion imaging of intracranial arteriovenous malformations (iAVMs) could better characterize and quantify the hemodynamic effects of iAVMs in situ, namely vascular steal which may put patients at higher risk for rupture after procedures. A novel approach to the quantification of cerebral perfusion, the bookend technique, has been validated in both SE-EPI and GRE-EPI. We report on the first study of quantitative MR perfusion in the evaluation of hemodynamic compromise in iAVMs.

MATERIALS & METHODS
AVM patients were scanned on a 1.5T MR (Avanto, Siemans AG Healthcare Sector, Erlangen, Germany) using both GRE-EPI, always acquired first, and SE-EPI perfusion sequences. Images were acquired using 2 single-dose injections of Gd-DTPA (0.1 mmol/kg b.w.), each time at a rate of 4ml/s: TR = 1290 ms, 13-15 slices, slice thickness/the gap between slices = 5/1.5mm, bandwidth = 1260Hz/pixel, TE (GRE/SE) = 47/60ms, tip angle = 90º. The SE-EPI images were acquired using parallel imaging (acceleration factor = 2, reference lines = 24) using GRAPPA reconstruction. Paired comparisons of qCBV and qCBF values from both sequences were performed on perinidal and contralateral areas. Perfusion images were overlaid onto T₁-weighted MR images to correlate perfusion changes with the angioarchitecture of the iAVM.

RESULTS
Regions of perfusion change around the iAVM nidus were more anatomically correct in the SE-EPI images (Figure 1). Areas of hypoperfusion, i.e., vascular steal (18-21ml/100g/min), were noted in brain parenchyma near large draining veins, which were not specifically notable in the GRE-EPI images (36-43ml/100g/min). Peri-nidal values of qCBF and qCBV were overestimated in the GRE-EPI sequences due to the inclusion of part of the iAVM nidus within the ROI, which was drawn on the T₁-weighted MR image. All other qCBF and qCBV values were insignificantly different; however, the SE-EPI images allowed more direct comparisons to the angioarchitecture of the iAVM.
CONCLUSION
Quantitative SE-EPI MR perfusion demonstrated improved anatomical correlation and vascular steal around than GRE-EPI imaging. The use of parallel imaging with SE-EPI acquisitions can improve image quality, while maintaining the same acquisition time. Use of this quantitative SE-EPI MR perfusion sequence may be used effectively when studying the perfusion changes affected by iAVMs.

KEY WORDS: MR perfusion, intracranial arteriovenous malformations, vascular steal

Scientific Poster 48
Volume Shuttle CT Perfusion for Cerebrovascular Disease Evaluation: Comparison of Radiation Dose with Standard Cine CT Perfusion

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PURPOSE
To compare the radiation dose of CT perfusion studies using volume shuttle (CTP_{volsh}) acquisition technique versus standard cine CT perfusion (CTP_{cine}) technique used for cerebrovascular disease evaluation. We also assessed the radiation dose for CT angiogram of the circle of Willis (CTA Head) at our institution, as CTP_{volsh} generates CTA images without need for additional acquisition. In comparison, the complete evaluation of the cerebral vasculature and cerebral perfusion using CTP_{cine} technique requires an additional separate CTA acquisition.

MATERIALS & METHODS
We retrospectively estimated the radiation dose of CTP_{volsh} and CTP_{cine} for cerebrovascular disease evaluation in 14 and 8 patients respectively. We also estimated radiation dose of CTA Head in 27 patients. We compared the radiation dose of CTP_{volsh} with CTP_{cine} and with CTP_{cine}+CTA Head. Perfusion studies were performed using 64-slice (VCT; GE Medical Systems, Milwaukee, WI) multi-detector row CT scanner, 50 ml of non-ionic contrast (Optiray 350 mg/ml) was injected at a rate of 4 ml/sec through a 20-gauge IV line using an automatic power injector. At 5 seconds into the injection, CTP_{volsh} or CTP_{cine} scan was initiated with the protocol as mentioned in the table.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>CTP_{volsh} (n= 14)</th>
<th>CTP_{cine} (n= 8)</th>
<th>CTP_{cine} +CTA Head (n= 8+27)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CTDIvol (mGy)</td>
<td>120.5</td>
<td>326.2</td>
<td>848.8</td>
</tr>
<tr>
<td>DLP (mGy-cm)</td>
<td>963.7</td>
<td>1361.8</td>
<td>2421.3</td>
</tr>
<tr>
<td>Effective Dose (mSv)</td>
<td>2.2</td>
<td>3.1</td>
<td>5.5</td>
</tr>
</tbody>
</table>

RESULTS
The CTDIvol and DLP was reduced using CTP_{volsh} by 85.8% and 60.2% respectively compared to the combination of CTP_{cine} +CTA Head. The CTDIvol and DLP was reduced using CTP_{volsh} by 63.1% and 29.2% respectively compared to CTPcine. The same diagnostic yield was able to be obtained using CTP_{volsh} Versus the combination of CTP_{cine}+CTA Head.

CONCLUSION
CTP_{volsh} for cerebrovascular evaluation affords a significantly reduced radiation dose as compared to CTP_{cine} but with double the coverage (8 cm vs 4 cm). In addition, CTP_{volsh} also provides additional CTA information and thus obviates the need for a separate CTA acquisition as would be needed if a standard CTP_{cine} is used. This further reduces the radiation dose. In addition, the amount of required intravenous contrast agent is reduced.

KEY WORDS: Volume shuttle protocol, CT Perfusion, Stroke

Scientific Poster 49
Impact of Delay Correction on the Volume of MR Derived MTT Abnormality in Acute Stroke Patients with Unilateral Carotid Occlusion

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PURPOSE
To investigate the impact of delay correction on the volume of MR derived MTT abnormality in acute stroke patients with unilateral carotid occlusion.

Materials and Methods:
Dynamic susceptibility contrast-enhanced magnetic resonance imaging (DSC-MRI) obtained in 10 acute stroke patients with evidence of unilateral carotid occlusion on gadolinium-enhanced MR angiography were processed using the Perfusion Mismatch Analyzer (PMA) program, (Version 2.0.9.0, supported by ASIST-Japan). Two algorithms were used to calculate MTT maps: singular value decomposition (SVD) -based deconvolution and first moment of the concentration-time curve before deconvolution. For both algorithms, the MTT maps were calculated twice, once without delay correction and once with delay correction using T_max, culminating in four separate MTT maps. The regions showing abnormal MTT were delineated by an experienced observer on all 4 sets of maps. The volumes of MTT abnormality and the volumes of MTT-DWI mismatch were recorded for the 4 sets of processed maps (SVD versus first moment, with and without delay correction), and compared using paired T-tests. The volumes of MTT abnormality were correlated with final infarct volume delineated on 4-day MR images of fluid attenuated inversion recovery (FLAIR) or CT images.

RESULTS
The volumes of MTT abnormalities were significantly smaller when delay correction was used (SVD: 162.4±78.4 mL with delay correction versus 202.9±54.4 mL without delay correction, p=0.012; first moment: 171.5±76.7 mL with delay correction versus 196.2±78.3 mL without delay correction, p=0.016). The volumes of MTT-DWI mismatch (penumbra) were significantly smaller when using delay correction (SVD: 104.8±48.7 mL with delay correction versus 129.5±50.9 mL without delay correction, p=0.016; first moment: 95.8±44.7 mL with delay correction versus 136±41.6 mL without delay correction, p=0.012). The volumes of MTT-DWI mismatch derived using SVD deconvolution compared to first-moment were not significantly different (p=0.276 with delay correction, and p=0.565 without delay correction). Pearson correlation coefficients for comparing the lesion volumes delineated on 4 sets of MTT maps with final infarct volume on 4-day FLAIR/CT images were all greater than 0.6 (p<0.05), but MTT with delay correction using SVD algorithm had the best correlation coefficient (r=0.803, p=0.005).

CONCLUSION
Applying delay correction for calculation of MTT maps in acute stroke patients with carotid occlusion results in significantly smaller volumes of MTT abnormality and MTT-DWI mismatch. The volumes of MTT-DWI mismatch varied significantly depending on the method used for perfusion analysis. Our results indicates MTT abnormality delineated on MTT maps with delay correction using SVD algorithm may be slight better for the prediction of final infarct compared to perfusion analysis using algorithm SVD without delay correction, as well as first moment algorithm. But, our analysis was only based on a small sample size. These differences should be taken into consideration in stroke trials using perfusion imaging to select patient for therapy.

KEY WORDS: MR Perfusion, MTT with delay correction, unilateral carotid occlusion

Scientific Poster 50
Radiation Dose Reduction in CT of the Brain. Can Advanced Noise Filtering Compensate for It?
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PURPOSE
Several commercial post-processing software solutions are available for noise reduction in CT to enable radiation dose reduction with maintained image quality. The purpose of this study was to evaluate if post-processing of CT of the brain with advanced noise filtering can compensate for a dose reduction by 30%.

MATERIALS & METHODS
Thirty patients referred for non enhanced CT of the brain were examined with two helical protocols: normal dose (CTDI 57 mGy) and low dose (reduced mAs, CTDI 40 mGy). The primary slices of the low dose examination were also post-processed with SharpView/CT, a noise reduction software with non-linear filters. This adaptive filters are supposed to reduce image noise while maintaining spatial information and enhancing local contrast. For each patient three axial 5 mm MPR stacks were reconstructed: 1. normal dose (ND), 2. low dose (LD), 3. filtered low dose (FLD). The three image stacks were presented side by side in randomized order for two radiologists (senior resident, neuroradiologist) blinded for dose level and filtering. The radiologist ranked the three stacks from 1 (=best) to 3 (=worst) for each patient according to three criteria: 1. gray-white matter discrimination (GWD), 2. delineation of basal ganglia (DBG), 3. general impression (GI). Measurements of mean Hounsfield units (HU) and standard deviation (SD) were performed in large ROIs (150 mm²) in the centrum semiovale. The study was approved by the local ethics committee.

RESULTS
In pooled data for both radiologists ND was ranked 1 (=best) in 31.7% for GWD (mean rank 1.75), in 51.7% for DBG (mean rank 1.53) and in 33.3% for GI (mean rank 1.70). FLD was ranked 1 in 68.3% for GWD (mean rank 1.32), in 48.3% for DBG (mean rank 1.52) and in 66.7% for GI (mean rank 1.33). LD was not ranked 1 in any case with mean rank 2.93 for GWD, 2.95 for DBG and 2.97 for GI. Both radiologists preferred FLD images for all criteria except for DBG where one radiologist preferred ND images. HU measurements showed no significant differences between the 3 groups. Mean SD values, as a measure for noise, were almost identical for ND and FLD (2.97 vs. 3.03) and 15% higher for LD (3.43).

CONCLUSION
The results from this study show that compensation for radiation dose reduction with advanced noise filtering (SharpView/CT) is feasible in CT of the brain. Both measurements of the noise levels and results from image quality rating indicate that filtered images obtained with 30% reduced dose have comparable image quality as normal dose images.

KEY WORDS: CT brain, dose reduction, post-processing
Scientific Poster 51

Quantitative MR Perfusion Using the Bookend Technique in Acute Stroke

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PURPOSE
To assess the predictive value of a novel quantitative MR perfusion technique in determining the size of the ischemic penumbra correlated to immediate post MRP digital subtraction angiography and patient outcomes after intra-arterial thrombolysis.

MATERIALS & METHODS
With IRB approval, we performed a retrospective review of the clinical and imaging data of patients who underwent a novel quantitative MR perfusion study using the previously described bookend technique immediately prior to undergoing cerebral angiography and intra-arterial thrombolysis for acute ischemic stroke. We recorded patient age, sex, presenting NIHSS, time to IA treatment, vascular lesion, average absolute MTT, CBF, CBV values in the ischemic core, in the same territory adjacent to the core and in the contralateral territory, DSA appearance (vessel occluded, degree, collateral flow), type of IA therapy, degree of IA reconstitution (TIMI grade), discharge NIHSS and final infarct size on MR and CT imaging.

RESULTS
Six patients had a quantitative MRP performed immediately prior to an IA thrombolysis procedure over a 2 year period. Mean age was 67 years and m:f ratio was 1:3. Mean presenting NIHSS was 19 and median time to treatment was 5 hours (range 3 to 24 hours - the 24hrs being in a case of basilar thrombosis). MR perfusion demonstrated profoundly reduced CBF (<10ml/100g/min) and CBV (<0.5ml/100g) in the infarct core corresponding to foci of diffusion restriction on MR, and higher CBF (>20ml/100g/min) and CBV (>2ml/100g) in the surrounding territory (non diffusion restricted). Two patients had mechanical thrombolysis alone, 1 had IA tPA alone and 3 had both. There was strong correlation between preserved MR perfusion values and collateral supply on angiography. At discharge average NIHSS was 11 with strongest correlation to outcome with time to treatment and size of core infarct at presentation.

CONCLUSION
This pilot study demonstrates that a novel quantitative perfusion MRI sequence can provide useful physiological information in the setting of acute stroke.

KEY WORDS: MRP, Bookend, Stroke

Scientific Poster 52

Clinical Utility of 32-channel 7T and 3T MR Imaging as a Problem Solving Tool

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PURPOSE
Many patients with neurologic symptoms, such as medically refractory focal epilepsy have no discernible abnormality on 1.5T and 3T using conventional techniques. This study identified patients with known or clinically suspected disease who may benefit from ultra-high field imaging at 7T to characterize non-specific findings or identify abnormalities in patients with clinically suspected focal disease.

MATERIALS & METHODS
Eight patients with known or suspected abnormalities were included. Six patients had conventional MR imaging with either non-specific or no findings. Two other patients had focal abnormalities which were not fully characterized at 1.5 or 3T. Seven patients had a history of epilepsy. Imaging was performed on a 7T Siemens Sonata MR scanner using a 32-channel phased array coil. Axial 2D Flash, T2* spoiled gradient-echo weighted images, T2 turbo spin-echo (TSE) images and MPRAGE were obtained with coverage targeted to the clinically suspected area of concern. All patients were also imaged on a 3T TrioTim Siemens MR scanner utilizing a 32 channel phased array coil, including sagittal MPRAGE, sagittal SPACE T2-weighted FLAIR, axial T2 TSE and axial diffusion tensor imaging (DTI).

RESULTS
In three of the patients, the combination of 32 channel 3T and 7T identified cortical dysplasias. In one patient, advanced imaging allowed better delineation of the focal cortical dysplasia (FCD), aiding surgical resection. Another patient had conventional MR imaging that was interpreted as FCD versus neoplasm; 7T imaging definitively characterized this lesion as a FCD. T2* imaging at 7T allowed identification of areas of hemorrhage in two patients. One patient had three non-specific foci of susceptibility artifact noted at 1.5T. At 7T, this was clearly defined as a developmental venous anomaly with associated cavernous malformations (see Figure). A focal area of encephalomalacia with a prior hemorrhagic infarct, not resolvable on prior imaging, was identified at 7T in another patient. The remaining three patients had no focal abnormality identified at higher field strength.
CONCLUSION
Imaging at 7T and 3T utilizing 32 channel phased array coils improved lesion identification, characterization and delineation. Areas with iron deposition as well as areas of cortical indistinctness were better identified at 7T. 3T imaging with volumetric FLAIR complemented 7T imaging in defining areas of abnormality. These two technologies hold great promise as a problem solving tool for both identifying focal lesions in “MR negative” patients as well as in further characterizing non-specific abnormalities on conventional imaging.

KEY WORDS: 7T, ultra-high field

Scientific Poster 53
Comparison of 1D, 2D, and 3D Estimates of Enhancing Tumor Volume for Predicting Survival in Recurrent Glioblastoma

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PURPOSE
Tumor size predicts patient survival in both newly diagnosed and recurrent GBM, but is difficult to assess on MRI. Criteria to estimate tumor volume range from simple linear measures (RECIST), to biaxial (Macdonald), to more complicated and time consuming volumetric measurements. Antiangiogenic therapies result in dramatic reductions in enhancement and may influence these, methods differentially. Here we compare the correlation of one-, two-, and three-dimensional estimates of enhancing tumor volume with progression free survival (PFS) and overall survival (OS) in a clinical trial of Bevacizumab.

METHODS
Forty-five patients (mean 54 y, range 38-85 y) with recurrent GBM enrolled in a phase II clinical trial of Bevacizumab alone (ClinicalTrials.gov identifier: NCT00290797) underwent MRI prior to and within 96 h of initiation of therapy (Bevacizumab 10 mg/kg i.v.) during which time their steroid dose was stable for at least 1 week. Postcontrast 3D T1 volumes (~1x1x1 mm³) were obtained. Pre and post treatment 3D T1 data was rigidly coregistered (FLIRT) to ensure accurate comparison. D1 (the longest diameter) and D1xD2 (the product of the longest diameter and its perpendicular) were measured manually. 3DV (the volume of all enhancing tumor voxels) was measured by first roughly outlining the enhancing tumor by hand, and then applying an expectation maximization algorithm. Tumor size before and after Bevacizumab and percentage change were correlated with the progression-free survival (PFS) and overall survival (OS) by Pearson correlation.

RESULTS
Each estimate of tumor size (D1, D1xD2, and 3DV) correlated with PFS and OS, both for pre-treatment and post-treatment estimates (Table 1). Enhancing tumor volume decreased significantly after a single infusion of Bevacizumab by each estimate (14.4% for D1, 28.0% for D1xD2, and 38.5% for 3DV, p<0.01 in each case). Furthermore, the percentage change after treatment correlated with PFS and OS, and did so more strongly than the absolute size estimates (Table 1). Of these estimates, the percentage change of the tumor size measured in D1 was the most strongly correlated to the PFS and OS (r = 0.50 for PFS and 0.52 for OS, p<0.01).

Table 1. Correlation coefficients between enhancing tumor size estimates and survival times

<table>
<thead>
<tr>
<th></th>
<th>PFS</th>
<th>OS</th>
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<tbody>
<tr>
<td>D1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>preRx</td>
<td>-0.23</td>
<td>-0.40*</td>
</tr>
<tr>
<td>postRx</td>
<td>-0.35*</td>
<td>-0.51*</td>
</tr>
<tr>
<td>% Change</td>
<td>0.50*</td>
<td>0.52*</td>
</tr>
<tr>
<td>D1xD2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>preRx</td>
<td>-0.28</td>
<td>-0.43</td>
</tr>
<tr>
<td>postRx</td>
<td>-0.32*</td>
<td>-0.48*</td>
</tr>
<tr>
<td>% Change</td>
<td>0.42*</td>
<td>0.47*</td>
</tr>
<tr>
<td>3D Volume</td>
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<td></td>
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<tr>
<td>preRx</td>
<td>-0.24</td>
<td>-0.33</td>
</tr>
<tr>
<td>postRx</td>
<td>-0.27</td>
<td>-0.35</td>
</tr>
<tr>
<td>% Change</td>
<td>0.38*</td>
<td>0.43*</td>
</tr>
</tbody>
</table>

* p<0.05

CONCLUSION
Enhancing tumor volume is a predictor of PFS and OS. The percentage reduction in tumor size after a single dose of Bevacizumab was a stronger predictor of PFS and OS than were the absolute size measurements, regardless of method. Surprisingly, the volumetric estimate (3DV) did not improve the predictive power as compared to the more simplistic D1 and D1xD2 estimates. This does not deny the important role of 3D segmentation of enhancing tumor for other purposes, such as defining volumes of interest in the evaluation of physiologic and functional parameters.

KEY WORDS: Segmentation, response, tumor
Scientific Poster 54

MR Imaging of Primitive Neuroectodermal Tumors (PNETs) in a Spontaneous JCV T-antigen Transgenic Mouse Brain Tumor Model at 7 Tesla

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PURPOSE
In this work we have developed and studied the MR imaging characteristic of primitive neuroectodermal tumors (PNET’s) in a spontaneous JCV T-antigen transgenic mouse brain tumor model at 7 Tesla.

MATERIALS & METHODS
MR scans were performed on seven spontaneous JCV T-antigen transgenic mice using a 7 Tesla scanner. Whole brain protocol consists: FOV = 2.56x2.56x0.75 cm, matrix=256x128x28, and NA=4, T2-weighted SE sequence (T1=2000 msec, T2=13 msec), Pre-Gad T1-weighted SE sequence (T1=1200 msec, T2=13 msec), and T2*-weighted SE and a 3D GRE (T1=430 msec, T2=8 msec, FA=35°). MR imaging was performed pre- and post- injection with gadolinium, animals were euthanized. Brain tissue was fixed and analyzed by histological staining and immunohistochemistry for the transgene, JCV T-antigen. Institutional Animal Care protocols were followed. A neuroradiologist reviewed all the MR images and characterized the normal and tumor areas of the mouse brain images. MR imaging results were correlated with the histological findings.

RESULTS
Following MR imaging characteristics were reviewed in the 7 JCV induced brain tumors in mice: Presence of solid tumor, normal brain tissue, contrast enhancement, necrosis, edema, and unusual features. MR was able to identify the presence of brain tumors within our mouse population. Figure 1 shows a correlation of radiological findings of PNETs in one representative animal and microscopic classification of a brain tumor and regions of adjacent brain.

CONCLUSION
Good correlations between MR imaging and anatomical findings were observed in areas of viable tumor, edema, necrosis, tumor margins, and normal brain tissue. Such a model will be useful for validation of molecular imaging tumor-specific contrast agents and experimental treatments for PNETs.

KEY WORDS: PNET, Animal Model, MRI

Scientific Poster 55

Insular Tumors - Importance of Recognizing Primary Location and Mode of Spread Within the Limbic Pathways

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PURPOSE
Insular tumors are a distinct group of brain tumors. The purpose of this study is to understand the distribution, behavior and characteristics of insular tumors.

MATERIALS & METHODS
We reviewed 29 cases of insular tumors managed from January 2000 to December 2008 at our tertiary neurosurgery referral centre. Study group comprised 18 males and 11 females. The age range was from 21 to 83 years. All patients underwent Magnetic Resonance Imaging (MRI) studies on a 1.5 or 3 Tesla scanner. High resolution volumetric data was acquired with multi-planar, multi-sequence technique. All patients underwent triplanar FLAIR and contrast studies. The studies were interpreted by 3 board certified Neuroradiologists. The medical records were reviewed for management and clinical outcome. The distribution of the tumors was subclassified to primary insular involvement, anterior insula with substantia innominata involvement, diffuse involvement of the insula, substantia innominata and amygdala and secondary insular involvement from substantia innominata, amygdala and orbitofrontal cortex. Short and
long gyri involvement of the insula and subcortical white matter extension were also observed. Correlation with histological subtype was evaluated.

RESULTS
There was variable pattern of insular involvement. In 6 patients, the tumor was primarily confined to an expansile mass within the insula. Most of these tumors were well defined, showing little or no contrast enhancement with no subcortical white matter changes. In 8 patients, more extensive involvement was seen with expansile lesions identified within the anterior and mid insular cortex and adjacent sub- stantia innomnata. Most of these lesions were well defined showing minimal to no contrast enhancement. In 10 patients, a much wider extension was seen with contiguous involvement of the amygdala. In these patients, subcortical white matter changes were seen as well as variable degrees of contrast enhancement was noted. In 9 patients, secondary involvement of the anterior insula was noted with primary expansile lesions seen in the amygdala and/or substantia innomnata. These abnormalities showed greater degree of contrast enhancement and adjacent subcortical white matter changes. In 5 patients, primary lesion started from the amygdala or substantia innomnata with minimal involvement of the anterior insula. In general, histopathology of the lesions with a lower WHO classification grading was seen in the more well defined lesions of primary insular tumors and those with contiguous involvement of the substantia innomnata and insula. In the more diffuse pattern, a higher WHO grading was seen.

CONCLUSION
It is important to recognize the anatomical display of the insula in all 3 planes particularly in the sagittal plane where the short and long gyri of the insula is well recognized. Primary insular tumors tends to be well defined and in general show a lower WHO grading. In the more diffuse pattern showing extensive involvement of the insula and adjacent structures with subcortical white matter changes, a higher WHO grading was found.

KEY WORDS: Insula, tumor, limbic

Scientific Poster 56
CT Perfusion for Evaluation of Grade of Cerebral Gliomas

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PURPOSE
The prognosis of patients presenting with a primary brain tumor depends on the histological grade of the lesion. Conventional imaging techniques such as computed tomography (CT) or magnetic resonance imaging (MRI) are not always accurate in predicting the histological grade of the lesion, particularly when there is a non-enhancing lesion. The purpose of this study is to assess the accuracy of CT perfusion in grading glioma.

MATERIALS & METHODS
After obtaining informed consent, CT perfusion (CTP) images were obtained in patients with suspected glioma presenting for neuronavigation (Brainlab) protocol for preoperative planning. Images were acquired every second for 60 seconds starting 5 to 10 s after injection of 40 cc of Omnipaque300 (4 cc/s) using 80 kVp, 190 mA, 512 X 512 matrix. Permeability surface area product (PS) and cerebral blood volume (CBV) maps was generated using the CT perfusion 3 software using deconvolution method. Regions-of-interest were obtained from areas of tumor with highest CBV and PS values. Correlation of those parameters with the histological grade of the lesion was performed following biopsy or excision of the lesion. Comparison of these parameters was made between different grade of gliomas and between gliomas and normal white matter. A p value less than 0.05 was considered significant.

RESULTS
Total of 21 patients were included in our study. The mean CBV and PS for normal white matter were 0.947 mL/100 g and 0.57 mL/100g/min respectively. The average value of cerebral blood volume was 4.17 mL/100 g for grade 4 gliomas (n=15), 3.53 mL/100g for grade 3 gliomas (n=5), 0.93 mL/100g for grade 2 gliomas (n=1). The permeability area product was 8.12 mL/100g/min for grade 4 gliomas, 3.82 mL/100g/min for grade 3 gliomas and 0.39 mL/100g/min for grade 2 gliomas. There was a significant difference (p<0.0001) between the CBV and PS of gliomas and normal white matter. There was also a significant difference (p= 0.022) between the PS of grade 3 and grade 4 gliomas. However there was no statistically significant difference (p= 0.411) between the CBV of grade 3 and grade 4 gliomas.

CONCLUSION
Our results suggest that CT perfusion derived PS values might be more accurate in differentiating between high grade 3 and grade 4 gliomas than CBV values.

KEY WORDS: Cerebral gliomas, cerebral blood volume, permeability surface area product

Scientific Poster 57
Radiologic, Clinical, Pathologic, and Genetic Features of Angiocentric Glioma, a Novel Brain Tumor Entity

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PURPOSE
Angiocentric glioma has recently been described as a, previously unknown epilepsy associated tumor with distinct clinicopathologic features and is recognized as novel tumor...
entity by the World Health Organization (WHO). Our aim is
to report the clinical, radiological, pathologic and genetic
findings in eight cases of this rare tumor type.

**Patients and Methods**

Eight patients (4 male, 4 female, aged 6-70 years) suffering
from pharmacotherapy-refractory epilepsy underwent (sub)
total lesionectomy (7) or biopsy (1) of cortical/subcortical
space occupying lesions in the temporal and parietal lobes.
Presurgical MR- examination, performed following different
protocols were reviewed with respect to solid and/or cystic
appearance, delineation, signal intensities on the respective
sequences, and contrast enhancement. Histopathology, ultra-
structure and protein expression profiles were characterized
in all tumor tissue samples using light and electron
microscopy and immunohistochemistry including a broad
panel of antibodies directed at glial, neuronal and cell-pro-
liferation associated proteins. Detailed genetic analysis was
performed using chromosomal comparative genomic
hybridization in 8 and high-resolution array-comparative
genomic hybridization in 3 cases.

**Results**

On MR-images, 7/8 tumors had a solid appearance, 1/8
showed cysts. 7/8 were well delineated, 1/8 diffuse infiltrat-
ing. T2-weighted(w) and on the FLAIR- sequence all lesions
appeared hyperintense to adjacent gray/white matter, rimlike
T1w- hyperintensity was seen in 7/8 (Figure), isointensity in
1/8. Contrast-enhancement was present in 5/8, in 3/8 no con-
trast-enhanced series were available. Histologically, the
tumors showed diffuse growth and distinct perivascular
(=angiocentric) tumor cell arrangements with features of
astrocytic/ependymal differentiation and lack of malignant
features (i.e. necrosis, proliferative activity). Genetic analy-
sis showed loss of chromosomal bands 6q24-q25 in one and
a copy number gain of two clones from chromosomal band
11p11.2 containing the protein-tyrosine phosphatase recep-
tor type J (PTPRJ) gene in another case. All patients are
seizure free and without evidence of tumor recurrence at fol-
low-up times ranging from ½ to 6.9 years.

**Conclusion**

Radiologically, the salient feature of angiocentric glioma
seems to be the T1- weighted appearance (FIG). Histology
and clinical course show that it is is a novel glial tumor enti-
ty of low-grade malignancy, thus widening the spectrum of
potentially epileptogenic benign tumors (1)

**References**

   Angiocentric glioma: report of clinico-pathologic and genetic

**Key Words:** Epilepsy, angiocentric glioma, histology
RESULTS
Of the thirty biopsy specimens, 13 were obtained from peritumoral non-enhancing regions and 17 were obtained from contrast enhancing regions. Contrast enhancing regions had elevated mean relative CBV values (3.75 vs. 1.30; P<0.01) and reduced mean relative ADC values (1.14 vs. 1.61; P<0.01) compared to non-enhancing biopsy sites. Relative FA values were not found to be statistically different. Within contrast enhancing regions; microvascular density (4.00 vs. 1.9; P<0.01), hypoxia (1.56 vs. 0.05; P<0.01), tumor cellular density (25.5% vs. 17.7%; P<0.01) and overall cellularity (1243 vs. 614; P<0.01) were significantly elevated compared to non-enhancing biopsy sites. A strong positive correlation was found between relative CBV and tumor cellular density (r=0.63; P<0.01), overall cellularity (r=0.57; P<0.01), tissue hypoxia (r=0.64; P<0.01), and microvascular density (r=0.35; P=0.05). No correlation was found between relative FA values and the histopathologic variables studied. RNA expression patterns between enhancing and non-enhancing biopsy sites were found to be significantly different (FDR<0.05). Enhancing regions were found to have up regulation of cellular proliferation, angiogenesis, and hypoxia genes. Hierarchical clustering of the top 500 most variant genes found clustering by biopsy region suggesting a large degree of regional biological variability.

CONCLUSION
Our findings provide an in vivo portrait of genome wide gene expression in GBM and provide insight into how tumor biology influences anatomic and physiologic MR imaging.

KEY WORDS: Glioblastoma multiforme, DSC perfusion MRI, image guided biopsy
perifocal edema, in 7 patients a discrete edema was noted, only one patient had a nameable edema. All medulloblastoma variants enhanced marked after i.v. contrast application, especially the medulloblastoma with extensive nodularity had a nodular enhancement pattern. We could depict hemorrhage in 2 cases; one of these cases had calcifications too. In 10 out of 11 patients a hydrocephalus was diagnosed. 2 patients had leptomeningeal metastases at the time of diagnosis.

CONCLUSION
The imaging spectrum of medulloblastoma variants is extended but variable and the differentiation between the variants can not be done based on imaging features only. The more aggressive variants of medulloblastoma (anaplastic and large cell) will more likely have a restricted diffusion consistent with their high cellularity.

KEY WORDS: Medulloblastoma, magnetic resonance imaging (MRI), WHO classification

Scientific Poster 60
Temozolomide Significantly Reduces Tumor Perfusion Prior to Tumor Shrinkage as Assessed by Dynamic Susceptibility Contrast MR Imaging Using a Brain Tumor Model

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PURPOSE
As of now, temozolomide is the only chemotherapy prooven to improve long-term survival as part of the Stupp scheme. Its mode of action is within the cleavage of the rapidly growing cells. Beside mitosis glioblastomas also have neovascularization and proliferation. Dynamic susceptibility contrast MRI (DSC-MRI) is commonly used preoperatively for differential diagnosis of brain tumors. The purpose of this study was to assess early perfusion changes caused by temozolomide in a malignant brain tumor model.

MATERIALS & METHODS
10-6 glioma C6 cells were stereotactically injected into the basal ganglia of the 13 Wistar rats inducing a rapid aggressive tumor growth. 16 days after injection of the cells an MRI was performed using a 3T Scanner and a dedicated solenoid coil (Philips, Best, The Netherlands) including T1- and T2-weighted sequences to define tumor size prior to therapy. 6 rats received 20mg/kg/d temozolomide i.p. for 5 days followed by another MRI including a DSC-MRI using a T2*-weighted EPI PRESTO sequence (TR/TE = 30/14 ms, matrix 64 x 64, FOV 90 mm; slice thickness of 1.5 mm). Ratios of rCBV and rCBF were created using the NordicIce Software (NordicNeuroLab, Bergen, Norway). The applied dose was corrected for the known increased metabolism of the animals accordingly.

RESULTS
Tumor size did not differ between therapy and control. Compared to the control animals, however; there was a significant reduction in rCBV (t = 4.09, P = 0.0025, one-tailed t-test) and rCBF (t = 4.08, P = 0.002, one-tailed t-test).

CONCLUSION
Temozolomide significantly reduces tumor perfusion already after 5 days of therapy as demonstrated by DSC-MRI. The chosen tumor model resembles the human glioblastoma multiforme demonstrating neovascularisation and vascular sprouting. Prior to a reduction in tumor size, temozolomide led to a significant reduction in cerebral perfusion values. DSC-MRI is a powerful tool in assessing early response to treatment and should become a mainstay of follow-up MRI exams in order to analyze perfusion changes at the borders of a resection cavity. This can be done immediately after the beginning of the therapy.

KEY WORDS: Temozolomide, DSC-MRI, brain tumor model

Scientific Poster 61
Whole-tract Reduction in Fractional Anisotropy in the Corticospinal Tracts of Amyotrophic Lateral Sclerosis Patients, as Measured Using a Weighted 3-D Region-of-Interest in Template Space After Deformable Diffusion Tensor Imaging Registration

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PURPOSE
To determine if a whole-tract measure of fractional anisotropy in the corticospinal tract is significantly reduced in amyotrophic lateral sclerosis. Amyotrophic lateral sclerosis (ALS) is a degenerative disease of motor neurons. Diffusion tensor imaging (DTI) measurements in the corticospinal tract (CST) of patients with ALS have shown reductions in fractional anisotropy (FA), thought to reflect axonal degeneration of the upper motor neurons. Regions-of-interest (ROI) measurements can be time-consuming if they require user interaction. We performed whole-tract (global) CST measurements of FA using a fully automated deformable diffusion-tensor image registration algorithm that warps individual DTI data into a common spatial frame (“template space”), and a 3-D region-of-interest of the CST defined in template space.

MATERIALS & METHODS
Twelve ALS patients (ages 31-76; mean 61) and seven healthy controls (ages 57-67; mean 63) were studied. DTI was performed on a 3.0-T Siemens Trio scanner using an 8-channel coil and a 30-direction single-shot spin-echo diffusion-weighted echo-planar sequence, GRAPPA acceleration of 3 (b = 1000 s/mm²). Other parameters: NEX = 3, TR = 6700 ms, TE = 85 ms, FOV = 245 x 245 mm, matrix = 128 x 112, slice 2.2 mm, gap 0 mm, voxel dimension 2.19 x 2.19 x 2.2 mm³, total scan time: 13 minutes. Diffusion tensor images were spatially normalized using a high-dimensional deformable registration algorithm that explicitly opti-
mizes tensor orientation for optimal alignment of white matter structures. Template-space FA was determined from the transformed tensors. A weighted 3-D ROI corresponding to the CST was defined in template space by applying the individual spatial transforms to binary masks of voxels traversed by fibers as determined by DTIStudio, using the Fiber Assignment by Continuous Tracking algorithm. The transformed masks of the seven controls were averaged together in template space to define the weighted 3-D ROI. Similar ROIs were constructed of the forceps minor (frontal projection of the corpus callosum) and the bilateral cingulated bundle. Whole-tract FA was measured by the mean FA in template space ROIs.

RESULTS
The diffeomorphic registration converged in 6 iterations. Whole-tract FA measurements were significantly different in groups of ALS patients and controls (Mann-Whitney-U, Z = -2.958; p = 0.003). There was no difference in whole-tract measurements of FA in the forceps minor (Z = -0.761, p = 0.447). Reduction in FA in the bilateral cingulate bundle did not meet the threshold for statistical significance (Z = -1.606, p = 0.1082).

CONCLUSION
We found a highly significant decrease in whole-tract CST FA in ALS. Because the registration algorithm requires no user input, this measurement method would be easier to apply to large groups of data. The use of a single summary measurement such as whole-tract FA is also attractive because (1) it avoids the multiple-comparison problems that complicate the statistical analysis of voxelwise approaches, and (2) it would be easier to use as a quantitative biomarker or a diagnostic test. Finally, axonal degeneration likely occurs in a random and widespread fashion throughout the CST (inasmuch as the disease can manifest in a variety of clinical presentations) so that a whole-tract measurement seems more appropriate than a voxel-wise approach.

KEY WORDS: Amyotrophic lateral sclerosis, diffusion tensorimaging, deformable registration

Scientific Poster 62
A Longitudinal Study of Changes in Diffusion Tensor Eigenvalues of the Corpus Callosum in Secondary Progressive Multiple Sclerosis

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PURPOSE
Secondary progressive MS (SPMS) is characterized by gradually accumulating neurological disability, and the progression speed varies widely among individuals. Our previously longitudinal study of SPMS had shown that diffusion tensor imaging (DTI) could distinguish between an active, progressive and a “dormant” disease process of SPMS [1]. The patients had been followed for one year and were divided into two groups, those with at least one examination with an enhancing lesion (active) and those who never showed enhancement (dormant). The enhancing group had a significant, progressive decrease in fractional anisotropy (FA) within the body and splenium of corpus callosum (CC), in contrast to the non-enhancing group which showed no significant FA changes. As tensor eigenvalues were commonly used to evaluate the subtle pathology process in MS [2,3], the purpose of present study was to evaluate other DTI parameters, specifically diffusion tensor eigenvalues’ change in different parts of CC in this patient group, since they might give more insight into the mechanisms behind the evolution of anisotropy.

MATERIALS & METHODS
Eleven untreated patients with clinically definite SPMS completed bimonthly MRI scans during one year. MRI was done on a GE Signa Excite 1.5 T scanner and included axial post contrast T1WI and DTI. The patients were divided into an enhancing and a non-enhancing group with 5 and 6 patients, respectively based on the presence of T1 enhancing lesions during study period. The FA value and eigenvalues ($\lambda_1$, $\lambda_2$ and $\lambda_3$) of the genu-, body- and splenium-CC were measured at every time point using a region of interest (ROI) method. Differences and changes over time in FA, eigenvalues, axial ($\lambda_1$) and radial diffusivity ($\lambda_2+\lambda_3$)/2 were evaluated using repeated measures analysis of variance (ANOVA).

RESULTS
The enhancing group showed again a significant, progressive FA decrease in the body- and splenium-CC ($p$ of 0.003 and 0.006), but not in the genu-CC of. $\lambda_1$ showed no significant change anywhere in the CC. $\lambda_2$ and $\lambda_3$, as well as the radial diffusivity were increased in body and splenium-CC, however only in body-CC, $\lambda_2$ and $\lambda_3$ and radial diffusivity were significantly increased ($p <0.05$) over time, while in the splenium-CC only $\lambda_3$ and the radial diffusivity changed significantly. There was no significant change of eigenvalues or radial diffusivity in the genu-CC, neither in any part of the CC in the non-enhancing group.

CONCLUSION
The body- and splenium-CC in the enhancing group of SPMS patients showed significant increase over time in radial diffusivity, $\lambda_2$ and/or $\lambda_3$. In the body part, both $\lambda_2$ and $\lambda_3$ were significantly increased, which may be the cause for the more prominent FA decrease in the body-CC when compared with the splenium-CC. In the splenium-CC it was predominantly the $\lambda_3$ increase that contributed to the anisotropy changes. Individual eigenvalues may provide a better understanding of the processes in SPMS progression, which could be helpful in monitoring treatment effects.

REFERENCES

KEY WORDS: SPMS, brain, DTI and eigenvalues
Scientific Poster 63

Evaluation of Basal Forebrain Atrophy in Alzheimer's Disease Using MR Imaging

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PURPOSE

The objective of our study was to detect and evaluate neuron loss of cholinergic brain structures in Alzheimer's disease (AD) in vivo using image regression analysis and voxel-based morphometry.

MATERIALS & METHODS

21 formerly untreated patients suffering from Alzheimer's disease and 21 healthy age-matched control subjects were examined in a prospective study. MRI was performed using a 1.5 T scanner acquiring primarily sagittal T1-weighted images (MPRAGE) and a proton weighted MRI sequence oriented perpendicular to the AC-PC-line. For the quantitative data analysis, we used an approach based on the combination of voxel-based morphometry and region of interest analysis (image regression analysis). Additionally voxel-based morphometry of the cortex was applied.

RESULTS

Significant decrease of signal intensity was found in the medial and lateral part of the substantia innominata, corresponding to the location of the Nucleus basalis Meynert, in AD patients relative to controls (p<0.01). The signal intensity in the anterior lateral substantia innominata was significantly correlated with grey matter volume loss in the bilateral prefrontal cortex, inferior parietal lobule and cingulate gyrus (p<0.005).

CONCLUSION

Signal changes in the Substantia innominata can be detected using image regression analysis based on MRI imaging. These findings may correspond to cholinergic neuron loss in Nucleus basalis Meynert in Alzheimer's disease and may serve as a basis for future measurement of disease modifying effects of the pharmacological treatment of AD.

KEY WORDS: Alzheimer, mr imaging, cholinergic neuron loss

Scientific Poster 64

Brain MR Imaging of Meningeal Involvement in Localized Scleroderma

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INTRODUCTION

Brain lesions in localized scleroderma may mimic tumors on imaging, especially if the primary condition is not known. The skin lesion usually predates neurologic symptoms by several years. We present brain MRI findings in a patient with localized scleroderma, emphasizing meningeal involvement which is a known pathologic feature of the disease but, to our knowledge, has not been previously described on imaging.

METHODS

Case Report: A 46-year-old female presented with a one month history of headaches, and right arm paresis. One week before admission focal seizures of the right upper limb were noted. Brain CT and MRI showed a non-enhancing calcified left subcortical frontal lesion, causing sulcal effacement and passive dilation of the frontal horn. Associated dural thickening and leptomeningeal exudate were seen. The patient underwent surgical excision of the lesion; leptomeningeal inflammatory changes were confirmed. Pathological examination of the brain lesion confirmed brain calcification; no parenchymal neoplasm or inflammatory processes were demonstrated. Pre-operative MRI and scans were reviewed; focal cutaneous and bony atrophy in the left frontal scalp were disclosed, corresponding to an asymptomatic depressed lesion which had been noted by the patient and remained stable since 20 years ago. Localized scleroderma was diagnosed.

DISCUSSION

When MRI findings suggestive of the disease (blurring of gray-white junction, focal atrophy, T2/FLAIR hyperintense lesions and calcifications) are seen, a search for skin and bony abnormalities, such as atrophy, alopecia, or hardening should be undertaken. Imaging signs of leptomeningeal exudate and meningeal enhancement suggest active inflammation providing support for immunosuppressive treatment.

KEY WORDS: MR imaging, scleroderma

Scientific Poster 65

Cerebrovascular Complications of Cocaine Use at a Tertiary Stroke Center

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PURPOSE

An association between cocaine and stroke has been reported, but few studies have examined the cerebrovascular complications of cocaine using modern stroke imaging. We
describe the most common presentations and neuroradiologic findings in a large cohort of cocaine users with stroke. The results provide new insight into the spectrum of cocaine-associated cerebrovascular disease.

MATERIALS & METHODS
Medical records from adult admissions to our tertiary neurovascular service from July 1, 1998 to July 1, 2008 were screened for active or prior cocaine use in the setting of acute ischemic stroke/transient ischemic attack (AIS/TIA), intracerebral hemorrhage (ICH), or subarachnoid hemorrhage (SAH). Patients presenting with ischemic stroke were classified according to the Trial of Org 10172 in Acute Stroke Treatment (TOAST) criteria subgroups: large artery atherosclerosis, cardioembolism, small vessel occlusion, stroke of other determined etiology, and stroke of undetermined etiology. Carotid ultrasound, CT and MR angiography, and conventional angiography for all patients were reviewed to characterize vascular abnormalities.

RESULTS
Of 5142 records screened, 96 patients with cocaine use were identified: 45 (47%) with AIS/TIA, 26 (27%) with ICH, and 25 (26%) with SAH. Sixty-one patients (63.5%) were categorized as active and 35 (36.5%) as previous cocaine users. Stroke type differed significantly between active and prior users (p=0.004), with active users more likely to have ICH compared with previous users (37.7% vs. 8.6%) and less likely to have AIS/TIA (36.1% vs. 65.7%). The most common etiology for ischemia according to TOAST criteria was large artery atherosclerosis in 20 (44%) patients. Neuroimaging reviewed independently of clinical information revealed similar findings, with early-onset large artery atherosclerosis in prior users and basal ganglionic hypertensive hemorrhage in current users occurring most commonly. Figure: Axial T2 FLAIR MRI (left) demonstrating infarct in the left lentiform nucleus in a former cocaine user. Catheter angiography revealed poor filling of the distal left M1 segment (right) and severe atherosclerosis of the proximal basilar trunk (not shown).

CONCLUSION
AIS/TIA is a common presentation in patients with a remote history of cocaine use, often due to premature atherosclerosis. Neither vasculitis nor vasospasm were common causes of stroke in this cohort. Intracerebral hemorrhage was more common among active cocaine users, perhaps due to acute spikes in blood pressure.

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KEY WORDS: Cocaine, stroke, intracerebral hemorrhage

Scientific Poster 66
Comparison of Perfusion-CT Studies Acquired Using Cine Versus Shuttle Mode in Patients With Suspected Acute Ischemic Stroke

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BACKGROUND
Perfusion-CT (PCT) has emerged as an imaging technique available in the emergency room to assess patients with suspected acute ischemic stroke. While more readily available than magnetic resonance imaging (MRI), especially in the emergency room setting, PCT has limited spatial coverage and does not afford whole brain coverage. Different approaches have been proposed to address the issue of limited coverage, including an approach consisting of toggling or shuttling the CT table between two locations during the PCT acquisition. This, however, results in decreased temporal resolution of the PCT acquisition, which may impact the accuracy of the PCT results.

PURPOSE
The purpose of this study was to evaluate the accuracy of PCT results using shuttle technique as compared to cine technique in patients with suspected acute ischemic stroke.

MATERIALS & METHODS
Imaging data from 10 PCT studies obtained in patients with suspected acute hemispheric ischemic stroke were retrospectively reviewed. Each patient had PCT performed at 2 levels, in order to cover the whole brain: cine-mode PCT to cover the inferior 4 cm (8 x 5mm) and shuttle-mode PCT to cover an additional 8 cm (16 x 5mm) more superiorly. In these 10 patients, there was an overlap of 1 or 2 slices. Cine-mode PCT and shuttle-mode PCT acquisitions involving these overlapping slices were processed to calculate parametric maps of mean transit time (MTT), cerebral blood flow (CBF), and cerebral blood volume (CBV). The MTT, CBF and CBV values were recorded in standardized regions of interest (ROIs), identical for the maps derived from cine-mode PCT and shuttle-mode PCT. Agreement between the cine-mode and the shuttle-mode values was quantified using the Bland and Altman method.

RESULTS
Variation between the cine-mode and the shuttle-mode was in the range of 7.5% for MTT, 12.2% for CBF and 21.3% for CBV. Variation was similar in the ischemic ROIs and in the
nonischemic ROIs. This variation was in a range similar to the interobserver variability typically observed for cine-mode PCT.

**CONCLUSION**
Cine-mode and shuttle-mode PCT yield similar values in terms of MTT, CBF and CBV, despite a lower temporal resolution for shuttle-mode PCT.

**KEY WORDS:** Perfusion CT, stroke

**Scientific Poster 67**

**Dose Exposure of Patients in Stroke Imaging With Multidetector Row Computer Tomography - Comparison between 320-Detector Row CT Scanner and 64-Detector Row CT Scanner**

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**PURPOSE**
To evaluate patient radiation exposure in comprehensive stroke imaging using 320-detector row CT with assessment of standard CT of the head, CTA of cerebral and cervical vessels and CT-Perfusion.

**MATERIALS & METHODS**
Examination protocols included Standard native CT, CTA of cerebral and cervical vessels and CT Perfusion and were performed using a 320-detector row CT Scanner (Toshiba Aquilion ONE) and a 64-detector row CT scanner (Toshiba Aquilion 64). Organ doses were measured with lithium-fluoride thermoluminescence dosimeters (LiF-TLD; TLD 100 (Harshaw)) located at several organ sites using an Alderson-Rando Phantom (Phantom Laboratory, Salem, NY). Effective doses were derived from these measurements for male and female subjects.

**RESULTS**
Measured Effective doses depending on the different scan protocols ranged between 1.65 mSv and 4.56 mSv, resulting in an effective dose for complete stroke imaging (standard native CCT, CTA of cerebral and cervical vessels and CTP) of 7.93 mSv/7.75 mSv (male/female) in 64 detector row CT and 11.6 mSv/10.56 mSv (m/f) in 320 detector row CT. Maximal organ dosis within the area of the primary beam were measured in skin (92.0 mGy) and cerebral hemispheres (70.0 mGy). A protection device was used to minimize eye lens radiation and reduction of 54 % was measured.

**CONCLUSION**
Based on the actual measurements comprehensive stroke imaging with multidetector row CT may result in effective radiation dose of 7.75 mSv/7.93 mSv (m/f; 64 detector row CT) up to 11.6 mSv/10.56 mSv (m/f; 320 detector row CT). The new technique of 320 detector row CT offers additional information about the time resolution of vascular imaging and the whole brain perfusion. Physicians have to weight the potential of the new technique against the higher radiation dose that is needed. Critical doses for organ damage were not reached.

**KEY WORDS:** CT perfusion, stroke imaging
24hr. On the 1 week follow-up scan, a mean 37.7% (Median=30.9%) of observed mismatch volume at 24 hour scan had infarcted.

**CONCLUSION**

Many patients who present outside the 3-hour window for IV tPA and have a visible mismatch on MRI may have physiology favorable to mismatch stability that may last 24 hours or longer.

**KEY WORDS:** Ischemic stroke, diffusion/perfusion mismatch, penumbra

**Scientific Poster 69**

**Acute Stroke and Electrocardiographic Abnormalities, a Brain Lesion Localization Study**

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**PURPOSE**

Heart diseases can be a cause, but also a consequence of stroke. Cardiac arrhythmias and electrocardiographic (EKG) abnormalities can develop in patients with acute stroke. Many studies have focused the role of insula and infralimbic cortex as the two cortical sites involved in the cardiac control. These cortical sites are connected with subcortical sites, brainstem sites and spinal cord sites. The final effect of these connections is the modulation of the autonomic control on the heart. Our objective was to study the relationships between EKG changes and the areas of the brain injured by the stroke, and whether there is a prevalence of sympathetic or parasympathetic impairment depending on the damaged area.

**MATERIALS & METHODS**

Retrospective review of EKGs and brain MRI of 95 consecutive patients with acute stroke (age 68.0 years old + 13.9) who developed EKG abnormalities during the hospital stay, and performed brain MRI with DWI-ADC and FLAIR imaging within 5 days from admission. The patients were divided in four groups, depending on their EKG abnormalities: abnormalities with prevalent parasympathetic component, abnormalities with prevalent sympathetic component, non-specific abnormalities, and atrial fibrillation. A probability map of ischemic brain lesion localization on MRI was obtained by free-hand drawing of the boundaries of the acute ischemic lesions as defined by high DWI-signal and low ADC map-signal using the MRMcron v1.0 software, then transferred into a stereotaxic space using the spatial normalization algorithm and the EPI template provided by SPM5 software. We obtained lesions overlap plots for the different patients' groups, and we correlated the brain lesions' localization, with the different subtype of EKG abnormalities. Statistical analysis consisted of the X2 test, Fisher's exact test, and a multivariate analysis. The significance level chosen was 0.05 in all tests.

**RESULTS**

The EKG abnormalities overlapped in some patients: 90 had non-specific EKG changes, 36 had parasympathetic changes, 30 sympathetic changes, 13 had atrial fibrillation. The maximum lesion overlap among the 95 patients with post-stroke EKG abnormalities was found in the left subcortical frontal lobe (X,Y,Z:-32,-22,28; coordinates of the stereotactic space). A significant correlation between left insular involvement and EKG abnormalities with parasympathetic system activation was found (p=0.04- Fisher's exact test).

**CONCLUSION**

Patients with acute stroke can develop EKG abnormalities. We observed that left insular involvement significantly correlates with the activation of the parasympathetic component of the autonomic system. These results must be considered with caution, because in an elderly patient with stroke, many other factors can concur in causing EKG abnormalities. Nevertheless, these results emphasize the importance of the EKG continuous recording in patients with acute stroke to readily recognize and treat potentially fatal arrhythmias.

**KEY WORDS:** Stroke, arrhythmias, electrocardiography

**Scientific Poster 70**

**Mismatches Between MR-based Risk Maps and Acute DW Imaging Can Predict Lesion Growth**

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**PURPOSE**

We sought to investigate whether mismatches between predicted lesion volumes using acute MRI-based risk maps and acute DWI lesion volumes can be used to predict lesion growth.

**MATERIALS & METHODS**

Patients admitted from 1994-2007 who were not given thrombolytic or catheter-based therapy or enrolled in clinical trials and who received acute MRI=5 d were retrospectively analyzed (n=120). Combinations of apparent diffusion coefficient (ADC), T2 (T2WI) and DWI (DWI), CBF, CBV, MTT and Tmax (time of peak of deconvolved residue function) were used as covariates in a generalized linear model (GLM) where the output is infarction risk on a voxel-wise basis. Predictions were made using bootstrapping and jack-knifing. Predicted lesion volumes (PLV) were defined as tissue >= 50% likelihood of infarction risk. Lesion growth was defined as the ratio of the difference between measured lesion volumes (MLV) on F/u and acute DWI with the initial DWI, i.e. (MLV-DWI)/DWI. GLM-DWI mismatch was defined similarly as (PLV-DWI)/DWI. MTT-DWI mismatch was defined as (MTT-DWI)/DWI. Data was dichotomized by mismatches > 20% and growth compared (Wilcoxon rank-sum test). PLV and MTT were correlated with MLV (Pearson's product-moment) and compared. Analysis was limited to patients with follow-up lesions >= 5cc (N=86).
**RESULTS**

Median NIHSSS was 7 with an interquartile range (IQR) 4-13. All values are reported as mean±SD unless otherwise noted: onset time-to-MRI (6.1±2.8 h), age (66±16 years old), gender (59 male), acute DWI lesion (38±47 cc), acute MTT lesion (148±119 cc), acute PLV (81±66 cc) and follow-up lesion (62±73 cc) volumes. PLV was found to have statistically greater (P<0.001) correlation coefficient (R=0.80) with respect to MTT than MTT did (R=0.57). One patient had no acute DWI lesion and was excluded. By dichotomizing by GLM-DWI mismatch > 20%, Growth was found significantly higher (P< 0.001) in patients with mismatch (N=64) than those without (N=21). When dichotomizing by MTT-DWI mismatch > 20%, no significant differences in Growth between patients with mismatch (N=77) compared to those without (N=8) were found.

**CONCLUSION**

Predictive algorithms combining multiple MRI parametric maps can accurately predict tissue outcome. This in turn leads to more accurate identification of patients with DWI lesions likely to expand without treatment. Our results suggest that MRI-based risk maps may be useful for identifying patients most likely to benefit from therapeutic intervention.

**KEY WORDS:** Acute Stroke, MRI, Prediction

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**Scientific Poster 71**

**Infarct Growth in Acute Proximal Middle Cerebral Artery Occlusion Depends on Pattern of Acute Infarct Core**

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**PURPOSE**

Tissue outcome in acute stroke due to M1-occlusion is highly variable. The purpose of this study was to quantify and evaluate anatomical distribution of early infarct core and infarct growth in acute stroke exclusively due to M1-middle cerebral artery (MCA) thrombus.

**MATERIAL & METHODS**

Patients with new onset acute stroke symptoms were screened consecutively between April 2003 and April 2008 for presence of unilateral M1-MCA occlusion on CTA. In 63 identified strokes, object maps of early ischemic infarct core were defined with semi-automated intensity thresholding in acute diffusion images (DWI) (<9h, mean 5h from symptom onset to imaging), and final infarct lesions were outlined visually in follow up MR or CT imaging (>48h, mean 7d onset to imaging). WebParc was used for automated cortex segmentation of brain using DWI images, a software program which incorporates a system of brain parcellation defined by functional anatomy. In WebParc, brain imaging studies are normalized and registered to template overlays integrated into standardized computerized brain atlases. Object maps of ischemic lesions of acute and final infarcts were processed with WebParc to calculate %-infarction of cortical brain regions. A subgroup of 40 cases with acute infarct volumes between 2 and 90ml was dichotomized by median growth into low (<35ml) and high (>35ml) growth infarcts and tested for differences in pattern of acute infarct core.

**RESULTS**

Cortical brain structures with the highest infarct growth (%, 95%-CI) were the planum polare (25.2, 17.0-33.5), insula (24.8, 18.8-30.8), Heschl’s gyrus (24.5, 16.6-32.5), central operculum (24.3, 16.7-31.9), and superior temporal gyrus (21.2, 13.0-29.4). Figure 1 shows areas of high infarct growth (%-increase of infarcted volume of cortical brain structures). Acute infarct core in the high (>35ml) growth group involved significantly more insular cortex than low (<35ml) growth strokes (Table 1). Mean total volume of acute infarct core was not significantly different between the two groups (22.8ml vs 15.8ml, respectively, paired t-test p=0.14).

**CONCLUSION**

In acute strokes due to M1-MCA occlusion, infarct grows most rapidly in areas that involve opercular, insular, and temporal cortex. Acute infarct core involving the insula correlates with higher overall infarct growth on follow up.

**KEY WORDS:** Middle cerebral artery, stroke patterns, infarct growth
**Scientific Poster 72**

**NAA and Glutamate as Neuronal Biomarkers in Systemic Lupus Erythematosus and Neuropsychiatric Systemic Lupus Erythematosus Patients. A Single Voxel 1H MR Spectroscopy study**

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**PURPOSE**
The purpose of this study was to explore for alterations in metabolic concentrations within specific brain regions between SLE and NPSLE patients with and without active disease. Correlations were also made between metabolite concentrations and pain sensitivity.

**MATERIALS & METHODS**
Subjects: The material consisted of 18 SLE patients with no neurological symptoms (1 men and 17 women aged 27-60, mean 38), and 9 NPSLE (9 women, aged 23-54, mean 39), and 11 age and sex matched healthy controls (HC). The study was approved by the local ethical committee and all subjects have given written consent to the study. All subjects had conventional MRI of the brain pre and post contrast administration and three SVS MR Spectroscopy examinations performed after contrast administration (PRESS, TR 2000ms, TE 30 ms, 2x2x2 cm voxel size). SVS volumes were placed in left frontal white matter (FWM), right insular (RI) and in the occipital gray matter (OGM).

**RESULTS**
Conventional MRI demonstrated no abnormalities in any of the patients or controls in the regions evaluate with SVS. The concentrations of N-Acetylaspartate (NAA), glutamate (Glu) and the glutamine-glutamate complex (Glx) were significantly lower in the SLE patients (p=0.008, 0.036, and 0.047, respectively) within the RI compared to HC. NAA was significantly lower (p=0.003) in the NPSLE patients. There was a positive correlation between the NAA and the Glu in the SLE patients in the right insula (coefficient 0.602, p=0.008). For the SLE group, the Glu concentration was also significantly lower in the left FWM (p=0.046) and there was a trend to lower Glx (p=0.056). A trend to lower Glu and Glx were also seen in the NPSLE patients (p=0.071, p=0.051, respectively). The patients with active disease, based on laboratory findings, SLE (n=9) + NPSLE (n=1) patients, have significantly lower Glu in the FWM than those with non-active SLE (mean (sd): active 2.31(1.85); inactive 5.51(0.68); p=0.007). There were no correlation between pain sensitivity and the metabolite concentrations and no other metabolites demonstrated any significant alterations.

**CONCLUSION**
Our findings suggest and support the idea that there is a reduction or destruction of neurons in patients with SLE regardless of neuropsychiatric symptoms as seen by the significant decrease in the NAA, which is considered a neuronal marker, in the insula and frontal white matter. The significant decrease in glutamate, a known excitatory neurotransmitter and also in the glutamine-glutamate complex (Glx) as well as the positive correlation between NAA and Glu demonstrated in the insular in the SLE patients suggests that the glu-gln cycle between astrocytes and neurons might be effected by the reduction of neurons in the SLE population.

**KEY WORDS:** SLE, MRS, glutamate

**Scientific Poster 73**

**Paraclinoid Aneurysms: Relationship Between Projecting Direction and Aneurysm's Position Whether It's Located at Intradural or Extradural Site**

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**PURPOSE**
Discriminating between intradural or extradural cavernous aneurysms is critical when considering treatment options. It is reported that fusion images with MRA and 3D-cisternography yielded clear visualization of the distal dural rings and to be useful to distinguish intradural paraclinoid aneurysms from extradural intracavernous aneurysms (1). The purpose of this study was to examine the relationship between projecting direction with MRA and intradural or extradural location using fusion images.

**MATERIALS & METHODS**
Forty-nine consecutive patients with 53 ICA aneurysms were examined using MR fusion images with 3D-cisternography and MRA on a 1.5T unit. Using the 3D-workstation, two neuroradiologists evaluated the location of the aneurysms on fusion images and classified them as intradural (ID), transdural (TD), and extradural aneurysms (ED) in consensus. We analyzed the projecting direction of aneurysm to internal carotid artery and divided into four directions; medial, lateral, upper and lower projection using MRA. We also measured the angle between aneurysm's dome and the perpendicular line of ICA on oblique coronal planes.

**RESULTS**
The location of aneurysms and projecting directions were as follows: medial projection 28 (ID=13, ED=14, TD=1), lateral projection 3 (ED=2, TD=1), upper projection 10 (ID=10), lower projection 12 (ED=8, TD=4). The projection angle and aneurysm’s location were shown in figure 1. For aneurysms with medial projection, the average angle of ID and ED aneurysms showed no significant differences, 57.1±11.1, 51.0±5.2 (mean±SD), respectively.
CONCLUSION
The aneurysms with medial projection were difficult to distinguish between intradural and extradural aneurysms. The upper projection indicates the intradural location, lateral projection indicates the extradural location, and lower projection indicates the extradural or transdural location. There were close relationship between projecting direction and aneurismal location.

REFERENCES

KEY WORDS: Paraclinoid aneurysm, diatal dural ring, MRA

Scientific Poster 74
Predictive Multiple Linear Regression Model of Basilar Artery Flow Rate Using Quantitative Magnetic Resonance Angiography in 280 Healthy Subjects

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PURPOSE
Blood flow rate in the basilar artery (BA) can be measured non-invasively with quantitative magnetic resonance angiography (QMRA). However, multiple factors including cerebrovascular anatomy and patient variables can affect normative BA flow ranges. A predictive model of BA flow rate, which incorporates relevant variables, would allow estimation of expected patient-specific BA flow.

MATERIALS & METHODS
QMRA was performed in 280 healthy subjects 18 to 84 years old (144 men, mean age 47±16; 136 women, mean age 47±15.). Predictive factors including continuous variables age, body-surface area (BSA), mean blood pressure (MBP), and categorical variables sex, race, left or right posterior communicating artery (PCOM) and fetal posterior cerebral artery (FPCA) were assessed in a multiple regression model to predict BA flow rate using a stepwise method. Interaction terms such as age x sex, age x BSA, and age x MBP were also included in the multiple linear regression model. All data analyses were performed with SAS (version 9.1, SAS Institute).

RESULTS
In the final model: BA flow = 196.6 - 0.8 Age (years) -52.8 left FPCA -10 left PCOM - 62.9 right FPCA -20.4 right PCOM. For subjects without PCOMs and FPCAs, the BA flow = 196.6 - 0.8 Age. The final model was statistically significant, F=43.76, p<0.0001. R-square = 0.43, adjusted R-square=0.44. All independent variables in the final model were statistically significant with P<0.05, see table1 with 95% confidence limits on each variable's coefficient.

Table1. The effects of age and brain artery anatomy on basilar artery flow

| Variable | Parameter Estimate | Standard Error | t Value | Pr > |t| | 95% Confidence Limits |
|----------|--------------------|----------------|---------|-------|---------------------|---------------------|
| Intercept | 196.58             | 6.48           | 30.36   | <.0001| 183.84              | 209.33              |
| Age       | -0.82              | 0.12           | -6.88   | <.0001| -1.05               | -0.58               |
| LFPCA     | -52.84             | 7.60           | -6.95   | <.0001| -67.81              | -37.87              |
| LPCOM     | -10.02             | 4.09           | -2.45   | 0.0149| -18.06              | -1.97               |
| RFPCA     | -62.86             | 7.75           | -8.11   | <.0001| -78.12              | -47.60              |
| RPCOM     | -20.38             | 4.05           | -5.03   | <.0001| -28.37              | -12.40              |

CONCLUSION
Basilar artery flow rate is mainly influenced by the existence of FPCAs and PCOMs bilaterally and by age. Using predictive modeling incorporating patient specific anatomic and age variables, individualized assessment of expected normal BA flow can be performed. Such estimations would help clinicians to interpret measured BA flows as normal, or reduced, especially in patients with vertebrobasilar disease.

KEY WORDS: Basilar artery flow rate, quantitative magnetic resonance angiography

Scientific Poster 75
Influence of Oscillatory Motion of the Basilar Artery on the Hemodynamics of Aneurysms at the Basilar Tip

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PURPOSE
To study the effects of proximal arterial motion on the intraneurysmal hemodynamic characteristics of basilar terminus aneurysms.

MATERIALS & METHODS
Two patients with aneurysms at the tip of the basilar artery who underwent conventional cerebral angiography were selected from our database of approximately 30 intracranial aneurysms imaged by dynamic DSA. These aneurysms were imaged with biplane dynamic digital subtraction angiography (DSA) acquired at 7.5Hz/2.0Hz during a six-second contrast injection, as well as with 3D rotational angiography (3DRA). These aneurysms were selected for analysis because they exhibited a substantial oscillatory motion of the basilar artery. Cine loops were created with the DSA images to visualize and characterize the motion of the basilar artery. The amplitude and center of rotation were determined by overlapping the DSA frames. Patient-specific computational
fluid dynamics (CFD) models of the two aneurysms were created from the 3DRA images. Pulsatile flow conditions were derived from phase-contrast magnetic resonance measurements in normal subjects and imposed as boundary conditions. Two flow calculations were performed for each patient. One had stationary vessel walls, and in the other, the vessel motion estimated from the DSA images was directly prescribed to the model. Visualizations of the flow patterns and wall shear stress (WSS) distributions obtained with the static and moving models of each aneurysm were created and compared. The WSS values obtained at each corresponding point within the static and moving models of each aneurysm were compared and a linear regression performed.

Results
The motion of the basilar artery and the aneurysm observed in the DSA images of both patients could be well represented by an oscillatory rigid rotation around a center of rotation located at the basilar tip in the sagittal plane (No motion was observed in the perpendicular (anterior-posterior) view.), near the anterior wall of the aneurysm and midway between the neck and the fundus of the aneurysm. Although the motion of the basilar arteries were among the largest observed in a series of intracranial aneurysms imaged with dynamic DSA, little differences between the flow patterns and WSS distributions were observed between the static and moving models. Qualitatively, the intra-aneurysmal flow patterns of the static and moving models were in very good agreement. The relative difference in the local values of the WSS magnitude between the static and moving models was below 5%. Linear regressions of the WSS values obtained with the static and moving models of each aneurysm indicate no relative over or under estimation of the WSS magnitude between these models.

Conclusion
The oscillatory motion of the basilar artery has little effect on the hemodynamics of basilar tip aneurysms, even though this motion can be quite large. Thus, CFD models with a static proximal artery position provide a good approximation of the in vivo hemodynamic conditions in these aneurysms. Studies of aneurysm pathophysiology using computational methods assessing relationships involving WSS and intraneurysm flow characteristics can achieve acceptable representations without incorporating parent artery oscillatory motion.

Key Words: Cerebral aneurysm, hemodynamics, vessel motion

Scientific Poster 76
4D-CTA Dynamic Wall Imaging of Intracranial Aneurysms

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Purpose
Cerebral aneurysms affect 2-6% of the population and are associated with an estimated 20-50% risk of subarachnoid hemorrhage (SAH), a complication associated with 50-75% severe morbidity or mortality (NEJM 2006; 355:928-39). These statistics indicate that many incidentally discovered cerebral aneurysms will not rupture during a patient’s life time. Correctly predicting aneurysm rupture risk and making only appropriate pre-emptive intervention is of major clinical importance. Aneurysm size and location in the cerebral circulation are the factors currently used to predict rupture risk in clinical trials such as ISUIA (NEJM 1998; 339: 1725-33). These criteria do not however include an analysis of aneurysm wall deformation with the cardiac cycle, a physiologic factor which may be linked to rupture risk. Our aim is to study cerebral aneurysms using CT protocols with sufficient spatial and temporal resolution to image aneurysm wall deformation with the cardiac cycle and demonstrate a correlation between maximum wall deformation and aneurysm growth.

Materials & Methods
A 35 year old male presented to the Toronto Western Hospital with symptoms of 6th nerve palsy. CTA indicated a 9.5x15.2 mm right cavernous sinus ICA aneurysm. A 4D dynamic CT scan was performed using the Toshiba Aquilion 320 slice scanner. After acquisition of a mask volume for digital subtraction, our protocol acquired a dynamic 4D dataset at 0.5x0.5mm in-plane spatial resolution and 0.5mm slice thickness reconstructed at 0.25mm intervals. Twenty-two subtracted volumes were generated at 0.1 second intervals, each volume requiring 0.667s of rotation time. Total radiation dose being 3.6 mSv. Volumetric reconstructions of the cavernous sinus aneurysm and animation were performed using the Vitrea™ workstation after region of interest selection and segmentation.

Results
Visual analysis of the reconstruction indicated maximum aneurysm wall deformation at the posterolateral aspect. Conservative management with close follow up was instituted. The patient returned in 10 days after developing a deficit of the lower two trigeminal nerve territories. Conventional angiography indicated aneurysm growth along the posterolateral aspect demonstrated as the site of maximum deformation on the initial dynamic study. Subsequent coiling was uneventful.

Conclusion
The latest generation of CT scanners are equipped with sufficient spatial and temporal resolution to image dynamic motion of an aneurysm wall without cardiac gating. We present a case where cerebral aneurysm growth is directly linked to the site of maximal wall deformation during the cardiac cycle. This type of analysis may provide a new method of predicting aneurysm growth and subsequent rupture. This would have broad clinical implications. Our presentation demonstrates this 4D CT technique, provides representative cases and discusses a framework for analysis, post-processing and avenues for statistical correlation in future clinical trials.

Key Words: Aneurysm, CT, deformation
Vertebral Artery Dissection with a Normal-ApPEARING Lumen at Multi-slice CT Angiography: The Importance of Identifying Wall Hematoma

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PURPOSE
CT angiography (CTA) is widely used and may be the only vascular imaging modality ordered for emergent evaluation of neurovascular disease. With thin-section multi-slice CTA, the resolution of vessel wall imaging has improved. We describe cases of acute VAD in which the only abnormality on CTA is a characteristic thickening of the wall of the V3 portion of the vertebral artery (VA). The arterial lumen at the dissection site was normal in caliber. This type of dissection is easily overlooked if only lumen-opacifying studies such as contrast MR angiography (MRA) or catheter angiography is performed. We highlight the importance of recognizing this finding in the V3 portion, the “suboccipital rind sign”, a segment commonly affected in VAD. The purpose of our study was to review the CTA imaging characteristics of patients with VAD in the V3 portion compared to normal controls.

MATERIAL & METHODS
Our imaging database was reviewed for cases of acute VAD and the presence of a “suboccipital rind sign”. A control group of 50 patients was randomly collected from a group of patients undergoing CT angiography. The VA luminal diameter, the wall thickness (total diameter-luminal diameter) and the ratio of luminal diameter/total diameter were measured along five adjacent V3 segments and were compared between the two groups.

RESULTS
There was no evidence of luminal tapering or narrowing in the dissected VA’s compared to normals (p=0.1). The average wall thickness of the dissection group was 2.96 mm greater than for the control group (p < .001 CI=2.6-3.3). There was a significant difference in the ratio of luminal diameter/lumen+wall diameter in dissected segments compared to normals (p<0.001).

CONCLUSION
Cross-sectional vascular imaging is often performed with multi-slice helical CTA for a variety of concerns, some without neurological symptoms. Our study confirms that in cases of the “suboccipital rind sign” the lumen appears normal in caliber, with wall thickening as the only imaging sign of VAD. In our centre, this clinically occult VAD would influence management with patients usually treated with anti-platelet agents. We caution using only luminal-opacifying techniques such as contrast-enhanced MR angiography or catheter angiography to exclude VAD as they are limited for evaluation of mural hematoma.

KEY WORDS: Vertebral, dissection, CTA

Cervical Collaterals May Reduce Incidence of Posterior Circulation Stroke after Occlusive Vertebral Artery Injuries

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PURPOSE
Vertebral artery (VA) injuries are a known complication of cervical spinal fracture-dislocation and of foramina transversaria fractures. Posterior circulation stroke following blunt VA injury has a reported incidence of 10.0-16.4%. We hypothesize that one of the factors limiting the occurrence of stroke after occlusive vertebral artery injury is the reconstitution of the VA by cervical collateral vessels.

MATERIALS & METHODS
Imaging and clinical course in 43 patients found to have VA injuries related to blunt trauma between 6/21/01 and 12/17/04 were retrospectively reviewed. All patients underwent either CT angiogram (CTA), digital subtraction angiography (DSA), or both at the time of initial evaluation. All patients also underwent non-enhanced head CT (NECT) at the time of initial evaluation. Initial NECT and subsequent NECT if performed within 3 months of trauma were evaluated. All NECT and CTA examinations were reviewed prior to review of DSA examinations by two experienced neuroradiologists, and DSA was considered the gold standard for injury grading over CTA in patients who had both performed. Level of injury and injury grade by the Biffl criteria were recorded. If the VA was occluded, presence or absence of VA reconstitution by cervical collaterals was evaluated. NECT head examinations were reviewed for presence and location of contusion, shear injury, and stroke.

RESULTS
Thirty-six patients underwent CTA, 20 underwent DSA, and 13 underwent both CTA and DSA. These 43 patients sustained 51 VA injuries by either CTA, DSA, or both. 18 patients (42%) sustained right VA injury, 33 (77%) sustained left VA artery injury, and 8 (19%) sustained bilateral injuries. 30 occlusive (grade 4 and 5) VA injuries were observed: 7 (16% of total) right VA occlusion, 22 (51%) left VA occlusion, and 1 (2%) left VA transection. Posterior circulation infarcts were seen in 5 (12%) patients by NECT. Of these, there was one grade 1 injury, one bilateral injury (grade 2 and grade 3), and three occlusive (grade 4) injuries. None of the 19 VA occlusive injuries that had VA reconstitution by DSA and/or CTA demonstrated posterior circulation infarcts by NECT. Of the 11 occlusive Grade 4 or 5 injuries without adequate reconstitution, 3 had associated posterior circulation strokes. Chi-squared analysis of occlusive vertebral artery injuries demonstrated a significant association between reconstitution of the vertebral artery by collateral vessels and absence of stroke (p<0.05).

CONCLUSION
The incidence of posterior circulation infarcts due to blunt VA injury in our series of patients with cervical spinal trauma is comparable to previous reports. The risk of stroke in patients with occlusive vertebral artery injury appears to be
lower in the setting of adequate reconstitution of the vertebral artery as demonstrated by DSA and/or CTA. A higher incidence of left than right VA injuries and occlusions was also observed.

**KEY WORDS:** Vertebral artery injury, stroke

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**Scientific Poster 79**

**Normative Geometry of the Intracranial Ventricular System with Reference to the Centre Axis**

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**PURPOSE**

Traumatic brain injury (TBI), including concussion, may be produced by rotational and translational accelerations, with or without impact to the skull. The shear stress intensity resulting from these forces will vary based on the nature of the opposing materials (grey vs white matter, CSF, vessel, etc.), as well as the distance and alignment of these interfaces from the center axis of the resulting rotation. The brain is irregular with material properties that are often inhomogeneous, anisotropic, and generally visco-elastic in nature. This complexity has hindered study of the correlation of neuropathology and biomechanics of TBI. This study was conducted to help establish normative data of the geometry of the intracranial ventricular system, which may aid in the development of more realistic models for biomechanical analyses of TBI and help to explain differences in patient susceptibility to traumatic events.

**MATERIALS & METHODS**

100 head MRIs of patients between the ages of 20 - 30, who were examined for reasons other than trauma, were retrospectively reviewed. Patients were contacted to ensure no history of prior head trauma, including concussion, and were excluded if such history was found. The roof of the third ventricle was identified on coronal images and used as the centre axis point. Lines drawn from this point to the lateral margin of each frontal horn established a ventricle-centre axis angle (VCA) and were documented (Fig. 1). Distance from the lateral margin of the frontal horn to the center axis was also documented and correlated with the VCA.

**RESULTS**

From the original 100 patients selected, 64 had no history of head trauma and could be included in this study. Among the 64 MRIs reviewed, the mean VCA was 69.73 degrees (range: 51 - 91 degrees), the mean bipyramidal distance (BPD) was 120.09 mm (range: 105 - 129 mm), and the mean VCA/BPD was 0.584. Average distance from the center axis to the lateral margin of ventricle was 28.03 mm (range 17 - 43 mm). Rotation and translation forces applied to the cranium will result in shear stresses at locations where there are opposing structures with differing material properties. The configuration of the ventricular system provides a center axis in which surrounding structures can twist and result in shear stress injury to the opposing matter. A change in the VCA will affect shear stress at the opposing matter interface. The normal variation in VCA in our population was 51-91 degrees. Individuals who have a VCA outside this range may be predisposed to, or potentially be protected, from shear stress injury compared to those individuals with “normal” VCA angles. Present routine MRI techniques may help identify those individuals with a predisposition to injury and help guide further management and career decisions.

**CONCLUSION**

The average VCA from our study was 69.73 degrees (range: 51 - 91 degrees). We hypothesize that a VCA outside this range may result in predisposition to, or protection from shear stress related brain injury, including concussion.

**KEY WORDS:** Concussion, trauma, ventricle

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**Scientific Poster 80**

**Resident Face-Off: How Do Radiology, Neurology, and Neurosurgery Residents Compare in Performance When Reading Head CT and MR Imaging Cases?**

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**PURPOSE**

In the modern hospital setting, neurology and neurosurgery residents have access to radiologic studies using PACS, many times making decisions in patient management without prior radiologic consultation. In this study, we will compare the reading performance of radiology, neurology, and neurosurgery residents at upper levels of training in traumatic and non-traumatic head CT and brain MRI cases.

**MATERIALS & METHODS**

Radiology, neurology, and neurosurgery residents were recruited for the study for a total of twelve residents. Two groups within each medical specialty, one senior and one junior group, with two members each, were created for a total of six physician groups. Each reader blindly evaluated a total of one hundred cases chosen among head CTs and brain MRIs obtained from our Level I trauma center. Half of the cases were trauma related and the other half non-trauma related. Two fellowship-trained neuroradiologists reevaluated the cases and their consensus opinion is considered to be the gold standard. Principal and secondary diagnostic findings are being statistically compared between and within the six groups. Statistical comparison of proportions of assertiveness is being performed between and within groups using Chi-square analysis. The intra and intergroup correlation coefficients are also being calculated. Furthermore, reading performance will also be compared between CT and MRI cases as well as traumatic versus non-traumatic cases. A p value of less than 0.05 will be accepted as statistically significant.

**RESULTS**

Intra and intergroup statistical analysis will illustrate differences between junior and senior radiology, neurology, and neurosurgery residents in their ability to attain the accurate primary and secondary imaging findings, established by our fellowship-trained neuroradiologists. The difference
between CT and MRI reading performances will also be analyzed between the groups. Finally, differences within and between groups will be obtained comparing traumatic versus non-traumatic reads.

CONCLUSION
We hypothesize that senior radiologists will demonstrate a superior diagnostic performance when compared to the other groups, regarding primary and secondary findings in both CT and MRI trauma and non trauma related cases.

KEY WORDS: Residents, neurology, neurosurgery

Scientific Poster 81
The Venous Hinge - An Objective Sign for the Diagnosis and Follow-up of Treatment in Patients with Intracranial Hypotension Syndrome

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PURPOSE
In spite of various imaging signs, approximately 20% of the cases of Intracranial Hypotension Syndrome (HIS) have no abnormalities on MRI and not all case of IHS will demonstrate the classic imaging features. In patients with IHS, we observed reduction of the angle between vein of the Galen (VOG) and internal cerebral vein (ICV), which returns to the baseline after treatment. We coin the term, “venous hinge” to describe this dynamic process and discuss its importance in IHS.

MATERIALS & METHODS
A mid sagittal T1W image showing both VOG and ICV in the same plane were retrospectively analyzed in 17 patients (3 male and 14 female) with IHS and 50 normal controls (20 male and 30 female). The angle between the lines drawn along the main axis of VOG and ICV (venous hinge angle) was measured and documented.
An independent t test was performed to calculate any significant difference (p<0.05) in the venous hinge angle between the male and female controls. A paired t test was also performed between the controls and the patients with IHS. Weighted kappa coefficients were calculated to assess the agreement between the different pairs of observers. Inter-class correlation coefficient was calculated to assess the agreement between all the three observers. A paired t test was also calculated to compare the venous hinge angle before and after treatment. Sensitivity and specificity for thresholds of the venous hinge angle were calculated.

RESULTS
The mean venous hinge angle formed by the veins in the IHS and control groups were 65° (35°-98°) and 91° (76°-124°) respectively (p<0.0001).

With a venous hinge angle of 79 degrees, the sensitivity and specificity for diagnosis of IHS was 88.24% and 92% respectively. Using a cut-off venous hinge angle of 84 degrees, the sensitivity and specificity was 94% and 78% respectively.

The weighted kappa coefficients between the three pairs of observers were 0.82, 0.52 and 0.51 suggestive of excellent to good agreement. The inter-class correlation coefficient for all the three observers was 0.0024 suggestive of excellent agreement between observers.

The 10 patients (58.8%), who were imaged following treatment for IHS demonstrated an increase in the mean venous hinge angle from 57.68 to 74.40 degrees (p=0.003).

CONCLUSION
We report a previously undescribed relatively acute angle at the confluence of the ICVs and VOG, “the venous hinge angle” in cases of IHS. Recognition of this sign may aid in the diagnosis of IHS. The venous hinge angle is dynamic and may return to a more obtuse appearance with successful treatment.

KEY WORDS: Intracranial hypotension syndrome, Venous hinge angle

Scientific Poster 82
A Comparison of 3T and 7T T1-Weighted-MPRAGE, T2-Weighted and SWI MR Imaging of Malignant Brain Tumors Using Gadolinium Based Contrast Agent and Iron Oxide Nanoparticles: Preliminary Report

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Oregon Health & Science University
Portland, OR

PURPOSE
To compare 3T and 7T MR imaging detection sensitivity for low molecular weight gadolinium (III) chelate (Gadoteridol) and high molecular weight iron oxide nanoparticles (ferumoxytol) in patients with malignant brain tumors.

MATERIALS & METHODS
Twelve patients with primary malignant brain tumors were studied in an IRB-approved research imaging protocol. All patients had a biopsy proven diagnosis and had received radiochemotherapy. MR imaging data were collected using 3T and 7T Siemens instruments with 12- and 8-channel phase-array head RF coils, respectively. The majority of patients were scanned pre-contrast, post-Gadoteridol and 24 hr post-ferumoxytol administration on both instruments, using T1-weighted-MPRAGE, T2-weighted and SWI sequences.

RESULTS
Images were assessed for total volume of signal enhancement (T1W) or loss (T2W, SWI) and contrast to noise ratio (CNR) for both contrast agents at both MRI instruments, and results are summarized in the table.
CONCLUSION

This preliminary report demonstrates that post-Gadoteridol T1-weighted-MPRAGE enhancement volume or CNR typically was equal or greater at 7T compared to 3T, but no signal differences were observed on T2-weighted and SWI MR imaging. In contrast to Gadoteridol, ferumoxytol produced consistently greater T1W-MPRAGE enhancement volume and CNR at 3T compared to 7T 24 hr post-administration. SWI signal loss was more prominent at 7T compared to 3T 24 hr after ferumoxytol injection.

KEY WORDS: Brain tumors, iron oxide nanoparticles, magnetic resonance imaging

Scientific Poster 83

Optimizing Dual Energy Bone Removal CT Angiography: An in Vitro and Vivo Study

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PURPOSE

Dual energy computed tomography (DE CT) is a new technique that has the potential to provide CT angiography (CTA) images without confounding overlying bone at the skull base. The purpose of this study was to validate alterations in DE CTA technique in order to provide significant improvement in the accuracy of bone removal.

MATERIALS & METHODS

All scans were acquired on a DE CT scanner (Definition: Siemens, Erlangen, Germany) over the course of 18 months. A different group of ten patients with clinical scans were examined at the outset and after implementing two changes in technique. The first group underwent DE CTA without any modifications to the manufacturer's recommended protocol. The second group underwent DE CTA after optimization of technique based on work with a phantom. This included reducing slice thickness and increasing mA. The third group underwent DE CTA after installation of a new software package that allowed increasing effective mAs from 75 to 175mA at 140 kV and from 300 to 565mA at 80 kV. The updated bone removal software was also utilized. For each of these groups, two experienced neuroradiologists rated the quality of bone removal at different segments of the ICA by comparing the source CTA images with the bone-removed images (rated on a scale of 1-10, with a score of 10 for optimal visualization of the vessel without any bone removal artifact).

<table>
<thead>
<tr>
<th>Imaging Results</th>
<th>3T greater</th>
<th>7T greater</th>
<th>3T and 7T equivalent</th>
<th>No enhancement</th>
</tr>
</thead>
<tbody>
<tr>
<td>MPRAGE Gd</td>
<td>n=1</td>
<td>n=6</td>
<td>n=2</td>
<td>n=1</td>
</tr>
<tr>
<td>MPRAGE Fe</td>
<td>n=10</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T2W Gd</td>
<td></td>
<td>n=11</td>
<td></td>
<td></td>
</tr>
<tr>
<td>T2W Fe</td>
<td>n=1</td>
<td>n=2</td>
<td>n=2</td>
<td>n=5</td>
</tr>
<tr>
<td>SWI Gd</td>
<td></td>
<td></td>
<td></td>
<td>n=9</td>
</tr>
<tr>
<td>SWI Fe</td>
<td>n=7</td>
<td></td>
<td></td>
<td>n=3</td>
</tr>
</tbody>
</table>

RESULTS

After each modification to the DE CTA technique the raters found significant improvements in image quality in all segments of the carotid artery (see Table, Image). While software changes and slice thickness were altered, the most significant change was the change in CTDI from 30mGy initially, then 40mGy, and in the last group we reviewed, 48 mGy.

Median ratings for each segment of internal carotid artery

(Confidence intervals represent +/- 1 SD)

<table>
<thead>
<tr>
<th></th>
<th>Unmodified DE CTA</th>
<th>1st Modification DE CTA</th>
<th>2nd Modification DE CTA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extraosseous</td>
<td>3.5 +/- 1.7</td>
<td>5.0 +/- 0.2</td>
<td>9.7 +/- 0.9</td>
</tr>
<tr>
<td>Intracranial</td>
<td>3.2 +/- 1.4</td>
<td>4.6 +/- 0.4</td>
<td>8.5 +/- 2.1</td>
</tr>
<tr>
<td>Cavernous</td>
<td>3.5 +/- 1.0</td>
<td>5.0 +/- 0.5</td>
<td>9.2 +/- 1.5</td>
</tr>
<tr>
<td>Clinoidal</td>
<td>3.1 +/- 0.9</td>
<td>4.4 +/- 0.4</td>
<td>9.2 +/- 1.2</td>
</tr>
<tr>
<td>Supraclinoid</td>
<td>3.9 +/- 1.3</td>
<td>5.0 +/- 0.1</td>
<td>9.7 +/- 0.9</td>
</tr>
</tbody>
</table>

CONCLUSION

We found that that dual energy bone removal was very sensitive to scan dose and validated that significant gains in quality were achieved when maximum mA allowed by the 80kV tube were utilized. These values remain well within ACR guidelines and less than used on many single source scanners for CTA.

KEY WORDS: CT angiography, dual energy

Scientific Poster 84

An Integrated Approach to Post Processing of Ischemic Stroke Images

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Following a stroke, the availability of diagnostic images depicting the affected vascular territory and extent of a stroke are of paramount importance. Dynamic susceptibility contrast cerebral perfusion MR imaging has been shown to be highly sensitive in detecting tissue at risk. Currently, offline post processing is used to generate the maps of relative cerebral blood flow (rCBF), relative cerebral blood volume (rCBV), local bolus timing (i.e. time to start, time to peak), and mean transit time (MTT), subsequent to an MR...
scan, and it takes on typically, over an hour of post processing time. In this work, an inline software tool has been developed eliminating the offline post-processing. We hypothesize that automated reconstruction can significantly reduce the production time of perfusion images. The inline evaluation of perfusion images was fully integrated into the image calculation environment of both clinical 1.5 and 3T scanner (MAGNETOM Espree and Trio, Siemens AG Healthcare Sector, Erlangen, Germany). The post-processing algorithm integrates unsupervised automated selection of the arterial input function and a voxel-by-voxel deconvolution analysis, and maps are generated and stored as standard DICOM images in the data base, using dynamic T2- and T2*-weighted contrast images. To quantify time efficiency, effort was measured between the automatic map calculation and the conventional clinical workflow of a typical stroke patient for imaging. This involves offline downloading of patient’s data, followed by offline processing and generation of the maps, before uploading them to the PACS for viewing. We quantified the time in a retrospective study of a consecutive series of 56 patients, scanned as part of the standard care at our institute.

The delay between image acquisition and PACS deposition served as an estimate of image availability latency (IAL) Fig. 1(A). The reconstruction time for inline map generation is less than 60 sec, after image acquisition. The average ratios of WM to GM over selected ROIs on the rCBF and rCBV, for online/offline reconstruction are 2.53±0.27/3.2±0.24 for rCBF, and 2.50±0.24/2.48±0.19 for rCBV, for a representative scan. The rCBF, rCBV, and MTT maps of a representative T2*-weighted perfusion scan are shown in Fig. 1(B). We found the standard of care post-processing protocol results in an IAL of 118 ± 253 min. Integrated image reconstruction eliminates the IAL inherent in the current paradigm for stroke imaging. This inline perfusion processing protocol significantly reduces the time for treatment for stroke patients, which is shown to improve patient outcomes, by eliminating post-processing delay.

**KEY WORDS:** Perfusion, stenosis, occlusion

Scientific Poster 85

**Ultra-Low SAR MR Imaging of Brain Using Modified 3D FSE T1, T2 and FLAIR Sequences**

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

**PURPOSE**

MRI of patients with implanted medical devices often generate significant heat from RF-intensive sequences. We have explored the limits to which SAR can be lowered using modified 3D FSE sequences, while preserving image quality. Two orders of magnitude SAR reduction was achieved using optimized low refocusing RF pulses with an investigational 3D FSE sequence.(3)

**MATERIALS & METHODS**

Pseudo-steady state approach with low refocusing pulses preserves MR signal while reduces SAR (1-2). Using an investigational version of a 3D-FSE sequence(3), in a 1.5T GE scanner we optimized long echo trains (50-150 for T2 and FLAIR, and 8 for T1) using stretched, variable angle refocusing pulses and parallel imaging. Results from phantom tests and normal subjects (three, age 22-50 under IRB approval) are shown below. Conventional 2D sequences were run for SNR and CNR comparisons.

**RESULTS**

Figure 1 shows a low-SAR thin coronal reformatted slice from 3DT1, and a sagittal 3DT1, sections. SNR and CNR values for grey matter, white matter and CSF from temporal lobe are reported in Table 1.

**Table 1: SNR, CNR, SAR,Total Scan Time Comparison Between Modified 3D FSE and Clinical 2D Sequences**

<table>
<thead>
<tr>
<th>Sequences Used</th>
<th>(Acquisitions in Sagittal Plane)</th>
<th>SNR GM</th>
<th>SNR WM</th>
<th>SNR CSF</th>
<th>CNR (gm,wm)</th>
<th>CNR (gm,csf)</th>
<th>Ave SAR (W/kg)</th>
<th>Total Scan Time (Min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3D FLAIR Sag FRFSE</td>
<td>87 51 15 36 72 0.02 9</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2D Clinical Sag FLAIR</td>
<td>47 32 4 15 43 1.2 5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3D T2 Sag FRFSE</td>
<td>96 61 430 35 334 0.01 9</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2D Clinical Sag T2</td>
<td>36 26 107 10 81 1.8 4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3D FSE Sag T1</td>
<td>62 90 28 32 34 0.04 6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2D Clinical Sag SE T1</td>
<td>120 160 45 40 75 1.5 2</td>
<td></td>
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</tr>
</tbody>
</table>

**Fig. 1:** (A) The distribution of IA values for 3 h under 3 h. All IA values greater than three hours failed to achieve the window of opportunity for T1 Permeability. (B) Parameters Maps. Perfusion map for rCBF, rCBV and MTT are generated.

**Fig. 2:** Line plot comparing low and high SAR imaging cases.
CONCLUSION
Using modulated refocusing RF pulses, high quality 3D FSE imaging costing almost 2 orders of magnitude lower SAR is achieved for T1, T2, and FLAIR brain MRI. This seems attractive at high fields that often generate high SAR and may provide safe MRI options when SAR is the only concern for patients with active implants or pacemakers.

REFERENCES

KEY WORDS: FSE, SAR, implants

Scientific Poster 86
Administration of Gadolinium Prior to DSC MR Imaging Alters T2* Signal Intensity-Time Curve Characteristics in Patients with Newly Diagnosed Glioblastoma Multiforme

Barajas, R. F. · Cha, S.
University of California San Francisco
San Francisco, CA

PURPOSE
Dynamic susceptibility weighted contrasted enhanced (DSC) magnetic resonance (MR) imaging utilizes susceptibility effects induced by gadolinium contrast to quantify three cerebral hemodynamic measurements; relative cerebral blood volume (rCBV), peak height (rPH), and percentage of signal intensity recovery (rPSR). These hemodynamic measurements can be used to accurately differentiate single brain metastasis from Glioblastoma Multiforme (GBM) and distinguish recurrent cerebral metastasis from Gamma Knife induced radiation necrosis. The administration of a gadolinium loading dose prior to DSC MR imaging attempts to more accurately estimate rCBV by reducing T1 shortening, however, its effects on rPH and rPSR have yet to be adjudicated. The purpose of this study was to determine if pre-dosing with gadolinium alters hemodynamic measurements obtained from patients with GBM using DSC MR imaging.

MATERIALS & METHODS
As part of their presurgical imaging protocol, 24 patients with newly diagnosed treatment naive GBM underwent DSC MR imaging. Ten minutes prior to DSC sequence acquisition 12 patients were pre-dosed with gadolinium contrast agent using a standard dose of 0.1 mmol/kg. In a blinded retrospective study using GE Functool post-contrast 3D SPGR and DSC images were co-registered. Regions of interest were drawn around the entire contrast-enhancing region and contralateral normal appearing white matter. The resulting T2* signal intensity-time curves were interrogated to produce rPH and rPSR. rCBV was calculated by integration of the negative enhancement portion of the T2* signal intensity-time curve. Univariate analysis utilizing Welch T or Chi Squared tests were used to compare mean, maximum, and minimum DSC imaging values and patient characteristics between the two groups. P value < 0.05 was considered statistically significant.

RESULTS
All 24 MR examinations were found to be of sufficient quality, without significant susceptibility artifact, to be included in this study. Patients from the pre-dosed group were found to be appropriately matched in age (mean, 57.0 yrs vs. 56.1 yrs), lesion location, gender (6/6 vs. 7/5; Male/Female), and volume of enhancement (mean, 18.5 ml vs. 24.6 ml) to the non-pre-dosed group (P> 0.05). The mean (68% vs. 79%; P< 0.01), minimum (63% vs. 72%; P< 0.01), and maximum (75% vs. 87%; P< 0.01) rPSR imaging value was found to be significantly lower within the pre-dosed group when compared to the non-pre-dosed group. No significant difference in mean (2.33 vs. 2.10; P= 0.44), minimum (1.69 vs. 1.35; P= 0.31), or maximum (2.91 vs. 3.05; P= 0.71) rPH was noted between the two groups. The mean (2.02 vs. 2.28; P= 0.43), minimum (1.53 vs. 1.63; P= 0.73), and maximum (3.28 vs. 5.50; P= 0.02) rCBV tended to be lower within the pre-dosed group compared to the non-pre-dosed group, however, this was only found to be statistically significant between the maximum rCBV imaging values.

CONCLUSION
Although the relatively small sample size of this retrospective study cautions against over interpretation, the results suggest administration of a gadolinium loading dose prior to DSC MR imaging in patients with newly diagnosed treatment naive GBM significantly alters the T2* signal intensity-time curve characteristics which may prove to detrimentally alter its clinical utility.

KEY WORDS: Perfusion, MRI, Glioblastoma

Scientific Poster 86
Administration of Gadolinium Prior to DSC MR Imaging Alters T2* Signal Intensity-Time Curve Characteristics in Patients with Newly Diagnosed Glioblastoma Multiforme

Barajas, R. F. · Cha, S.
University of California San Francisco
San Francisco, CA

PURPOSE
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CONCLUSION
Although the relatively small sample size of this retrospective study cautions against over interpretation, the results suggest administration of a gadolinium loading dose prior to DSC MR imaging in patients with newly diagnosed treatment naive GBM significantly alters the T2* signal intensity-time curve characteristics which may prove to detrimentally alter its clinical utility.

KEY WORDS: Perfusion, MRI, Glioblastoma
Scientific Poster 87

Feasibility of Intraoperative DSC-MR Imaging (iDSC-MRI)

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University Hospital of Schleswig-Holstein
Kiel, GERMANY

PURPOSE
Intraoperative MR imaging has been introduced as an early resection control while further resection within the same anesthesia is still possible. Surgical manipulation can lead to a temporary disruption of the blood-brain-barrier and thus contrast enhancement can simulate residual tumor burden. Dynamic susceptibility contrast (DSC) MR imaging has been used preoperatively to assist distinction of various 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 if DSC-MR imaging is feasible intraoperatively with special regard on this known temporary blood-brain-barrier disruption.

MATERIALS & METHODS
Six 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 Tesla MR unit (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. Phantom studies were performed to assess the image distortion at a water-air level as well as in a flow phantom. For intraoperative DSC(iDSC) MR imaging a dynamic susceptibility contrast-enhanced T2*-weighted EPI PRESTO sequence (TR / TE = 17 / 8 ms; FOV 240 mm; matrix 128x128; 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. In five of the six patients complete removal was already achieved by the time of iDSC-MR imaging. The resection cavity was clearly depicted and no increased perfusion values were obtained in the adjacent brain parenchyma. In one case residual tumor was found that demonstrated identical increased rCBV and rCBF values compared to the contralateral hemisphere as in the preoperatively acquired data.

CONCLUSION
Intraoperative DSC-MR imaging is feasible and enables judgement of the resection cavities despite an estimated distortion caused by an air-water level. Residual tumor can easily be depicted, perfusion ratios are as reliable as preoperatively acquired data and the method is independent from surgical induced blood-brain barrier disruption. iDSC-MR imaging could become an important tool in neurosurgical patient care.

KEY WORDS: iDSC-MR imaging, perfusion, neurosurgery

Scientific Poster 88

Precontrast T1 Hyperintensity Within Primary CNS Lymphoma Masses Associated with Decreased Risk for Recurrence

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PURPOSE
MR imaging is routinely utilized to follow patients during and after treatment for primary CNS lymphoma (PCNSL), and for surveillance of recurrent disease. The purpose of this study is to assess whether non hemorrhage-related pre-contrast T1-shortening (T1 hyperintensity) within CNS lymphoma undergoing treatment can help predict decreased risk for future recurrence of tumor.

MATERIALS & METHODS
One hundred fifteen immunocompetent patients with biopsy proven primary CNS lymphoma (PCNSL) from 2000-2007 were identified with pre- and post-therapy MRI scans performed and with documentation of positive clinical response to treatment. All patients had T2- and T1-weighted images with and without contrast enhancement. Correlation with each patient’s post remission surveillance scans was made to determine whether the patient had recurrence of tumor.

RESULTS
The median patient age was 64 years (range 24 to 84 years) and 57 of the patients were men and 58 women. Of the 68 patients free of PCNSL recurrence during the post-treatment follow-up period (783 days average follow-up among this group, std dev = 697 days), 51 (75%) demonstrated hyperintense T1 signal within the resolving post therapy lesion. Of the 47 patients who later developed recurrence (822 days avg follow-up, std dev = 666 days), 21 (45%) showed hyperintense T1 signal within. The correlation of T1 hyperintensity with lack of disease recurrence was statistically significant as calculated by the two-tailed Fisher’s Exact Test with a p value = 0.0016.

CONCLUSION
Precontrast T1 hyperintensity within PCNSL may help predict tumor that is more amenable to long term remission.

KEY WORDS: CNS lymphoma, T1 hyperintensity, Recurrence
Elevated Insular Glutamine in Patients with Temporomandibular Disorders (TMD) Prior and Post Pain Stimulation Demonstrated by 1H Proton SVS MR Spectroscopy

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INTRODUCTION
Temporomandibular disorders (TMD) affect 7 - 17% of adults and can lead to chronic, debilitating pain and dysfunction. The etiologies and pathophysiology are not well understood.

PURPOSE
The purpose of the present proton magnetic resonance spectroscopy (1H-MRS) study was to test the hypotheses that Glu, Gln and Glx activities in the insula, a sensory-processing region that shows augmented activity in fibromyalgia and related chronic pain syndromes, are altered in TMD subjects, and that the activities of these metabolites are significantly correlated with reported subjective pain among the TMD patients.

MATERIALS & METHODS
Subjects: Eleven patients, who met the inclusion criteria for TMD and 11 age, weight, height, ethnicity and gender matched controls (HC) with no documented TMD, acute or chronic pain were included. All subjects had general screening, psychophysical testing, and neuroimaging. Pain stimulation: An apparatus that is compatible with the scanner environment delivered 120 precise computer-controlled pressure applications to the left anterior temple and left thumb to evoke pain. Direct measures of clinical symptoms were applied on the Box scale and the McGill Pain Questionnaire and related chronic pain syndromes, are altered in TMD subjects, and that the activities of these metabolites are significantly correlated with reported subjective pain among the TMD patients.

RESULTS
The mean concentrations of Gln, and Glu were higher in the TMD patients compared to controls both pre- and post pain testing. The Gln and the combined Glu+Gln complex (Glx) concentrations were significant higher in the TMD subjects in the right posterior insula compared to HC prior to pain testing (p = 0.005, and p = 0.017, respectively). No significant differences between the groups were present post pain testing.

CONCLUSION
This preliminary prospective study on alterations of brain metabolites prior to and post pain stimulation to the face and thumb in patients with TMD suggests that glutamine might play a role in pain-related plastic changes in TMD. Future studies have to be conducted to evaluate the role of Gln in the TMD and if Gln can be used as a biomarker and/or as a useful endpoint for clinical trials in chronic pain management.

KEY WORDS: MR spectroscopy, brain, temporomandibular disorder

Building a Human Brain Template for Diffusion Tensor Imaging

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PURPOSE
Previously published efforts to produce a diffusion tensor imaging (DTI) brain template4,5 have been compromised by factors related to image quality, the effectiveness of the image registration approach, the appropriateness of subject inclusion criteria, the completeness and accuracy of the information summarized in the final template. The purpose of this work was to develop a DTI human brain template in ICBM space using techniques that address the shortcomings of previous efforts.

MATERIALS & METHODS
Sixty-seven healthy human subjects (20-40 years of age) were scanned with Turboprop-DTI on a 3T MRI scanner. The DTI data from one subject were normalized to the commonly used ICBM-152 T1-weighted template and functioned as a temporary template. The mean DW volumes from 11 randomly selected subjects were normalized to the mean DW of the temporary template using different smoothing sizes, and non-linear registration. The resulting transform was estimated in white matter for different smoothing sizes. The average coherence of primary eigenvectors was estimated in white matter for different smoothing sizes. The same procedure was repeated with normalization based on: a) mean DW and FA, b) mean DW, FA and trace. The procedure that provided the highest average coherence was applied on all 67 subjects. The mean and median DTI templates were produced, and then compared to previously published templates and to each other. The accuracy of normalization was assessed based on the ability to match selected brain landmarks.

RESULTS
The selected normalization approach was based on mean DW and FA information, and smoothing with a Gaussian kernel with FWHM=4mm. The mean error in matching brain landmarks was approximately equal to 1.1mm. Comparison of the mean b=0sec/mm² maps to the published ICBM-152 T1-weighted template showed good correspondence of the
size and location of brain structures between the two datasets, in contrast to previously published efforts. The anisotropy color maps derived from the mean DTI template appeared sharper than that from previously published DTI templates. Small white matter structures such as the anterior commissure, and the decussation of the superior cerebellar peduncles were visible only in the template developed in this work. Images derived from the median DTI template were noisier than the corresponding images from the mean template. In white matter, FA of mean tensors was lower on average than FA of median tensors. Near the interface of brain tissue and CSF-filled spaces, the eigenvalues and trace were increased for mean compared to median tensors. These findings were verified with simulations.

**CONCLUSION**
The quality of the DTI template developed in this work was superior to that of other templates developed to date. A high-quality DTI template is particularly crucial for accurate inter-subject spatial normalization of DTI data.

**REFERENCES**

**KEY WORDS:** Template, DTI, brain

**Scientific Poster 91**

**ALE Meta-analysis of Functional Neuroimaging in Mild Cognitive Impairment**

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**PURPOSE**
Mild cognitive impairment (MCI) represents a transitional phase between normal aging and Alzheimer's disease (AD). Functional neuroimaging techniques provide a “window” into the functional alterations that occur in MCI and AD patients.

**MATERIALS & METHODS**
A substantial body of literature has been fostered assessing brain function during complex cognitive processes, such as memory and learning. The aim of this activation likelihood estimation (ALE) meta-analysis is to quantitatively analyze studies estimating brain function of MCI at rest condition and during cognitive tasks using functional neuroimaging (PET, SPECT and fMRI). Relevant studies were identified with MEDLINE from January 1990 to April 2008 according to inclusion criteria. Meta-analysis and meta-regression were then performed on this data. Data on the diagnostic performance of each modality were combined quantitatively across eligible studies. We estimated weighted summary sensitivities and specificities, weighted summary likelihood ratios (LR), and summary receiver operating characteristic (ROC) curves.

**RESULTS**
Twenty-four eligible nonoverlapping studies were included, which enrolled a total of 1112 patients. FDG-PET [LR+=4.610 (95% CI, 3.176–6.693), OR=40.146 (18.532–86.971)] performed statistically better in LR+ and OR than SPECT [LR+=2.589 (1.445–4.639), OR=9.288 (4.477–19.271)] and structural MR imaging [LR+=3.471 (2.619–4.600); OR=10.583 (6.580–17.021)]. No statistical difference was found in pooled sensitivity, specificity and LR between each modality. The Q* index estimates for FDG-PET, SPECT, and structural MR imaging were 0.86, 0.75, and 0.76. In meta-regression, statistical significance was found only between modality and log OR with a regression coefficient of -0.575.

**Scientific Poster 92**

**FDG-PET, SPECT and Structural MR I for Prediction of Rapid Conversion to AD in Patients with Mild Cognitive Impairment: A Meta-analysis**

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**PURPOSE**
Mild cognitive impairment (MCI) patients were at-risk subjects of Alzheimer's disease (AD) and to diagnose AD at a very early stage was to develop highly specific and sensitive tools capable of identifying AD as early as possible among at-risk subjects. The purpose of this study was to evaluate and compare FDG-PET, SPECT and structural MRI for prediction of conversion to AD in MCI patients.

**MATERIALS & METHODS**
Relevant studies were identified with MEDLINE from January 1990 to April 2008 according to inclusion criteria based on QUADAS quality assessment tool and the aim of our meta-analysis. Meta-analysis and meta-regression were then performed on this data. Data on the diagnostic performance of each modality were combined quantitatively across eligible studies. We estimated weighted summary sensitivities and specificities, weighted summary likelihood ratios (LR), and summary receiver operating characteristic (ROC) curves.

**RESULTS**
No statistical difference was found in pooled sensitivity, specificity and LR between each modality. The Q* index estimates for FDG-PET, SPECT, and structural MR imaging were 0.86, 0.75, and 0.76. In meta-regression, statistical significance was found only between modality and log OR with a regression coefficient of -0.575.
CONCLUSION
This meta-analysis showed that FDG-PET had better performance in the prediction of conversion to dementia in the patients with MCI than SPECT and structural MRI.

KEY WORDS: metaanalysis, mild cognitive impairment, Alzheimers disease

Scientific Poster 93
Diffusion Lesion Reversal in a Canine Ischemic Stroke Model
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PURPOSE
Diffusion imaging and apparent diffusion coefficient (ADC) maps have been used to indicate ischemic stroke tissue that is irreversibly infarcted. A reduced ADC can be a marker for irreversibly infarcted tissue, which is particularly important in the perfusion-diffusion mismatch model that is showing promise in clinical trials. However, there is evidence that the acute ADC lesion can reverse, which brings into question the utility of the perfusion-diffusion mismatch model if the circumstances of diffusion lesion reversal cannot be explained. Using a canine ischemic stroke model in a separate study, we observed diffusion reversal of a stroke lesion and examine the ADC time-course of these changes in an effort to better understand and explain diffusion reversal.

MATERIALS & METHODS
Ischemic stroke was induced by injecting autologous clot into the right internal carotid artery. Pre-stroke diffusion imaging was performed to define a normal threshold for ADC and then serial imaging was performed for 3 hours after stroke. Using the b = 0 s mm-2 images, all diffusion maps were registered to the first diffusion acquisition (SPM2, Wellcome Institute for Neurosciences). Time-to-infarct maps were created based on the time the ADC of each voxel fell below the normal threshold. Similarly, the time at which each voxel recovered to prestroke normal ADC range was set as the time to reverse. A single voxel could not infarct multiple times.

RESULTS
The figure shows the time-to-infarct and time-to-recovery maps for one slice of this animal. The ADC map at 3 h shows no appreciable diffusion lesion. At the end of the 3 h observation period, 68.7 mm3 of the brain infarcted, 40.9 mm3 of which reversed. Beyond the time-to-recovery being later than the time-to-infarct, minimal correlation between the two times was observed (R² = 0.096, p < 0.001), i.e., voxels with earlier infarct times did not have a noticeable trend towards earlier reversal times. Within the volume that showed a reduced ADC, the variability of ADC appeared greater over time and space compared to the contralateral tissue.

CONCLUSION
The time-to-infarct and time-to-reverse maps are an interesting technique to evaluate ischemic diffusion changes and reversal. This experiment was originally a part of a different set of experiments, in which large, severe strokes were induced (typical infarct volumes of ~4000 mm3). The time-to-reverse analysis mirrors the time-to-infarct technique and is used to display the time-course of the diffusion reversal.

KEY WORDS: Diffusion imaging, ischemic stroke, diffusion lesion reversal

Scientific Poster 94
CT Perfusion for Predicting Delayed Cerebral Ischemia After Aneurysmal Subarachnoid Hemorrhage
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PURPOSE
CT perfusion imaging (CTP) can help in better management of patients with delayed cerebral ischemia (DCI), a major cause of morbidity and mortality after aneurysmal subarachnoid hemorrhage (SAH). The objective of our study was to evaluate the role of CTP in predicting DCI after SAH.

MATERIALS & METHODS
We prospectively studied the CTP parameters, noncontrast head CT (NCCT head) and CT angiography (CTA) at the time of admission in 30 patients with aneurysmal SAH and followed them for one week postoperatively by neurologic assessment and NCCT head for development of DCI (defined as drop in Glasgow Coma Scale (GCS)/ new hypodensity on NCCT head). We analysed various clinical and CTP parameters between patients with and without DCI. Statistical analysis was done using non parametric tests (p-value <0.05).

RESULTS
Among the 19 patients who developed DCI, the average lowest relative cerebral blood flow (rCBF) and relative cerebral blood volume (rCBV) were 0.77 and 0.85. The average highest time to peak difference (ΔTTP) and mean transit time difference (ΔMTT) were 1.20 and 1.35. The corresponding values in 11 patients without DCI were 0.90, 0.91, 1.07 and 1.14 respectively. With threshold values of 0.75, 0.80, 1.0 and 1.1 for rCBF, rCBV, ΔMTT and ΔTTP for distinguishing patients with and without DCI, the sensitivities of
TTP and MTT were 95% and 70%, and the specificities were 30% and 43% respectively. CBF and CBV had a sensitivity of 43% and 40%, and specificity of 85% and 71% respectively. The relative risk for DCI was 1.875 for an elevated ΔMTT (>1.15).

**CONCLUSION**

CTP can be combined with NCCT head and CTA for predicting DCI after SAH. TTP is a sensitive predictor of vasospasm and combination of TTP and CBF has better sensitivity and specificity than individual CTP parameters.

**KEY WORDS:** Delayed cerebral ischemia, CT perfusion, subarachnoid hemorrhage

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### Scientific Poster 95

**Evaluation of Cerebrovascular Reserve Capacity by Whole Brain Perfusion Imaging Using a 320 Detector Row CT-Scanner Before and After Acetazolamide Test**

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**PURPOSE**

Recently introduced 320-detector row CT featuring a detector width of 16cm permits whole brain coverage by a single gantry rotation and thus allows for simultaneous assessment of four-dimensional, time-resolved CT-angiography and whole brain perfusion imaging. The study used the acetazolamide test to evaluate the feasibility of whole brain CT perfusion (CTP) imaging to assess cerebrovascular reserve capacity in chronic cerebrovascular disease.

**MATERIALS & METHODS**

We performed whole brain CTP imaging (320-detector row CT Aquilion One, Toshiba, Japan) at rest and after administration of acetazolamide (Diamox®, Aventis Pharma Spécialités, Maisons Alfort, France) in eight patients (five female, three male) to evaluate cerebrovascular reserve capacity. Four patients had severe stenosis of at least one intracranial artery and/or extracranial carotid stenosis, four patients had moyamoya disease. A test bolus scan (2 mm slice thickness, 80 kV, 100 mAs, 20 ml contrast medium [CM, Xenetix 350, Guerbet, Sulzbach, Germany], 5 ml/sec. flow) was acquired first to determine the exact arrival time of the bolus. CTP at rest was then performed using a low dose protocol (80kV, 100mAs). The acquisition started with three intermittent unenhanced single rotation scans for bone subtraction followed by high-flow administration of CM (40 ml, flow rate of 5 ml/sec) and a simultaneous scan of 15 sec duration, which was started based on the precomputed arrival time of the CM bolus. During this scan, we covered the period of arterial and capillary circulation. Last, five intermittent scans at every fifth second covered the period of venous outflow. For the stress CTP 1000 mg acetazolamide were administered intravenously over 5 minutes and after a delay of another 10 minutes whole brain perfusion imaging was repeated with identical patient position, scan protocol and with the initially determined arrival time of the test bolus. Using a delay invariant deconvolution method (SVD+, Toshiba, Japan), perfusion maps of regional cerebral blood flow, blood volume, mean transit time and delayed perfusion were generated. Percentual change of CBF, CBV and MTT before and after acetazolamide administration were computed in both perfusion scans to determine altered hemodynamics. Time-resolved CT-Angiography was visually evaluated in all patients.

**RESULTS**

One patient showed reduced baseline values of the mean blood flow in an affected vessel territory compared to the contralateral unaffected brain region. All patients revealed none or only marginal increase after acetazolamide testing in at least one vessel territory indicating an impaired cerebrovascular reserve capacity. Time-resolved CTA angiography allowed the assessment of intracranial vessels in all patients and showed stenosis and/or occlusions of intracranial vessels in four patients.

**CONCLUSION**

Our results demonstrate that whole brain CT Perfusion combined with an acetazolamide test allows to identify subjects with reduced cerebrovascular reserve capacity. This is of important diagnostic value, as this patient group may improve hemodynamically by an extracranial-intracranial bypass. Time resolved CT Angiography was reconstructed from the same scan and allows for further diagnostic evaluation of the patients.

**KEY WORDS:** CT perfusion, cerebrovascular reserve capacity

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### Scientific Poster 96

**Comparison of Perfused CBV Values Obtained Using Whole-Brain versus First-Pass CT Perfusion**

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**PURPOSE**

To determine whether perfused CBV values obtained using the whole-brain CTA data are equivalent to those obtained from First-Pass CTP.

**MATERIALS & METHODS**

Twenty patients were randomly selected from the 2003 cohort (n = 98) that underwent whole-brain CT perfusion and First-Pass CTP within 6 hours of ischemic stroke. Whole-brain perfusion was acquired using 140kVp, 170mA, 1 second rotation and a pitch of 0.75, 25 seconds following the beginning of injection of 80ml of Iohexol-300 at 3.5ml/sec. 1.25mm thick images were reconstructed at 1mm centers. First-Pass CTP used 80kVp, 200mA and a 1 second rotation, starting 5 seconds after onset of injection of 50ml of Iohexol-300 at 7ml/sec. The acquisition was through the basal ganglia. Four 5mm contiguous slices were acquired. The data sets were manually co-registered on a GE Advantage workstation (ADW4.4) and the whole-brain data re-sliced to correspond to the angle and thickness of the First-Pass acquisition. Regions-of-interest (ROIs) were placed on the thalamus of the unaffected hemisphere, avoid-
REFERENCES:


KEY WORDS: CT perfusion, whole brain, first pass

Cerebral Infarcts on MR Imaging: Correlation of Clinical Reports and a Standardized Scoring System

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PURPOSE

While the identification of infarcts on MR imaging may seem elementary, the reproducible scoring of infarcts on large multicenter cohort studies has required the creation of relatively complex scoring systems often with two inde-
Visibility of Transcerebral Veins on T2*-Weighted Images at 3T in Acute Stroke Patients and Healthy Subjects

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PURPOSE
To study the frequency and the pathological value of the visibility of the transcerebral veins (VTV) on T2*-weighted images at 3T in acute stroke patients.

MATERIAL & METHODS
Sixty acute (<6 hours) carotid territory stroke patients imaged on a 3T MRI were consecutively enrolled and matched on age and sex with forty healthy subjects. The visibility of the transcerebral veins has independently been analyzed by two neuroradiologists, blinded to the clinical data and the side of the infarct. Intensity of the VTV was graded, for each cerebral hemisphere, as follows: 0-none, 1-moderate, 2-obvious. Frequency of the VTV, asymmetry between hemispheres and correlation analysis with clinical and radiological covariates have been recorded.

RESULTS
In acute stroke patients (mean age: 66 years, mean baseline NIHSS: 15, 63% treated by tPA), the VTV is more frequent in the stroke hemisphere than in the contralateral side (59.3% vs 9.4%, p=0.0002) and than in healthy subjects (28%, p=0.004). Asymmetry in the VTV between both hemispheres was more specific of stroke patients than healthy subjects (53.4% vs 12.5%, p=0.0001). For acute stroke patients, asymmetry in the VTV was significantly correlated with final infarct growth (ρ=0.291, p=0.04) and the occurrence of symptomatic hemorrhagic transformation (ρ=0.262, p =0.04).

CONCLUSION
The visibility of the transcerebral veins on T2* sequence at 3T is more frequent in acute stroke patients on the affected hemisphere than in healthy subjects. The pathological value of this sign resides more in its asymmetry than in its intensity of visibility, as it is correlated with clinical and radiological data of interest in acute stroke patients' management.

KEY WORDS: Adult brain, stroke, T2*-weighted images

Early Clinical Experience with Whole-brain 4D CT Angiography Using 320-slice CT

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PURPOSE
To report initial experiences in the assessment of the cranial vasculature and its pathologies by whole-brain four-dimensional, time-resolved CT angiography (4D CTA) using a recently introduced 320-slice CT scanner. Due to the detector width of 16 cm, image acquisition of the whole brain can be achieved in a single gantry rotation enabling simultaneous acquisition of whole-brain 4D CTA and CT perfusion studies.

MATERIALS & METHODS
The intracranial vasculature of 46 patients with acute or chronic neurologic dysfunction was evaluated by 4D CTA using a 320-slice CT scanner (Aquilion One, Toshiba, Japan). After bolus-timing, 4D CTA was performed in a low voltage and low amperage technique (80kV, 100mA) consisting of three intermittent, unenhanced scans for acquisition of an unenhanced CT scan and a bone-subtraction mask, being followed by a continuous scan of 15 sec duration to cover the arterial, capillary and venous passage of the contrast bolus (40 ml @ 5ml/sec). Rotation time amounted to 1 second. Performing half-scan reconstructions, the image reconstruction window length amounted to 0.5 seconds. Subsequently, five intermittent scans every 5 sec were performed to complete perfusion information. Data were postprocessed using either the console of the scanner or a dedicated workstation (Vitrea fX, Vital Images, Minnesota, USA). Series of bone-subtracted whole-brain maximal intensity projections (MIP) were generated as well as volume rendered images.

RESULTS
In 45 patients 4D CTA quality was evaluated as diagnostic. One data set could not be assessed due to motion artefacts of an uncooperative patient. Pathologies imaged were arterial occlusion in the setting of acute ischemic stroke (n=8), chronic atherosclerotic steno-occlusive disease (n=11), steno-occlusive disease in patients with Moya-Moya Syndrome (n=2), venous occlusions (n=6) as well as arterio-venous malformations (n=3). In 6 patients with symptoms of acute stroke no vascular pathology was found. The remaining 12 patients had various other kinds of intracranial pathologies. The intracranial vasculature and pathology could be evaluated both morphologically and hemodynamically with this technique.

CONCLUSION
By whole-brain 4D CTA using a 320-slice CT scanner evaluation of the intracranial vasculature and its pathologies can be performed both morphologically and hemodynamically overcoming the limitation of conventional static 3D CTA. This enables analytic assessment of hemodynamically relevant pathologies and may reduce the need for invasive catheter angiography.

KEY WORDS: 320-slice CT, 4D CTA, intracranial vascular pathology
Scientific Poster 100

Visualizing Collateral Flow with Arterial Spin Label MRI in Moyamoya Patients: A Comparison Study with Cerebral Angiography

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PURPOSE

Collateral flow is poorly understood despite its importance in maintaining the cerebral circulation in the setting of large vessel occlusion [1-3]. The gold-standard, digital subtraction angiography (DSA) is relatively invasive, time-consuming, and costly. Arterial spin labeling (ASL) is a noncontrast MR imaging method that combines aspects of perfusion and angiography and can be made exquisitely sensitive to arterial arrival delays. Bright intravascular ASL signal known as “arterial transit artifact” (ATA) contains information about late-arriving flow [4, 5]. Moyamoya patients have highly-developed collaterals due to stenosis of the supraclinoid anterior circulation. They are an ideal population in which to rigorously study imaging correlates of collateral flow. We hypothesized that ASL can determine the presence and intensity of collateral CBF in these patients, using DSA as a gold-standard.

MATERIALS & METHODS

ASL and DSA were performed in 5 newly-diagnosed Moyamoya patients. ASL was performed with a background-suppressed pulsed continuous method with 3DFSE readout at 1.5T [6]. Parameters were TR/TE/label time/post-label delay = 5500/2/1500/1500 ms; 6 minutes acquisition time. DSA images were reviewed in a blinded fashion by a neuroradiologist using a 4 point scale that allows comparison between angiographically-defined regions and axial images using slices compatible with ASPECTS [7]. A separate blinded neuroradiologist graded ASL regions as follows: 0=minimal/no ASL signal, 1=intermediate ASL signal with ATA, 2=high ASL signal with ATA, 3=normal ASL signal, no ATA). Outcome measures were sensitivity and specificity of ASL for predicting presence of collaterals as well as agreement of the entire 4 point scale was using kappa methodology.

RESULTS

An example of ASL images and collateral scores is shown (Figure). The prevalence of abnormal regions determined by DSA was 48% (95% CI 38-58%) of the 100 ROI's. The sensitivity and specificity of ASL for predicting the presence of collaterals was 95.8% and 96.2%, respectively. Linearley-weighted kappa was likewise good (k=0.78, 95% CI 0.72-0.83).

CONCLUSION

ASL had a high predictive value for regions supplied by collateral flow as determined by DSA in this small cohort of Moyamoya patients. It suggests that ASL may yield information about collateral flow without the need for DSA, which could improve triage of acute stroke patients.

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KEY WORDS: MRI, cerebral blood flow, Moyamoya disease

Scientific Poster 101

Volumetric Analysis of Subaracnoid Hemorrhage Clot: New Ways of Assessing Bleeding Severity

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PURPOSE

SAH bleeding is assessed with the help of qualitative scales that show moderate interobserver reliability and moderate relation with vasospasm and outcome. New methods have
been described in order to quantify the volume of subarachnoid hemorrhage. The objective of this study is to assess the reliability of two different methods for quantifying subarachnoid hemorrhage volume and to establish their relation with different clinical factors, the presence of vasospasm and outcome.

MATERIALS & METHODS
The CTs of 90 patients suffering spontaneous SAH were reviewed. DICOM images were evaluated using ANALYZE 8.1 software running on a personal computer. SAH bleeding volume was estimated using two methods: ROI measurement with semiautomated delineation of the bleeding in each section; and using the Cavalieri principle. Both methods were compared using simple correlations and comparing differences between measurements. SAH bleeding volume was related to different clinical variables, appearance of vasospasm and outcome assessed with GOS by means of univariate and multivariate logistic regression analysis.

RESULTS
Both methods obtain very similar results (less than 10% average difference, correlation coefficient 0.95). Bleeding volume correlates with the level of consciousness at admission and outcome, although it does not correlate with Fisher grade. There is an increased risk of clinical vasospasm and ischemia in patients with higher bleeding volumes. A total volume of bleeding over 20 cc increases nearly four times the risk of poor outcome after adjusting for confounding factors such as age or WFNS at admission.

CONCLUSION
Volumetric estimation of SAH clot could be helpful in assessing prognosis after SAH and more reliable than classical scales that assess the severity of the bleeding in CT.

KEY WORDS: Subaracnoid hemorrhage

Scientific Poster 102
Evaluation MDCT-64 and 1.5 Tesla MR Angiography in the Evaluation of Intracranial Aneurysms in Patients with Acute Subarachnoid Hemorrhage

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PURPOSE
The study was designed to compare the accuracy of CTA and MRA using MDCT-64 slice and 1.5 Tesla systems in patients with acute SAH and to determine whether the use of 3 D post processing tools improves the visualization of aneurysm morphology over source images.

MATERIALS & METHODS
Twenty-five patients of acute SAH underwent angiography on MDCT-64 and 1.5 T MR followed by post processing of source images using 3D tools which were analysed in a blinded manner for aneurysm detection and morphological details. The data was then statistically analysed for accuracy, sensitivity and specificity, PPV, NPV for both CTA and MRA on per patient and per lesion basis. All findings were confirmed on surgery. Chi Square test and Wilcoxon sign rank tests was performed to determine the significance of differences between image quality and the results between CTA and MRA and to determine advantages of 3D over source images in treatment planning of patients with acute subarachnoid haemorrhage.

RESULTS
Out of 25 patients of acute SAH there were 09 males and 16 females with mean age 53.28+- 24.72 years. The overall per patient sensitivity, specificity, PPV and NPV for CTA were 100% with an accuracy of 100% while for MRA these were 86.36%, 100%, 100% and 50% respectively with accuracy of 88%. Out of 29 aneurysms in 22 patients, 11 (38%) aneurysms were in the ACA complex, 9 (31%) aneurysms were in the MCA complex, 7 (24%) aneurysms were in the ICA complex and 2 (7%) aneurysms were in the vertebrobasilar system. For intracranial aneurysm of any defined size in the present study, CTA had a sensitivity, specificity, PPV, NPV and accuracy of 100% each while on MRA, these values for very small aneurysms (upto 3 mm) were 60%, 100%, 100% and 84.61% respectively with accuracy of 87.50%, and for small aneurysms (3-10mm) these were 85.71%, 100%, 90% and 90% respectively with accuracy of 93.75%, while for large (10-25mm) aneurysms these were 100% each; similar to that of CTA. On CTA, per patient Chi Square value for VRT vs MPR was 4.337 (p = 0.037, SS). On MRA, per patient Chi Square value for VRT vs MPR was 0.0473 with p value of 0.087, NS). For visualization of circle of Willis, both CTA and MRA were equal (p = 0.083, NS) however CTA scored over MRA in visualization of all the anatomical details of the aneurysms using Wilcoxon sign test.

CONCLUSION
CTA and MRA have good sensitivity of 100% and 83.6% respectively however MRA had negative predictive value of 50% compared to 100% of CTA in the detection of intracranial aneurysms and the results on MRA were dependent on the size and location of the aneurysm with MRA performing badly in ACA and MCA complex aneurysms. Post processing tools are robust in the visualization of morphological details of the aneurysm on both CTA and MRA and VRT was found to be the best.

KEY WORDS: CTA, MRA, SAH

Scientific Poster 103
Comparison of Standart-DSA and 64-Channel-CTA of Subjects with Subarachnoid Bleeding in Terms of Aneurysm and Vasospasm

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PURPOSE
We compared DSA and CTA findings of subjects with subarachnoid hemorrhage (SAH) in terms of aneurysm and vasospasm.
**Materials & Methods**

Forty-five (25 female, 20 male) subjects with SAH were enrolled. DSA and CTA performed within 12 hours of each other were reviewed retrospectively. CTA was performed using 64 channels MDCT (5 ml/sn with total 50 ml idonated contrast agent). Source images, MIP, volume rendering views were all evaluated. Standard DSA were used with carotid vessels imaged in Towne, oblique and lateral projections (4 ml/sn with total 8 ml idonated contrast agent in each projection) and vertebral arteries in Towne and lateral projections (3 ml/sn with 6 ml idonated contrast agent in each projection). All subjects were evaluated on both CTA and DSA in term of presence of aneurysm, vasospasm and collateral congestive vascular structures. Collateralization may develop distal to severe vasospasm, or stenoses. Detected aneurysms on both imaging modalities were anatomically reevaluated in which CTA and DSA were compared in term of ability to show nearby important vascular branches, surgically important bone or other soft tissue structures, hematoma surrounding the aneurysm, thrombus in partially filled aneurysms and from which side anterior communicating artery (Acomm) aneurysms fill.

**Results**

In 11 subjects, aneurysm was not found. In the remaining 34 subjects, total 41 aneurysms (2 aneurysms in five subjects, 3 aneurysms in one subject) were detected. The smallest aneurysm diameter on CTA was 2 mm. 39/41 aneurysms were noted on both DSA and CTA and 2/41 noted only on CTA. In the evaluation of neck of 39 aneurysms visualized on both modalities, we found 21/39 aneurysms CTA>DSA (better visualized on CTA than DSA), 2/39 DSA>CTA, 14/39 DSA=CTA (equal visualization on both) and 2/39 DSA- CTA- (not well shown on both). In anatomical evaluation of 39 aneurysm, we found as 6/39 DSA>CTA, 15/39 CTA>DSA and18/39 DSA= CTA. In all subjects with SAH, vasospasm was found in 23 subjects. Among them, vasospasm was observed only on CTA in one subject (1/23 CTA+ DSA-), only on DSA in two subjects (2/23 DSA+ CTA-). In all subjects with SAH, collateralization was found in 5 subjects. Among them, collateralization was observed on both in 4 subjects (4/5 DSA+ CTA +), only on CTA in one subject (1/5 CTA+ DSA-). Statistical evaluation could not be performed due to the limited number within the cells.

**Conclusion**

We have not noticed big difference between the DSA and CTA in the detection of aneurysm and vasospasm. In depiction of aneurysm neck, 64-CTA is more successful. However DSA is dynamic technique which reveals from which side Acomm aneurysms fill. On the other hand, CTA is valuable in demonstration of real size of partially thrombosed aneurysm, the presence of surrounding hematoma and relation of aneurysm to the nearby vascular branches and other surgically important anatomical landmarks. Collateralization was observed in both techniques. However, collateralization distal to middle cerebral artery vasospasm is better visualized on CTA; collateralization around brain stem is better seen on DSA.

**Key Words:** Aneurysm, vasospasm, 64-CTA, standard-DSA, comparison

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**Scientific Poster 104**

**Etiologies of Intraventricular Obstruction as Revealed by CISS Imaging in Patients Undergoing Preoperative Assessment Prior to Endoscopic Third Ventriculostomy**

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**Purpose**

Retrospective review of all adult patients with who underwent preoperative MR imaging including isotropic CISS for obstructive hydrocephalus prior to endoscopic third ventriculostomy (ETV) over a 16 month period.

**Materials & Methods**

IRB approval for a retrospective review of data was obtained. Of the 25 patients who underwent ETV at Johns Hopkins Hospital during the period under study 16 underwent MRI which included sagittal CISS through the cerebral aqueduct (including one case with equivalent SSFP images). Of the 16 patients three were determined not to have an intraventricular etiology of hydrocephalus. Images and radiology reports on the remaining 13 patients were reviewed and the images were classified as either demonstrating masses or non-neoplastic etiologies including webs or other obstruction.

**Results**

Of the 13 patients studied two were found to have masses that obstruct or partially obstruct the cerebral aqueduct. The remaining 11 patients demonstrated either focal aqueductal webs, obstruction at the level of the superior medullary velum, or long segment regions of narrowing without focal adhesions or webs.

**Conclusion**

Intraventricular obstructive hydrocephalus is a common indication for ETV. Focal webs or other non-neoplastic etiologies of obstruction of CSF flow are more frequently found than neoplasms in this population on high-resolution MR imaging.

**Key Words:** Hydrocephalus, CISS, ETV
**Scientific Poster 105**

**Alterations in Cerebrospinal Fluid Flow Dynamics and Pressure Gradient Generated by Acute and Chronic Changes in Intraabdominal Pressure: Early Results of MR Imaging Measurements Performed on Volunteers at 3 T**

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**PURPOSE**

Abdominal binders are used to alleviate symptoms of patients who have ventricular shunts and are over-shunted. The purpose of this study was to demonstrate feasibility of assessing cerebrospinal fluid (CSF) flow dynamics and pressure gradient, which is proportional to intracranial pressure (ICP), after acute and chronic changes in intraabdominal pressure using a 3 Tesla MR scanner.

**MATERIALS & METHODS**

Four females (aged 28-32; weight 66-88 kg) underwent the following experiment: Baseline measurements, measurements while 7.6 kg of weight was placed on the abdomen, measurements following wearing an abdominal binder for 7 days and measurements 15 minutes after removal of abdominal binder were obtained. The MR protocol consisted of acquisitions of CSF flow and vascular flow using phase contrast CINE technique in axial plane at mid-C2 level. The velocity encoding gradient was set to 100 cm/second for the vascular flow study and 5 cm/second for the CSF flow study. Internally developed software was used to determine the cross sectional area of CSF flow, and quantify the mean CSF velocity for each cardiac phase. The CSF pressure gradient time course over a cardiac cycle was obtained from the Navier-Stokes relationship, neglecting terms containing viscosity and spatial variation of the velocity. Intracranial volume changes were also studied.

**RESULTS**

Alterations were recorded after acute and chronic changes in intra-abdominal pressure. The baseline peak pressure gradients ranged from 0.040 to 0.051 mmHg/cm (median 0.044 mmHg/cm). Following placement of weight on the abdomen, the peak pressure gradient decreased in 3 volunteers (median 16%, range 9-17%) and increased in 1 volunteer (12%). After wearing the abdominal binder for 7 days, the pressure gradients ranged from 0.033 to 0.057 mmHg/cm (median 0.048 mmHg/cm) and following removal of the binder, the gradient increased 12% in 1 volunteer and decreased from 1 to16% (median 3%) in 3 volunteers.

**CONCLUSION**

The peak pressure gradient can be altered by placing a weight on the abdomen for 15 minutes or wearing an abdominal binder for 7 days as measured by MR. Ability to measure changes in CSF flow dynamics may have utility in understanding the mechanisms by which abdominal binders are effective in treatment of patients with over-shunting and help in patient selection.

**KEY WORDS:** Cerebrospinal fluid flow dynamics, intracranial pressure gradient

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**Scientific Poster 106**

**Evaluation of Malignant Brain Tumors by Diffusion Tensor Imaging and 3D Fiber Tracking at 3T Scanner**

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**PURPOSE**

The purpose of this study is to evaluate brain tumors with diffusion tensor imaging and 3D fiber tractography and demonstrate their relation with corticospinal tract as well as type of involvement such as edema, infiltration or destruction.

**MATERIALS & METHODS**

Thirty six patients with malignant brain tumor were evaluated with DTI. Images were acquired using a SENSE head coil on 3T wholebody MR scanner (Achieva, Philips Medical Systems, Best, The Netherlands) equipped with explorer gradients (40 mT/m). For acquisition, an 8-element arrayed RF coil, with the 8-channel receiver system, was used. Diffusion tensor imaging sequence was obtained by using single-shot spin echo-echo planar sequence (SE-EPI), with diffusion gradients applied in 16 non-collinear directions and b = 800 s/mm². Sixty axial slices were acquired, parallel to the AC-PC line. The field of view (FOV), the size of the acquisition matrix, and the slice thickness were 224x224 mm,128x112 mm and 2 mm. All images were zero-filled to the final reconstruction matrix of 256x 256. The imaged voxel size was...
2/2/2 mm and reconstructed voxel size was 1.75/1.75/2 mm. Other imaging parameters were: TR = shortest ms; TE = 60 ms; NSA = 2 and SENSE reduction factor = 2.5. To improve the signal-to-noise ratio, two datasets were acquired, leading to a total acquisition time of 6 min. A 3D TFE T1 sequence was also acquired for background imaging. DTI data were analyzed on the Philips expanded workstation with release 2.5.3.0. by using FiberTrak package. Fiber tracking was performed by line propagation method using minimum FA value of 0.15, maximum angle change of 27 degree and minimum fiber length of 10 mm. Mean diffusivity (MD) and fractional anisotropy (FA) values of the fibers were detected individually. Classification of tract involvement was made on the basis of previously defined knowledge (1,2).

RESULTS
Edema, infiltration and destruction were successfully detected in all patients. 3D fiber tractography images were more useful than MD and FA calculation in the assessment of focal lesions but FA values were quite useful in the assessment of infiltrative tumors.

CONCLUSION
Diffusion tensor imaging can easily delineate corticospinal tract invasion and displacement brain tumors. Diffusion tensor imaging is a very promising tool in the differentiation focal and diffuse lesions as well as in the demonstration involved tracts individually. These data are also very helpful for guiding surgery or surgical biopsies. Further pathologically cross matched studies are needed to exact delineation of the type of involvement as well as individually involved tracts.

REFERENCE

KEY WORDS: Brain tumor, diffusion tensor imaging, 3D fiber tractography

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Scientific Poster 108

A Pilot Study Evaluating Anti-VEGF Treatment in the Malignant Gliomas: Perfusion Magnetic Resonance Imaging (PWI), Tumor Volume and Clinical Outcomes

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PURPOSE
To correlate relative cerebral blood volume (rCBV) value on PWI and tumor volume on post contrast enhancing T1 images with clinical progression to evaluate efficacy of anti-vascular endothelial growth factor (VEGF) treatment.

MATERIALS & METHODS
Five patients (4 male, 1 female with average age of 51yrs) with glioblastoma multiforme underwent partial tumor excision and radiation therapy were recruited. All the patients were given Bevacizumab 4-6 weeks after their last radiation treatment. Each patient obtained chemotherapy prior to, 2 month and 6 month after Bevacizumab MR study. Pre and post Gadolinium axial and coronal T1 images, GRE EPI perfusion MR imaging (TR/TE 1500/50, FA 90, FOV 24cm, 5mm slice thickness, total of 40 phases) were acquired on 1.5T MR scanner. The tumor volume was measured on both axial and coronal post-T1 images using MacDonald criteria. Color coded rCBV maps were generated and projected onto the T2 weighted images. Region of interest (ROIs) were placed on contralateral normal appearing white matter (NAWM) and within the tumor. The maximum rCBV value within the tumor and suspicious surrounding parenchyma was selected for quantitative analysis. The rCBV value was expressed as ratios relative to the contralateral NAWM. A 5-point qualitative scale was used clinically to evaluate the treatment efficiency. Correlation coefficient was calculated between the rCBV value, tumor volume and clinical outcome. Additional patients are currently recruited for further evaluation.

RESULTS
Based on clinical qualitative evaluation, one patient showed progressive disease and the other four patients were clinically stable after 6 months of Bevacizumab therapy. rCBV value correlated more accurately with clinical outcome (r = 0.87) compare to the tumor volume assessment. For the patient with progressive tumor growth, rCBV value increased 4 month earlier than the tumor size increase and 2 month earlier than the progress of clinical symptoms.

CONCLUSION
Bevacizumab shows marked reduction in overall enhancement without significant change in the tumor volume. Perfusion MR imaging may provide more accurate assessment of the progression of the residual glioma than conventional tumor volume methods.

KEY WORDS: Malignant gliomas, anti-VEGF treatment, perfusion weighted imaging
3D Chemical Shift Imaging (CSI) and Diffusion Tensor Imaging (DTI) of Gliomas and Gliomatosis Cerebri: An Indispensable Combination of Techniques for Radiation Treatment Planning and Post-Radiation Therapy Evaluation

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PURPOSE
To evaluate the extent of tumor infiltration in patients with diffuse gliomas or gliomatosis cerebri, beyond the visible (by imaging criteria) borders of the tumor.

MATERIALS & METHODS
One hundred sixteen patients with gliomas or gliomatosis cerebri (ages 23-79, mean age 47) were examined at 1.5 Tesla (Signa HDx, GE, Milwaukee, USA), with use of a quadrature head coil in order to ensure more homogeneous signal intensities in the entire Volume of Interest. The pulse sequence PRESS was used under PROBE. Diffusion Tensor Imaging (DTI) was performed on all patients. Post-processing was performed on an external workstation Advantage Windows 4.3, GE, Milwaukee, USA).

RESULTS
In all cases except three pure oligodendrogliomas, tumor infiltration was determined beyond the visible borders of the lesions, and in two extreme cases of gliomatosis cerebri infiltration was found in the entire brain (in one case) and at distances as far as 6 cm away from the visible border of the lesion in another case. Often the corpus callosum had higher cellularity in “normal” (by MRI criteria) areas than areas with pathological signal intensity. The spectroscopic results were sufficient to cover the pathological volume in question (only in a few cases a small visible pathological area was left out) and often overturned the well-established notion of highly sensitive MRI. The revelation of more extensive than “seen” by MRI criteria infiltration was utilized by the oncologists collaborating with our Institution to alter their initial radiation treatment plans. In some cases the clinical status of the patients could not be explained by the MRI findings alone, and in those cases the spectroscopic findings made the difference. The DTI findings were useful in confirming the spectroscopic results, showing the extent of damage or deviation of the involved tracts.

CONCLUSION
The combination of 3D CSI and DTI appears to be a very powerful method for evaluating the extent of tumor infiltration in gliomas and gliomatosis cerebri patients, assess the effect of therapy, answer the question of tumor recurrence versus radiation necrosis and guide the oncologists in the proper treatment planning.

KEY WORDS: Glioma, gliomatosis cerebri, DTI, CSI

Isolated CNS Whipple's Disease: A Case Report

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PURPOSE
Whipple's disease (WD) is a rare systemic condition with subacute or chronic course associated with a persistent intra-cellular gram-positive bacillus, Tropheryma whippelii. Small bowel, lymph nodes, joints and muscle are predominantly involved. Central nervous system (CNS) involvement is not uncommon during the course of the illness. We report a case of isolated WD with acute course.

MATERIALS & METHODS
A 32-year-old man from Romania presented because of onset of confusion, speech difficulty, right arm weakness and nuchal pain over the previous 3 days. CSF examination showed a mild pleocytosis. Treatment with acyclovir and broad-spectrum antibiotics was initiated but clinical conditions rapidly deteriorated to coma.

RESULTS
An initial MR imaging showed T2-hyperintense, ill-defined, extensive lesions involving the white matter of both temporobasal regions and the left precentral gyrus, where the cortex was also involved. Diffusion-weighted sequence suggested vasogenic edema. After gadolinium injection an irregular enhancement appeared, at the interface between grey and white matter. MR scan 2 weeks later showed slight enlargement of the lesions. A focal leptomeningeal enhancement was also noted. MR spectroscopy showed striking reduction in N-acetyl aspartate (NAA) and a peak of lipid/lactate.

A 18F-FDG Positron Emission Tomography (PET) of the brain documented marked reduction of glucose metabolism in the affected regions. A third MR control showed further progression of the process, with extension to the posterior fossa structures. Brain biopsy showed aggregated of macrophages with period acid-Schiff-positive inclusions, highly suggestive of WD. The diagnosis was confirmed by molecular analysis. Repeated chest x-rays, echocardiography, body CT scan and endoscopic jejunal biopsy excluded concomitant processes of the disease.
**CONCLUSION**
The diagnosis of isolated cerebral WD is a clinical challenge and a crucial issue upon which depends the possibility to prompt specific treatment of a potentially life-threatening condition. In the absence of proven disease in other organs, the definite diagnosis is generally based on brain biopsy. While sensitive, showing lesions without clinical expression, MR imaging lacks specificity; however, the possibility of cerebral WD can be suggested by the presence of multiple, confluent T2-hyperintense lesions in the white matter of mediobasal temporal regions, the brainstem and the middle cerebellar peduncles.

**Key Words:** Adult brain, Whipple's disease

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**Scientific Poster 111**

**Neuroimaging of Temporal Lobe and Limbic Lesions with MR Imaging: Differential Signs**

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**Purpose**
Many neurological diseases can mimic brain neoplasms on neuroimaging or on histological examination, including inflammatory disease, stroke, seizure activity, etc. Conversely, certain brain neoplasms, such as gliomas, can present in the absence of typical heterogeneous enhancing lesions, creating difficult diagnostic challenges. This study examines neuroimaging signs that may help to differentiate different types of pathology involving the temporal lobe and limbic system, and therefore provide greater accuracy in the non-invasive diagnosis of temporal lobe lesions.

**Materials & Methods**
Patients presenting with temporal lobe lesions were retrospectively evaluated (n=12). The clinical presentation included seizures, headaches, speech and language symptoms. Patients had head CT scans, brain MR scans without and with contrast, spectroscopy and diffusion tensor imaging, as well as complete neurological examinations. 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 regions of the temporal lobe were detected in all patients. The pathology included limbic encephalitis associated with myasthenia gravis, Herpes encephalitis (HSV-1 and HSV-6), paraneoplastic syndrome, glioblastoma multiforme (GBM), glioma, gliomatosis cerebri, stroke, post seizure edema. Differentiating features included involvement of other brain areas such as cingulate gyrus (limbic encephalitis), thalamus (gliomatis cerebri), medial temporal lobe (Herpes), bilateral temporal and hippocampal regions (paraneoplastic), heterogeneity, enhancement and increased choline (GBM), resolution of edema on follow-up (post seizure). Decreased diffusion tensor connectivity was observed within regions of limbic encephalitis. MR spectroscopy demonstrated increased choline peaks in cases with neoplasms.

**Key Words:** Encephalitis, tumor, limbic

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**Scientific Poster 112**

**Whole Brain Perfusion Imaging in Cerebrovascular Disease by Using 320-Detector Row CT**

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**Purpose**
Recently introduced 320-detector row CT featuring a detector width of 16cm permits whole brain coverage by a single gantry rotation. This enables dynamic volume scanning and allows for four-dimensional, time-resolved CT-angiography and whole brain perfusion imaging that can be acquired simultaneously. Especially accurate detection of the whole extent of altered blood supply may guide treatment decisions. To report initial experience with a 320-detector row CT scanner in assessing cerebrovascular disorders.

**Materials & Methods**
Forty patients with acute and/or chronic cerebrovascular disease underwent whole brain perfusion (CTP) using a 320-detector row CT (Aquilion One, Toshiba, Japan). Before acquisition of CTP data the examination started with a test bolus scan (2 mm slice thickness, 80 kV, 100 mAs, 20 ml contrast medium [CM; Xenetix 350, Guerbet, Sulzbach, Germany], 5 ml/sec. flow, chased by 30 ml saline) to determine the exact bolus arrival time. CTP was then performed using a low dose protocol (80kV, 100mAs) starting with the acquisition of three intermittent, unenhanced scans for subsequent bone subtraction. Based upon the bolus arrival time this scan was followed by a continuous scan of 15 sec duration to cover the arterial and capillary phase and by five intermittent scans every 5 sec. For CTP 40 ml CM were injected with a flow rate of 5 ml/sec. Using a delay invariant deconvolution method (SVD+, Toshiba, Japan) perfusion maps of regional cerebral blood flow, blood volume, mean transit time and delayed perfusion were generated and evaluated for regions of altered hemodynamics.

**Results**
In 39 patients perfusion maps could be calculated from the 320-detector row CTP scans. Because of severe motion artefacts one patient could not be analysed. Cerebrovascular disorders that were successfully examined contained clinically suspected acute ischemic stroke (n=19), chronic ischemia...
due to vessel stenosis or occlusion (n=14) and venous occlusive disease (n=6). On the resulting whole brain perfusion maps regions of normal and limited regional perfusion even in areas remote to the level of the basal ganglia could be detected. Postprocessing time for CTP data amounted up to ten minutes. The estimated effective dose was 3.6 mSv.

CONCLUSION
320-detector row dynamic CT is a feasible and robust method. For the first time whole-brain perfusion imaging can be performed by CT bearing great potential regarding pathologies that alter cerebral hemodynamics and overcoming the shortcomings of previously available multi-detector CT systems.

KEY WORDS: Perfusion, volume-CT

Scientific Poster 113

Value of Susceptibility-Weighted Imaging in Acute Ischemic Stroke with Perfusion Defect

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PURPOSE
Susceptibility-weighted MR imaging (SWI) is a useful imaging modality in the detection of hemorrhagic signals, which are due to the susceptibility effect of deoxyhemoglobin in thrombi. We evaluated the usefulness of SWI in acute ischemic stroke patients with perfusion defect within the anterior circulation territory.

MATERIAL & METHODS
Consecutive patients were scanned within 12 hours after symptom onset using identical acute MRI protocol. We inspected the relationship between susceptibility vessel sign (SVS) and stroke subtypes. We inspected the correspondence between hypointense vein signs (HVS) and perfusion defect.

RESULTS
Sixty-five patients (mean age 65.5 ± 11.6 years, 49.3% women) were included. SVS on SWI (p=0.027) and GRE (p=0.025) were more commonly associated with cardioembolic stroke than other stroke subtypes. Asymmetrical HVS on SWI was identified in 64 of 65 patients (98%) with perfusion defect compared with HVS of GRE image (74%). SVS was related to cardioembolic stroke and subsequent recanalization. This study reveals HVS on SWI might be a good marker of perfusion defect.

CONCLUSION
In patients with acute ischemic stroke, SWI can be used as a viable alternative modality in identifying clot composition and acute perfusion defect.

KEY WORDS: Acute ischemic stroke, susceptibility-weighted imaging, MR perfusion

Scientific Poster 114

Source of Intramural Low Dense Materials in the Carotid Stent; a Vessel Phantom Study

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PURPOSE
After carotid artery stenting, it is commonly accepted that neointimal hyperplasia or recurrent atheromatous plaques are cause of restenosis. To detect the primary change of the restenosis, which is expressed as intraluminal low dense substance, we should know the characteristic of the carotid stent itself. However, there was no previous report that evaluates characteristics of the metallic carotid stent and intraluminal substances on high-resolution CT images. In the last ASNR, we had testified the reliability of CT scan by varying collimation thickness, and angles toward the gantry. During clinical use on follow up, almost 70% of our cases after carotid stent, we had been experienced some cases with intramural low dense substances that tend to occur in the middle of the stent. MIP images or thick MPR images showed the lesion tends to occur in the place where the stent mesh structure opens wide. In a present study, we aimed to evaluate the significance of this kind of artifact that resembles restenosis using vessel phantom by changing parameters such as mesh widths and directions towards gantry.

MATERIALS & METHODS
We used two types of clinically used 10mm diameter carotid stent (WALLSTENT, 10mm diameter, Boston Scientific Co.; PRECISE stent, Cordis a Johnson & Johnson company). Each vessel phantoms opacified with 400Hounsfield Unit (HU), which were covered with stent and were in the same diameter, were sunk in the filled water. These phantom sets were scanned with multi-detector CT (Aquilion 64, Toshiba, Japan) using following condition, 120kV, 50mA, 0.5s/rot, helical-pitch: 41, kernel: FC03. Using profile curves along the stent axis, two experienced neuroradiologists evaluated independently under several conditions as follows: stent length; 50mm, 40mm, 30mm: angle toward the gantry; 0, 45, 90 degrees.

RESULTS
Width of the stent mesh was proportional with total stent length. In the profile curve, all the stent showed minimum HU at the site corresponds with mesh. When the stent was stretched 50mm, WALLSTENT showed from 1000 to 1550HU, Precise stent showed from 165 to 770HU, respectively. When stretched 40mm, WALLSTENT showed from 1600 to 2200HU, Precise stent showed 400 to 1000HU, and when contracted to 30mm, 2000 to 2300HU, 750 to 1150HU, respectively. In each phantom, as the degree toward the gantry increased, the profile curve deteriorated.

CONCLUSION
In a present study, we could evaluate a source of intramural low dense material in the carotid stent. It is known that mural thrombus seen in carotid arteries shows about from 120 to 180 HU. When the stent mesh is well widened, especially after the procedure with Precise stent, artifact that originated
from stent itself resembles with neointimal hyperplasia or recurrent atheromatous plaques. When we met the findings, we should take stent mesh width into consideration.

**Key Words:** Carotid stent, artifact, stent mesh

**Scientific Poster 115**

**Dual Energy CT in the Distinction of Hemorrhage versus Contrast Staining After Intra-arterial Thrombolysis for Acute Stroke**

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**Purpose**

Many patients who undergo endovascular therapy for acute stroke will have contrast staining within areas of ischemia on post-procedure CT. Hemorrhage cannot be excluded, and follow-up CT is recommended in these patients based on the premise that contrast staining will typically clear on delayed scans. We report our experience with dual energy CT in the evaluation of acute blood versus contrast staining in three patients that had endovascular therapy for acute stroke.

**Materials & Methods**

All patients were evaluated by the stroke and endovascular neuroradiology teams and met criteria for endovascular treatment for acute stroke. Pre-procedural CT scans of the head were performed to exclude intracranial hemorrhage. Patients then underwent intra-arterial thrombolysis, without intra-procedural complications. Post-procedural dual energy CT scans of the head were performed on a Siemens Definition 16 slice scanner (Tube 1: 140 kV, 128 mA; Tube 2: 80 kV, 560 mA). Images were reconstructed at 1.5 mm intervals and reviewed on a GE PACS workstation. Patients underwent an additional follow-up CT scan within 24 hours to evaluate for resolution or change. On the dual-energy scans, differences in attenuation between the 140 kV and 80 kV acquisitions were used to calculate an attenuation ratio for normal soft tissue structures (measured by the temporalis muscle), areas of contrast staining, and areas of hemorrhage.

**Results**

In two patients, the abnormal hyperdensity completely resolved on delayed scanning, indicating the presence of contrast rather than blood. In the third patient, there was partial resolution of hyperdensity, with some persistent hyperdensity consistent with hemorrhage. The attenuation of the temporalis muscle increased by a factor of only 1.0 to 1.2 between the 140 kV and 80 kV datasets in all patients. The two patients with contrast staining only, the attenuation of the abnormal hyperdense areas increased by a ratio of about 1.6 between the 140 kV and 80 kV datasets. In the third patient, both the areas of contrast staining and hemorrhage increased by a ratio of over 1.6, but the area of hemorrhage demonstrated markedly increased density on both acquisitions (over 200 HU at 140 kV, and over 350 HU on 80 kV), suggesting pooling of contrast.

**Conclusion**

Preliminary data indicates that dual energy CT can be a valuable tool in distinguishing contrast staining from hemorrhage in patients who have undergone intra-arterial thrombolytic therapy. We propose that an attenuation ratio of over 1.5 between the 140 kV and 80 kV acquisitions can help predict the presence of contrast staining. Those areas where contrast appears to pool may be a predictor of hemorrhage, and further investigation is needed to confirm these results.

**Key Words:** Stroke, hemorrhage, dual-energy CT

**Scientific Poster 116**

**Craniovertebral Junction: A Pictorial Essay of Anatomy and Pathology in Adult and Pediatric Patients**

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**Purpose**

To study the anatomy and craniometry of the craniovertebral junction (CVJ) in pediatric and adult population. To assess the stability of CVJ in various pathologies and effect on cervico-medullary junction.

**Materials & Methods**

We studied a set of normal pediatric and adult patients and compared them to patients with various CVJ pathologies. Multidetector computed tomography (CT) and magnetic resonance imaging (MRI) were performed in all cases. Submillimeter CT scans were performed on multidetector CT scanners with sagittal, coronal and 3-D reconstruction. MR imaging studies were performed on 1.5 or 3 T scanners. High-resolution volumetric data were acquired with multiple MR sequences. Various craniometric measurements were made to objectively assess the alignment of CVJ. The studies were interpreted by three board certified neuroradiologists. The medical records were reviewed for management and clinical outcome.

**Results**

The CVJ is a complex anatomical structure. It comprises of occiput, atlas, axis and supporting ligaments. The pediatric and adult CVJ have different osseous and ligamentous anatomy and elicit significantly different biomechanical response. Broad spectrum of pathologies involving the CVJ encompassing various congenital, traumatic, inflammatory, degenerative and neoplastic conditions were evaluated. We present examples of CVJ pathologies which include: Short clivus syndrome, achondroplasia with intracranial venous hypertension, atlanto-axial subluxation with myelomalacia of the cord, rheumatoid arthritis with large lytic lesion in the odontoid process and cranial settling, distal clival chordoma involving the occipital condyles and lateral atlanto axial joint, spherular os-odontiodum and plasmacytoma of the occipital condyles and C1 vertebra.
Craniovertebral junction is a complex anatomical structure. We present a comprehensive review of CVJ anatomy, craniometry and a broad spectrum of pathologies affecting this region.

**KEY WORDS:** Craniovertebral junction, craniometry, anatomy

**Scientific Poster 117**

**Increased Incidence of the Interparietal Bone in Craniosynostosis**

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**PURPOSE**

The squamous portion of the occipital bone consists of two parts: interparietal (superior portion composed of membranous bone) and supraoccipital (inferior portion composed of cartilaginous bone). The interparietal bone (os Incae) is formed by the persistence of the mendosal suture, at the boundary between the interparietal and supraoccipital parts of the occipital bone (approximated by the highest nuchal line and/or superior nuchal line). This suture is a normal variant in the human cranium well known in the anatomy and standard radiology literature. While the variations in the frequency of the interparietal bone have been studied in many human populations, and its occurrence may have a genetic component (autosomal dominant inheritance has been suggested) all of the studies have been limited by type (anthropologic) and sample (museum specimens). There are no known clinical sequela associated with the presence of an interparietal bone. While craniofacial abnormalities in general, and specifically craniosynostosis, have been associated with significantly increased frequency of wormian bones, there is a paucity of literature regarding the true association between craniosynostosis and the incidence of the interparietal bone. An incidental finding of the interparietal bone in a 6-week-old infant with sagittal craniosynostosis, prompted a retrospective study to investigate a possible increased incidence of the interparietal bone in infants with craniosynostosis.

**RESULTS**

Of the 93 craniosynostosis cases, 5 (5.4%) were found to have some variation of the interparietal bone. The incidence in this study was approximately two times as great as that seen in the general population (2.6%). We present images of the interparietal bones from some of these cases. We also differentiate between the interparietal bone and wormian bones or fractures, structures that can resemble the interparietal bone.

**CONCLUSION**

The interparietal bone is derived from the upper, membranous part of the occipital squama when the mendosal suture persists. To date it has not been associated with any other craniofacial abnormalities. Based on the results of our retrospective review of 3D CT scans, it appears that there may be an increased frequency of the interparietal bone in children 2 years of age or less with craniosynostosis.

**KEY WORDS:** Interparietal bone, craniosynostosis, Os Incae

**Scientific Poster 118**

**Intraorbital Arteriovenous Fistula with Intracerebral Drainage: The Value of MR Imaging Flow Voids and Insight into the Sphenoparietal Sinus Anatomy**

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**PURPOSE**

Intraorbital arteriovenous fistulae or malformations are exceedingly rare. Further, those with intracranial drainage usually involve the cavernous sinus without spontaneous intracerebral drainage unless cortical venous hypertension is present. We present a small intraorbital fistula in a young patient with pure intracranial venous drainage into the sphenoparietal sinus and retrograde intracerebral drainage into medullary veins resembling a developmental venous anomaly (DVA) on MR imaging and ending in a thalamostriate vein.

**MATERIALS & METHODS**

A 28-year-old female presented with headaches and intermittent right eye pain. Contrast-enhanced MR imaging demonstrated confluent enhancing vascular structures in the deep hemispheric white matter suggestive for a DVA except for one single paraventricular flow void, consistent on all sequences, prompting cerebral angiography. A small arteriovenous fistula was found, which drained into the sphenoparietal sinus and the superficial middle cerebral vein (SMCV). Intracerebral drainage was retrograde into dilated, enhancing medullary veins that reached a dilated thalamostriate vein. Extracerebral drainage was into the pterygoid plexus without cavernous sinus drainage.
RESULTS

1) We report a patient with a small arteriovenous fistula with intraorbital shunting and drainage into the deep cerebral venous system. The presence on all MR imaging sequences of a subtle paraventricular flow void associated with enhancing medullary veins organized in a pattern that mimicked a DVA allowed the discovery of the fistula. This subtle finding confirms that flow voids associated with vascular structures should always be suspicious for the presence of arterial flow.

2) Further, the pattern of venous drainage of this fistula provides insight into current concepts of intracranial venous anatomy. The sphenoparietal sinus, described in 1836 by Gilbert Breschet, a French anatomist, was described as a confluence connecting the SMVC and meningeal veins in the region of the lesser wing of the sphenoid. A recent, large cadaver study has challenged this notion, concluding that the SMVC does not connect to the sinus of the lesser sphenoid wing, and rather drains into the cavernous sinus, the laterocavernous sinus, or a paracavernous sinus (1). However, and despite different embryologic origins, the primitive tentorial sinus for the SMVC, and the primitive maxillary sinus for the sphenoparietal sinus, both structures may communicate together and with the cavernous sinus and paracavernous veins, derived from the prootic sinus (2).

CONCLUSION

The presence of vascular flow voids on MR imaging, even subtle, should prompt concern as to the possibility of arteriovenous shunting. We report a small intraorbital arteriovenous fistula which pattern of intracranial venous drainage into the sphenoparietal sinus and the superficial middle cerebral vein does not support the recent anatomical claim that the sphenoparietal sinus is separate from the SMVC.

REFERENCES


KEY WORDS: Sphenoparietal sinus, orbital arteriovenous fistula, SMVC

Scientific Poster 119

An Atlas-Based Method to Define Regions of Interest in the Individual Brain

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PURPOSE

We applied techniques commonly used in functional neuroimaging research to develop a method for automatic identification of brain regions of interest (ROI) in individual patients for clinical and research applications.

MATERIALS & METHODS

Masks for each brain ROI were created in the standard atlas space (e.g., ICBM 452) and saved as ROI templates. The spatial transformation required to match each patient’s brain to the standard atlas (normalization) and the inverse of that transformation were computed. The inverse transformation was applied to the ROI template images to generate the corresponding ROI masks for each patient’s brain. This method was tested in eight pediatric brain tumor patients, age 6 to 18 years, who were enrolled in an IRB-approved research protocol. Tumors included three medulloblastoma, two parietal/temporal primitive neuroectodermal tumor, one frontal lobe primitive neuroectodermal tumor, one atypical teratoid rhabdoid tumor, and one pineoblastoma. The ROI templates used in the test included precentral gyrus, inferior occipital gyrus, hippocampus, and temporal lobe and were automatically generated by the WFU_pickatlas software (http://www.fmri.wfubmc.edu/cms/software#PickAtlas). Normalization transformations were calculated using the SPM5 software (http://www.fil.ion.ucl.ac.uk/spm/software/spm5). The ROI masks generated for each patient were overlaid onto the patient’s 3D-T1 MR image to evaluate the accuracy of the masks.

RESULTS

Alignment of each ROI mask was accurate in all eight patients, even in the cases where brain lesions were located near the ROI. Figure 1 shows the template ROI of temporal lobes and precentral gyri on the standard brain atlas and the individual ROI overlaid on brain images for two patients. The arrow indicates a surgical void in the right frontal lobe of Patient 2.

CONCLUSION

The atlas-based automatic ROI method is easy to implement and affords flexibility to define ROIs or combinations of ROIs. This is a promising approach to help identify 3D structures or regions in patients for applications such as radiation treatment planning.

ACKNOWLEDGEMENT

This study was supported by NIH grants HD049888 and CA21765, and by ALSAC.

KEY WORDS: Brain atlas, regions of interest, brain tumor
Scientific Poster 120

Creation of a High-Resolution Brain Atlas for Image-Guided Deep Brain Stimulation

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PURPOSE
Deep brain stimulation (DBS) is increasingly widely used to treat tremor, rigidity, and drug side effects for patients with Parkinson disease and essential tremor. The subthalamic nucleus (STN) is a common target for DBS, but is poorly visualized by MR imaging at standard clinical field strengths. Incorrect placement of DBS electrodes may reduce therapeutic efficacy and/or produce unwanted side effects with occasional serious complications. Current placement relies on standardized atlas coordinates and intraoperative adjustments. The present study evaluates the ability of 7T MR imaging to visualize STN directly, allowing improved surgical planning, and construction of an improved stereotaxic atlas.

MATERIALS & METHODS
Using a protocol approved by the Vanderbilt University Medical Center IRB, subjects underwent 3T and 7T field-strength adjusted scans using a Philips Achieva 3T (Philips Healthcare, Best, Netherlands) and a Philips Achieva 7T scanner (Philips Healthcare, Cleveland, OH). A 3D-volumetric data set was acquired using T1-weighted turbo field echo (TFE) at both field strengths (voxel = 1.0mm\(^3\) at 3T, 0.7 mm\(^3\) at 7T). In addition, a T2*-weighted 2D fast-field echo (FFE) was acquired at 7T with a resolution of 0.5x0.5x1mm. The parameters of acquisition for this T2*-weighted sequence were based on T2* calculations of previous data sets to maximize the contrast of deep brain structures at 7T. The 7T images were coregistered with high resolution 3T MR images obtained from the same volunteer for surgical planning, using a nonlinear coregistration algorithm to correct for residual geometric distortion present in the 7T data.

RESULTS
Figure 1 compares MR images collected at 3T and 7T demonstrating increased conspicuity of STN at 7T. Figure 1A displays a T1-weighted coronal slice through the STN acquired at 3T; the STN is not clearly visible in this image, nor was it consistently visualized at 3T using any other sequence. Figure 1B demonstrates the excellent contrast in high-resolution T2*-weighted images obtained at 7T. The 7T images provided increased STN contrast and resolution with an imaging time similar to that for routine clinical 3T.

CONCLUSION
The increased sensitivity, resolution, and especially contrast conspicuity of deep brain structures including STN available with ultrahigh field strength 7T MR imaging shows promise for improving treatment planning in DBS electrode placement.

REFERENCES

KEY WORDS: Deep brain stimulation, subthalamic nucleus, 7 T

Scientific Poster 121

Ischemic and Hemorrhagic Disease of the Posterior Circulation: Requisite Vascular Anatomy for Appropriate Diagnosis and Management

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PURPOSE
Advances in imaging, particularly in the field of endovascular therapy, have contributed greatly to improvements in our understanding of cerebrovascular disease. This is especially true in the diagnosis and treatment of vascular pathology involving the vertebrobasilar system. With these changes, imaging has become indispensable in the diagnosis, treatment planning and follow up of patients with posterior circulation disease. Accurate imaging interpretation is vital and may be life-saving in this setting, and requires detailed knowledge of the pertinent vascular anatomy, associated variants and the spectrum of disease. This review will focus on ischemic and hemorrhagic disease of the posterior circulation, with an emphasis on the advances in anatomical and physiologic characterization of this disease by neuroimaging.

MATERIALS & METHODS
Didactic cross-sectional and angiographic imaging cases from the diagnostic and interventional neuroradiology pro-
programs at major academic medical centers were compiled. Case selection highlights the spectrum of normal anatomical variations, with correlative cases of ischemic and hemorrhagic disease. Relevant anatomy that is presently beyond the resolution of current imaging methods is discussed with original photographs of colored silicone arterial and venous injections of the cadaveric intracranial vascular tree. The important treatment-related issues are discussed.

RESULTS
The cases compiled for presentation include both distal branch and large vessel vertebrobasilar occlusion, which provide a detailed understanding of vascular supply to the posterior fossa. Hemorrhagic disease caused by aneurysms, pial and dural AVMs and venous sinus thrombosis is presented to discuss the manifold etiologies of posterior fossa hemorrhages.

CONCLUSION
The cases presented in this exhibit will provide what we believe is requisite knowledge of vascular anatomy in the posterior circulation. Such knowledge is critical to appropriate patient diagnosis and management given the vital structures these vessels supply.

KEY WORDS: Posterior circulation, vertebrobasilar disease

Scientific Poster 122

Use of Adjuvant Interferon Alpha 2B Augments the Effect of Endovascular and Surgical Intervention in Patients with Juvenile Nasopharyngeal Angiofibroma

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PURPOSE
Juvenile nasopharyngeal angiofibroma (JNA) is a locally invasive nonmalignant fibrovascular tumor of the nasal cavity and skull base, with occasional intracranial extensions. The tumor typically presents with epistaxis in pubescent males. Local recurrence is rather common, with residual tumor often continuing to grow and cause symptoms, necessitating additional interventions. In these cases, adjuvant therapy with Interferon alpha 2B prior to intervention may decrease the tumor size and vascularity, allowing for safer and more efficacious management.

MATERIALS & METHODS
Patients with multiply recurrent JNA following partial resections, or patients with symptoms related to intracranial extension, proptosis, or medically significant epistaxis were evaluated in multidisciplinary conference review. In cases not amenable to surgical and interventional options, medical therapy was recommended. Seven children were identified, and consented to individualized treatment protocol, as per institutional guidelines. Three of the seven patients had clinical signs of intracranial extension of the tumor, and another two had severe epistaxis. In each case, CT scan and/or MR imaging were performed, demonstrating lesion origin, extent, enhancement pattern, and other significant complicating issues.

RESULTS
All patients had clinical and radiographic responses to therapy. Clinical improvement occurred within 4-6 weeks after beginning therapy, with decrease in proptosis, decrease in intracranial extension, and complete cessation of epistaxis. Initial findings, within the first 6 months, included MRI changes consisting of decreased tumor enhancement and focal tumor necrosis. At 6 months, measurable decreases in tumor volume were present. The therapy was continued for a minimum of 6 months until the size of the tumor became amenable for resection, with prior endovascular intervention. Following resection (either gross total or near-total), therapy was continued for a minimum of 3 months, with the intent to continue to decrease angiogenic drive in the surgical bed.

CONCLUSION
Complex, uncorrectable or otherwise high-risk JNA tumors may benefit from preprocedural Interferon therapy. Future prospective clinical trial evaluation should be undertaken to evaluate the use of preoperative antiangiogenic therapy with Interferon Alpha 2B in managing JNA.

KEY WORDS: Juvenile nasopharyngeal angiofibroma, Interferon

Scientific Poster 123

Cone Beam Computed Tomography for Paranasal Sinus Imaging: Our Preliminary Experience

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PURPOSE
The use of cone beam computed tomography (CBCT) in sinonasal imaging is fairly novel and remains limited to date. We compared (1) the eye lens dose and (2) image quality between paranasal sinus imaging acquired on a multidetector (MDCT) and cone beam computed tomography (CBCT) in our institution.

MATERIALS & METHODS
Approval was obtained from the institutional ethics review board for this study. Sixteen patients (8 men, 8 women, mean age 45.6 years) underwent CT imaging of their paranasal
Sinuses for the evaluation of rhinosinusitis on both a CBCT and MDCT. Eye lens dose was measured using lithium fluoride thermoluminescent dosimeters (TLD) during each scan. The scans were read separately by two independent readers for the presence of artifacts, sinonasal opacification, and clarity of the osseous structures, soft tissues using a 5-point grading scale.

RESULTS
The mean eye lens dose was 1.4 mGy (1.3, 1.6) on the MDCT and 1.0 mGy (0.8 - 1.5) on the CBCT. Grading scores for artifacts, opacification, osseous structures and soft tissues were 4.3, 4.2, 4.6 and 4.2 on the MDCT compared to 3.9, 4.3, 4.0 and 2.0 on the CBCT respectively.

CONCLUSION
For paranasal imaging, eye lens dose on the CBCT are lower than those on the MDCT. The CBCT image quality is generally slightly lower, although not amounting to diagnostic uncertainty in the assessment of osseous structures and sinus opacification in our study cohort. However, soft tissue assessment is significantly worse on CBCT scans.

KEY WORDS: Cone beam CT, paranasal sinus, image quality

Scientific Poster 124

Anthropometric Measurements: Effect of CT Soft Tissue Depth on Tracheotomy Tube Selection

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PURPOSE
The purpose of this study is to determine if an objective independent metric - the depth of soft tissue over the tracheotomy site as measured on CT - can be used as a guideline for the choice of appropriate length of tracheotomy tube needed for placement. Tracheotomy is one of the most commonly performed surgical procedures to facilitate the long-term ventilation for patients, and is generally well tolerated. Several complications of tracheotomy are well established in the literature. One of the most serious complications of tracheotomy is tube dislodgement, which results in airway compromise. This complication is associated with long-term morbidity or mortality from hypoxia. One cause of tube dislodgement is inaccurate choice of tube length, in particular the failure to use an extended-length tube when needed. The choice of tube length is often guided by surgeon experience, a qualitative evaluation of patient body habitus, and in assessment of tube fit during the procedure. A more direct measurement of tube length requirement has the potential to reduce complications associated with improper tube length selection.

MATERIALS & METHODS
Following an IRB-approved process, a retrospective review of the electronic medical record to identify patients who underwent tracheotomy tube placement at a single tertiary-care institution was performed. Those patients who had CT scans that could be assessed for soft tissue depth over the anterior neck were selected to be included in the analysis. Measurement of the depth of anterior soft tissues at the level of the 1st-2nd tracheal rings was performed and compared to the choice of tracheotomy tube at surgery. The postoperative course was reviewed to determine posttracheotomy complications.

RESULTS
Four hundred thirty-eight patients who had tracheotomy tubes inserted were identified, of whom 2/3 had an appropriate CT scan within 1 month prior to their surgery. A statistically significant correlation between the depth of the anterior soft tissue and the need for an extended-length tracheotomy tube was seen. A discriminatory soft tissue depth for the need for an extended-length tracheotomy tube was calculated.

CONCLUSION
CT measurement of the anterior soft tissue depth is a simple tool that appears to provide a discriminatory threshold of the need for an extended-length tracheotomy tube. Further validation of this model through prospective application is needed; this process, however, has the potential to decrease tracheotomy tube dislodgement and subsequent morbidity.

KEY WORDS: Tracheotomy, anatomy, CT

Scientific Poster 125

Solitary Cystic Cervical Lymph Node Metastasis at Level II: Comparison with Benign Cystic Lesion at CT

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PURPOSE
Level II solitary cystic lymph node metastasis as a sole manifestation of occult malignancy can mimic benign cystic lesion. The purpose of this study is to determine significant CT features differentiating metastatic lymphadenopathy from benign cystic lesion in the solitary cystic cervical mass at level II.

MATERIALS & METHODS
This study prospectively included 42 patients (20 men and 22 women, age range 17-67 years, mean age 40.5 years) with level II solitary cystic cervical mass without any evidence of primary malignant focus at CT. By the two radiologists blinded to final pathology, both independent and consensus analyses of CT features were performed, focusing on insinuation, septation, complete wall enhancement, nodularity in cyst wall, and perilesional infiltrative changes. The statistical difference for each CT feature was analyzed with the Fisher's exact test. Weighted kappa was used to measure interobserver agreement.

RESULTS
There were metastatic lymph node (n=10) and benign cystic lesions including branchial cleft cyst (n=22), lymphoepithelial cyst (n=3), epidermal cyst (n=2), neurogenic tumor (n=1), and benign cystic lesion with undetermined patholo-
gy (n=3). Primary malignancy of metastases is various: lymphoma (n=2), oropharyngeal cancer (n=5), thyroid cancer (n=1), malignancy from branchial cleft cyst (n=1), and metastasis of unknown origin (n=1). Between lymph node metastases and benign cystic lesions, there were statistically significant differences in the absence of insinuation (90% vs 38%, P=0.0089), the presence of septation (50% vs 13%, P=0.0228), and the presence of nodularity (80% vs 31%, P=0.0104). The interobserver agreements for insinuation, wall septation, and wall nodularity were moderate (K=0.57), very good (K=0.86), and good (K=0.66), respectively.

**CONCLUSION**

For the differentiation of metastatic lymphadenopathy from benign cystic lesion in the solitary cystic cervical mass at level II, the significant CT features were the absence of insinuation, nodularity, and septation of cyst wall, with moderate to very good interobserver agreement.

**KEY WORDS:** Cystic, metastasis, CT

**Scientific Poster 126**

**Congenital Infiltrating Lipomatosis of the Face with Unilateral Megalencephaly**

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**PURPOSE**

Congenital infiltrating lipomatosis of the face is a rare disorder, causing unilateral facial asymmetry characterized by enlargement of the cheek or chin. The case of congenital infiltrating lipomatosis of the face associated with unilateral megalencephaly presented here was diagnosed from CT and MR findings.

**MATERIALS & METHODS**

A 1.5-year-old boy presented with unilateral facial swelling since birth. Physical examination revealed a soft, immobile mass, which caused facial asymmetry in the left cheek and parotid region. The patient underwent MR and CT examination of face and brain.

**RESULTS**

MR imaging of the face showed a subcutaneous lesion containing fat on the left side of the face that was isointense to subcutaneous tissue on T1- and T2-weighted images, showed homogeneous signal suppression on fat-saturated sequence, and showed no contrast enhancement. In addition, MR revealed fatty infiltration in the left masseter muscle and left parotid gland. The CT images showed a homogeneous lesion with the density of fat that was not associated with osseous hypertrophy. An incisional biopsy of the lesion revealed mature lipocytes, and there was no evidence of any malignant cells. MR imaging of the brain showed enlargement of the left hemisphere, indistinct gray-white matter distinction, polymicrogyric appearance, and dysplastic deep white matter.

**CONCLUSION**

Cheek and face lesions containing fat should suggest the diagnosis of congenital infiltrating lipomatosis of the face in a young child. The association of congenital infiltrating lipomatosis of the face and intracranial anomalies has been reported. When the diagnosis of CILF is established, any associated megalencephaly should be evaluated.

**KEY WORDS:** Congenital infiltrating lipomatosis, unilateral megalencephaly, MR

**Scientific Poster 127**

**Correlation of MR Imaging and Electromyography Findings in Subjects with Clinical Brachial Plexopathy**

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**PURPOSE**

We retrospectively compared the MR imaging (MRI) findings of subjects with clinical brachial plexopathy to electromyography (EMG) results.

**MATERIALS & METHODS**

MR imaging and EMG of total 29 subjects with clinical brachial plexopathy were reviewed retrospectively and compared. Ages of subjects (15 female, 14 male) ranged from 8 days to 74 years old. MR imaging and EMG taken into consideration were performed within 3 months of each other. Brachial plexus MRI (1.5 T) were performed from C4 to T2 with sagittal T2-weighted images for cervical spine, pre and post-contrast fat saturated axial and coronal T1-weighted for brachial plexuses, axial T2-weighted through cervical spine for radiculopathy, spinal cord lesion and pseudomeningocele and 3D heavy T2-weighted for root avulsions and small sized pseudomeningocele. If there is a clinical suspicion of thoracic outlet syndrome, additional MR angiography and venography of subclavian vessels were obtained in abduction and if necessary in neutral positions. In electrophysiologic assessment, the muscles innervated by C5, C6, C7, C8, and T1 were evaluated by using standard needle EMG. Nerve conduction studies were performed at the same time. The brachial plexus lesion was grouped as upper trunk (C5, C6), middle trunk (C7) and lower trunk (C8, T1).

**RESULTS**

In each technique, results were regarded as positive if abnormal or negative if normal. EMG and MRI results regardless of positive or negative agreed in 22 of 29 subjects (75%). In all 29 subjects, EMG results were positive in 25 (86%) and negative in four whereas MRI results were positive in 19 (66%) and negative in 10. All 19 MRI positive subjects were EMG positive. However, among 25 EMG positive subjects, MRI positivity was observed in 19 (76%). In traumatic injury, most commonly in neonates and adolescent, MRI findings observed were asymmetric thickening and contrast enhancement of brachial plexus fibers, root avulsion, pseudomeningocele, and contrast enhancement at the root entry zone. Other MRI findings noted especially in middle and older ages were radiation plexopathy, diskopathy,
radiculopathy (chronic disk degeneration, foraminal disk extrusion, malign foraminal extraosseous infiltration), Chiari malformation with syringohydromyelia, thoracic outlet syndrome.

**CONCLUSION**

In brachial plexus lesions, EMG was reported as being more sensitive than MRI and EMG is successful in distal, whereas MRI is more successful in proximal lesions. In trauma cases, MRI showed mostly asymmetric thickening and contrast enhancement of nerve fibers. On the other hand, in these cases, EMG can give more specific localization about which trunk or cord is affected. Moreover, root avulsion and pseudomeningocele were only shown by MRI. Regarding radiculopathy, both techniques were successful in lesion localization although MRI can reveal the cause of radiculopathy whether it is osteophyte, extruded disk or extraosseous malign infiltration. In our study, among subjects with clinical brachial plexopathy, EMG positivity (86%) is higher than MRI positivity (65%) and EMG and MRG results regardless of positive or negative findings agreed in 75%. Electromyography is more successful in lesion localization and MRI is more valuable in lesion characterization. Overall, two studies should be regarded as complementary diagnostic modalities.

**KEY WORDS:** Brachial plexus lesions, MRI, electromyography

**Scientific Poster 128**

Retrospective Review of Tumors Involving the Clivus

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**PURPOSE**

Tumors of the clivus pose unique challenges to the skull base surgeon because of their precarious location. Imaging provides an invaluable tool for preoperative diagnosis and surgical planning. Therefore, any distinctive imaging features of clival tumors would prove useful to the surgeon. We retrospectively reviewed the CT and MR imaging features of these tumors in order to define distinguishing characteristics that would aid in diagnosis.

**MATERIALS & METHODS**

We retrospectively reviewed brain MR and CT images in 58 pathologically proved tumors involving the clivus. Lesion location, invasiveness, associated secondary effects, and imaging features were reviewed on T1-weighted, T2-weighted, and enhanced T1-weighted MR images and CT.

**RESULTS**

The most common tumors included meningioma, adenoma, chordoma, chondrosarcoma, metastasis, and squamous cell carcinoma. Meningioma and pituitary adenoma tended to invade the clivus from above. Isolated cases of schwannoma and cylindrical cell papilloma also were seen. Meningomas were homogeneously isointense on T1-weighted, hypointense on T2-weighted MR images and homogeneously hyperintense on enhanced T1-weighted images. On CT, meningiomas tended to be expansile and cause hyperostosis. Adenomas, although often quite large, arose in the sella. Although MR signal intensity varied, adenomas tended to heterogeneously enhance. On CT, adenomas were expansile with well-defined margins. Bilateral carotid encasement was common. The most common tumors arising in the clivus included chordoma, chondrosarcoma, and metastasis. Isolated cases of lymphoma, chordoblastoma, and plasmacytoma also were identified. The chordoma epicenter was in the midline. On MR imaging, chordomas demonstrated hypointensity on T1-weighted, and hyperintensity on T2-weighted images with heterogeneous enhancement. On CT, these tumors were expansile and lytic, often with a cauliflower or bubbly appearance. On MR imaging, chondrosarcomas demonstrated hypointensity on T1-weighted and hyperintensity on T2-weighted, images with enhancement. The epicenter of these tumors was off midline. Metastatic lesions had varying imaging features. Nasopharyngeal squamous cell carcinoma was the most common tumor to invade the clivus from below. An isolated case of spindle cell sarcoma was seen. Squamous cell carcinomas tend to have varying signal characteristics; however, their epicenter remained in the nasopharynx.

**CONCLUSION**

Tumors involving the clivus can be divided into three categories: tumors invading from above, invading from below, and arising in the clivus itself. Determining the epicenter of the tumor narrows the differential diagnosis. The most common tumors arising above the clivus are meningiomas and adenomas. Meningiomas have classic MR signal characteristics, and the presence of a dural tail and hyperostosis helps secure the diagnosis. Pituitary adenomas virtually always arise within the sella and frequently encase both carotid arteries. Chordoma, chondrosarcoma, and metastasis are difficult to differentiate radiographically. Location can help differentiate chordoma from chondrosarcoma given the typical midline location for chordomas. In our study, we found chordomas often had a bubbly appearance. Finally, the most common tumor invading the clivus from below is nasopharyngeal squamous cell carcinoma. Differentiating clivus tumors remains difficult solely with imaging, however attention to lesion site of origin and signal characteristics narrows the list of possible diagnoses.

**KEY WORDS:** Clivus, skull base, head and neck tumors

**Scientific Poster 129**

Get Rid of the Bone: CTA of the Head and Neck

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**PURPOSE**

Computed tomography angiography (CTA) is a well accepted imaging modality to evaluate the supraaortic vessels. Over-projection of bone may hamper easy and fast assessment of vessels. Different techniques (segmentation, rendering techniques with 1D and 2D transfer functions, image registration, and dual energy based algorithm) to suppress bone in the final CTA image will be discussed in this study.
**MATERIALS & METHODS**
Thirty patients underwent CT angiography of the head and neck on a dual source CT system. Different postprocessing techniques (segmentation, rendering techniques with 1D and 2D transfer functions, image registration, and dual energy based algorithm) were applied to remove bone from the final CTA images. Two examiners evaluated overall bone suppression and image quality regarding integrity of the vessel lumen of different vessel segments with a 5-point scale (1 = poor, 5 = excellent), CTA source data served as the reference. Wilcoxon signed rank test was used to determine differences between the techniques.

**RESULTS**
Both bone suppression techniques could be applied successfully in 25 patients. Segmentation procedures as well as rendering techniques with 1D and 2D transfer functions required most user interaction. Dual energy (DE) and image registration procedures (bone subtraction CTA, BSCTA) worked fully automated without additional user interaction and revealed highest image quality scores. Dual energy performed better in the vessel segment of the neck (external carotid artery, common carotid artery, V1-V3 segment of the vertebral artery, subclavian artery), whereas BSCTA was superior in the cranial vessels (C3-C6 segment of the internal carotid artery, ophthalmic artery). Vessel integrity was superior with BSCTA; the subclavian artery was truncated most frequently using DE postprocessing.

**CONCLUSION**
Dual energy and BSCTA are fully automated procedures to remove bone with high accuracy. The results of BSCTA are inversely related to the amount of motion between the nonenhanced and contrast-enhanced scan. Dual energy data are acquired during a single scan and therefore motion is of minor importance. Segmentation and rendering approaches require an experienced person to perform postprocessing.

**KEY WORDS:** CTA, carotid artery, bone removal

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**Scientific Poster 130**

In-Plane Bismuth Thyroid Shield Application During Neck MDCT Examination: Comparative Analysis of Radiation Dose, Attenuation and Noise Between Shielded and Unshielded Neck

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**PURPOSE**
To determine the diagnostic acceptability of in-plane bismuth thyroid shield by assessing the mean CT attenuation value, noise and radiation dose on shielded and unshielded neck CT.

**MATERIALS & METHODS**
Both phantom and human studies were performed. Eighty-four patients (M:F=41:43; mean age: 42.3 years ± 14.8) were randomized into the two groups depending on whether applying thyroid shield (AttenuRad, bismuth impregnated latex; F & L Products) on anterior neck or not. Thyroid shield covered the surface of neck with cotton spacer. Using a 64-slice scanner (Philips, Brilliance 64), same neck CT (64x0.625 mm; axial 3mm reconstruction interval;120 kVp and 250 mAs) protocols were performed with contrast material (350 mgI/ml) administered to right arm. On unshielded or shielded CT, we quantitatively analyzed the mean attenuation numbers and noises in a uniform region of interest (ROI) chosen in both superficial neck muscles of each patient. Radiation doses measured in five times by a 16cm diameter head CT dose phantom containing ionization chambers were averaged.

**RESULTS**
For shielded neck CT, mean CT attenuation values were increased significantly for both superficial neck muscles (P < .05), while noises were unaffected as compared with unshielded CT (P > .05). The phantom study demonstrated that use of shield over the neck significantly decreased radiation dose, up to 68.2% at 0 o'clock.

**CONCLUSION**
When applying in-plane bismuth thyroid shield on neck MDCT examination, erroneously increased CT attenuation could be possible in superficial neck structures.

**KEY WORDS:** CT, radiation dose

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**Scientific Poster 131**

Comparison of 25 and 40 Milliliters of Saline Flush in the Assessment of the Perivenous Artifacts on the Right Subclavian Vein in Cervicocranial Computed Tomography Angiography

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**PURPOSE**
To compare the qualitative and quantitative performance of the perivenous artifacts on the right subclavian vein in cervicocranial CT angiography (CTA) using two different volumes of saline flushing.

**MATERIALS & METHODS**
CT angiography ranging from the aortic arch (AA) to distal to the circle of Willis (cW) was performed on a 32-MDCT system. Fifty patients with the history of suspected atherosclerotic disease of the anterior or posterior circulation were the subjects. Patients received 40 ml of 370 mg I/ml contrast material (CM) at the flow rate of 4.0 ml/sec with venous access through the right antecubital vein were randomly divided into two groups: the first 25 patients received following 25 ml of saline flush (group A), and the other 25 patients received following 40 ml of saline flush (group B). Single level dynamic CT scans were performed with the tilted gantry parallel to the anterior skull base to calculate time to peak arterial enhancement at cW (Tc) using 20 ml of CM followed by 25 ml of saline flushing. Tc was measured as the largest value among the bilateral internal carotid arteries and vertebralbasilar artery. As scan speed was 96.9 mm/sec, scanning delay was decided individually as [(Tc+4) - scan dura-
tion between AA and cW]. Measurement of the mean arterial attenuation values along the z-axis at eight points in the carotid-cerebral artery (CCA) and at three points in the verteobasilar artery (VBA) were quantitatively conducted. Postprocessing images also were analyzed qualitatively, using 4-point scale. Measurement of mean venous attenuation values at four points including subclavian vein at the distal and proximal level, brachiocephalic vein, and superior venous cava (SVC) on the right side were performed. In addition, the degree of the perivenous artifacts on the right subclavian vein was assessed qualitatively, using 4-point scale.

RESULTS
Arterial attenuation profiles revealed maximum attenuation at the distal common carotid artery in both protocols. Although mean arterial attenuation of the CCA (404 ± 66 HU vs 400 ± 70 HU; p=0.82) and VBA (391 ± 73 HU vs 379 ± 63 HU, p=0.64) did not show differences between the group A and group B. Mean venous attenuation among the right subclavian vein and SVC was lower in group B than in group A (262 ± 297 HU vs 449 ± 459 HU; p=0.001). Although qualitative evaluation of the arterial images demonstrated no difference between the two protocols, that of the perivenous artifacts on the right subclavian vein were less prominent in group B.

CONCLUSION
We conclude that cervicocranial CTA in group B can achieve sufficient venous image quantitatively and qualitatively maintaining arterial image, compared to that in group A.

KEY WORDS: CT, angiography, saline

Scientific Poster 132
Doctor! Why is My Eye Getting Lower? Primary Osseous Lesions of the Orbit
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PURPOSE
With the exception of fibro-osseous lesions and intraosseous meningiomas, primary lesions of the bony orbit are distinctly uncommon in clinical practice. The purpose of this exhibit is to illustrate the diverse spectrum of primary osseous lesions of the orbit evaluated by CT and MR imaging with clinical photographs and histopathologic correlation.

MATERIALS & METHODS
We have compiled numerous representative cases from the teaching files of several academic institutions demonstrating the radiologic diversity of orbital osseous lesions with special emphasis on CT and MR imaging. Although imaging is often times diagnostic, nonspecific imaging findings need to be correlated clinically and/or histolopathologically in order to arrive at the proper diagnosis.

RESULTS
Primary osseous lesions of the orbital comprise a varied group of disease processes that can be classified into three main clinicopathologic categories. The first group demonstrates a slowly progressive course with symptoms primarily related to mass effect resulting in facial asymmetry and orbital dystopia. This group is best exemplified by benign fibro-osseous lesions such as fibrous dysplasia, ossifying fibromas, and osteomas, as well as intraosseous meningiomas. While these are the most common entities encountered in clinical practice, uncommon lesions, such as Engelmann's disease and osteopetrosis, also are showcased. Additionally, both vascular and proliferative lesions can display a benign presentation and also are reviewed, including hemolytic anemias, intraosseous hemangiomas, and Langerhans cell histiocytosis. The second group produces a somewhat subacute course that can be complicated by more acute mass effect and ocular displacement secondary to intralesional hemorrhage. This can be seen in reactive-type lesions such as cholesterol granulomas, aneurysmal bone cysts, and hematic cysts. The last group is associated with a rapidly progressive course with infiltrative features that result in pain, diminished motility, or optic nerve involvement. This is primarily seen in malignant neoplastic lesions such as osteosarcoma, chondrosarcoma, and Ewing's sarcoma. In this exhibit, we present cases from all three categories with emphasis on cross-sectional imaging, correlated with both clinical and intraoperative photographs. Appropriate histopathology images also are included.

CONCLUSION
The viewers of this exhibit will gain an appreciation for the wide radiographic spectrum of common and uncommon benign and malignant disease processes that affect the bony orbit. In the context of the three main clinical settings, radiologists may more accurately characterize the lesion and offer an appropriate differential diagnosis.

KEY WORDS: Orbit, bone, neoplasm
Scientific Poster 133

Gadolinium-Enhanced MR Imaging in the Assessment for Facial Nerve Involvement in Parotid Malignancy

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PURPOSE
To assess the efficacy of gadolinium contrast-enhanced MR imaging in the assessment of the facial nerve for perineural disease in patients with a pathologically proved primary or secondary parotid malignancy.

MATERIALS & METHODS
Approval for this retrospective study was obtained from the hospital's research ethics review board. The hospital's radiology information system (RIS) database was searched from the time period January 2001 to August 2008 to look for MRI studies that satisfied the inclusion criteria: All patients with a pathologically proved primary or secondary parotid malignancy that underwent contrast-enhanced MR imaging prior to radiation therapy and/or surgery (fine needle aspiration was excepted). The imaging studies were reviewed independently by two fellowship-trained neuroradiologists with expertise in head and neck oncology. The studies were assessed for the presence or absence of facial nerve enhancement and where present, the region(s) of nerve enhancement were recorded. Any discrepancies were resolved by consensus. Also recorded were the patient's age and sex as well as the tumor histology, the presence or absence of facial nerve symptoms and the presence of microscopic facial nerve perineural disease in those who eventually underwent surgical excision.

RESULTS
Eighty-six patients met the study inclusion criteria. There were 53 male and 33 female patients with an age range of 22-93 years with a median of 66 years. The number of cases that demonstrated facial nerve enhancement was 12/86 (14%). The pathology of these 12 cases was: 1 lymphoma, 4 squamous cell carcinoma, 1 melanoma, 1 adenoid cystic carcinoma, 1 Merkel cell carcinoma, 2 salivary duct carcinomas, 1 carcinoma ex-pleomorphic carcinoma and 1 poorly differentiated carcinoma. The locations of facial nerve enhancement in these 12 cases were: 3 canalicular, 5 mastoid, 1 showed enhancement from the geniculate region through to the mastoid segment, 1 showed enhancement from the geniculate region through to the parotid parenchyma and 2 showed enhancement from the canalicular portion through to the mastoid region. Of the 86 patients, 30/86 (34.8%) were noted to have facial nerve symptoms at the time of MR imaging. Of these 30 patients, 9/30 (30%) showed facial nerve enhancement on MR imaging while the remaining 21/30 (70%) did not. Fifty-eight patients eventually underwent surgical excision of the tumor and 31/58 of these patients had documented facial nerve perineural involvement on histology. There were 22 patients with facial nerve symptoms and histologic perineural disease and positive gadolinium nerve enhancement was only 4/22 (18%).

CONCLUSION
The presence of documented facial nerve enhancement in patients with a known parotid malignancy is important as it would guide the patient's treatment options. At this time, contrast-enhanced MR imaging is the best available imaging method to assess for such perineural disease. From this study, however, we conclude that the efficacy of MR imaging in detecting facial nerve disease is poor. In the absence of gadolinium nerve enhancement, treatment decisions for these patients will need to be based upon the histologic findings of facial nerve involvement, tumor histology and patient symptomatology.

KEY WORDS: Parotid, facial nerve, malignancy

Scientific Poster 134

Parapharyngeal Paragangliomas and Schwannomas: Growth Patterns Beyond Carotid Splaying

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PURPOSE
To retrospectively study and compare the typical and atypical growth patterns of parapharyngeal paragangliomas and schwannomas with clinical and surgical correlation.

MATERIALS & METHODS
Surgically proved cases of parapharyngeal (pre and poststyloid) space paragangliomas from 1997 through 2008. CT and/or MRI soft tissue neck exams reviewed by a neuroradiologist. Clinical presentation and operative report also reviewed. We introduce a new classification for carotid body tumors growth pattern based on mediolateral growth pattern as the tumor grows out of the carotid fork in contrast to the anterio-posterior growth pattern used by Shamblin et al. A straight line drawn from ECA to ICA at the level of maximum lateral transverse dimension of the tumor: Type A- no greater than 60% mediolateral tumor growth on any side of ECA-ICA line, Type B- greater than 60% but not more than 90% tumor growth outside the fork, Type C-10% or less of the tumor left in the fork and Type D- no tumor in the fork. According to this classification, paragangliomas which may extend to the fork, pertains to other parapharyngeal paragangliomas which may extend to the fork. Dominant growth pattern is medial (M) or lateral (L). Shamblin type also determined by imaging method (Arya et al). Rest of the tumors are classified based on caroticojugular displacement or splaying: Type S- splaying, typical for vagal tumors with oblique medio-lateral splaying, Type A- true anterior displacement, Type L or AL- typical for cervical sympathetic chain tumors, lateral or antero-lateral displacement, Type AM- anteriomedial caroticojugular displacement and Type P- typical for large prestyloid mass with posterior caroticojugular displacement.

RESULTS
A total of 27 cases. Twelve carotid body tumors with following growth patterns: 4 Type A (3 Shamblin type I and 1 Shamblin type III), 6 Type B- all medial (M) except one (L) (4 Shamblin type I and 1 type II) and 2 Type C- all medial
(all Shamblin type I). Fifteen noncarotid body tumors. Type S- 5 glomus vagale and 1 vagal schwannoma. Type A- a single case of vagal schwannoma. Type AL- 2 sympathetic plexus schwannomas, 3 sympathetic plexus paragangliomas. Type L- parapharyngeal schwannoma presumably of pharyngeal plexus origin. Type AM- parapharyngeal schwannoma of unknown origin. Type P- prestyloid trigeminal branch schwannoma. All the tumors were either incidental imaging findings or presented with palpable masses except each case of sympathetic plexus schwannoma and paraganglioma who presented with Horner's syndrome.

**CONCLUSION**
Mediolateral growth patterns of carotid body tumors is likely related to tumor size, arterial tortuosity and/or carotid body location variation. Growth pattern of rare sympathetic plexus paragangliomas is similar to sympathetic schwannomas. Vagal schwannoma may anteriorly displace rather than splay internal carotid artery and jugular vein. Unknown origin parapharyngeal schwannomas may represent origin from pharyngeal plexus or a major nerve branch.

**KEY WORDS:** Paragangliomas, schwannomas, carotid body tumors

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**Scientific Poster 135**

**Inter- and Intra-Observer Reliability for the Detection of Semicircular Canal Dehiscence with Multidetector CT**

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**PURPOSE**
Dehiscence of the superior semicircular canal is a recognized structural cause of vertigo. Patients may experience vertigo or oscillopsia in response to loud noises or stimuli that precipitate changes in middle ear or intracranial pressure. Utilizing a simple grading system, we aim to determine inter- and intra-observer agreement for the identification of semicircular canal (SCC) dehiscence with multidetector CT imaging of the temporal bone.

**MATERIALS & METHODS**
Sixty-five patients, imaged with multidetector CT of the temporal bone, were retrospectively enrolled into the study in a tertiary academic institution. Three neuroradiologists independently reviewed each randomized CT study in a blinded fashion, scoring individual SCCs and utilizing multiplanar reformations of the axial data set, including orthogonal and oblique, coronal and sagittal images. One reader assessed the studies on two separate occasions, with the subsequent repeat reading one month later. A four-level grading system was utilized to rate the osseous covering of each SCC: 1 = definitely intact, 2 = suspected intact, 3 = suspected dehiscent, 4 = definitely dehiscent. A random sample of 10 studies was initially reviewed by all readers with consensus reached regarding administration of the grading system. The kappa statistic and the Intraclass Correlation Coefficient (ICC) were utilized to determine inter-observer and intra-observer agreement.

**RESULTS**
There was a preponderance of females in the study group (36 of 65) and median patient age at CT of 53 (range, 23-86) years. Of the 130 temporal bones available for review, there had been unilateral temporal bone surgery in 19 cases, with 335 SCCs remaining for assessment. Imaging studies were performed as part of the routine investigation of a spectrum of neurotological pathologies and symptoms, including vertigo. Inter-and intra-observer weighted kappa and ICC values were excellent, between 0.96 and 0.98 for the superior SCC, 1.0 for posterior SCC, and between 0.99 and 1.0 for the lateral SCC. Twenty individual SCCs, 5.8% (20 of 335) were rated as ‘definitely dehiscent’ by at least one reader, with unanimous agreement in eighteen of these. There were 297 individual SCCs rated ‘definitely intact’ by at least one reader, with unanimous agreement in 99.3% (295 of 297).

**CONCLUSION**
With the utilization of a simple grading system, excellent inter- and intra-observer reliability for the identification of semicircular canal (SCC) dehiscence can be achieved with routine multidetector CT imaging of the temporal bone.

**KEY WORDS:** Temporal bone, semicircular canal, dehiscence

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**Scientific Poster 136**

**Withdrawn**

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**Scientific Poster 137**

**Use of High Resolution Dynamic CT Imaging (4DCT) to Guide Surgery in Patients with Prior Neck Dissection and Recurrent Hyperparathyroidism: Prospective Observational Single Institutional Experience**

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Charlottesville, VA

**PURPOSE**
In most patients (~85%), hyperparathyroidism results from a single parathyroid adenoma. Definitive treatment for hyperparathyroidism is surgical. Identification of the culprit gland(s) can be challenging with conventional imaging (ultrasound, sestamibi), particularly in patients with prior neck surgery. A relatively new technique, dynamic CT imaging (4D-CT) has shown promise for pre-operative planning; however, there is a lack of data demonstrating the utility of this technique in patients with prior (failed) neck dissections. We describe our experience demonstrating the clinical utility of 4D-CT for repeat surgical planning in patients with recurrent hyperparathyroidism with prior neck dissections.

**MATERIALS & METHODS**
All patients referred for 4D-CT are entered into a database including patient demographics, laboratory values, other imaging findings (including Sestamibi scanning), surgical findings, and pathologic data. Imaging parameters are performed as follows: Helical 0.625 mm axial images (reconstructed at 1.25 mm) are obtained from the skullbase to the
thoracic inlet prior to intravenous contrast material administration. Subsequent dynamic post-contrast imaging is performed through the neck, using a 25 cm field-of-view, with an identical acquisition to the non-contrast images at 25, 55, and 85 seconds following 120mL of contrast material administration.

RESULTS
To date, n=19 (M:F= 4:15; age= 59± 9 years) patients have been enrolled in our 4D-CT neck database. (Additional studies are being added at an increasing rate, currently approximately 3-4 patients per month). 79% (15/19) patients had prior neck dissections, 13 of which had Sestamibi scans. Sestamibi scans were negative/ndiagnostic in 46% (6/13). 4D-CT was positive in 85% (12/14); of these, 3 patients had multiple hyperfunctioning glands (25% of positive studies); 2 patients had hyperfunctioning tissue in the mediastinum (17%). 100% of repeat neck explorations (n=5) had pathologically confirmed hypercellular parathyroid tissue excised from the correlating area identified on 4D-CT. All patients intra-operative PTH fell >50%, allowing (with the findings on the scan) a more directed surgical approach. All patients had abnormal Ca+ and PTH levels pre-surgery that normalized after repeat surgery ([Ca+] 11.0 + 0.2 vs. 8.7 + 1.4, p = 0.007; ([PTH] 109 + 37 vs. 31 + 25, p = 0.005). The recurrent laryngeal nerve was undisturbed in all cases.

CONCLUSION
Conventional imaging is often nondiagnostic in patients with recurrent hyperparathyroidism after surgery which complicates management. Additionally, a high proportion of these patients have unusual variants such as multiple hyperfunctioning glands or mediastinal tissue. Use of 4D-CT guidance in patients with recurrent hyperparathyroidism allows targeted repeat neck dissection providing shorter surgical times, reduced morbidity, and definitive cure.

KEY WORDS: 4DCT, hyperparathyroidism

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**Table 1. Patterns of Hyperdensity**

<table>
<thead>
<tr>
<th>Hyperdensity Type</th>
<th>Frequency Postintervention</th>
</tr>
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<tbody>
<tr>
<td>None</td>
<td>3 (7.0%)</td>
</tr>
<tr>
<td>Enhancement</td>
<td>19 (44.2%)</td>
</tr>
<tr>
<td>Enhancement + Extravasation</td>
<td>4 (9.3%)</td>
</tr>
<tr>
<td>Enhancement + Hemorrhage</td>
<td>5 (11.6%)</td>
</tr>
<tr>
<td>Extravasation + Hemorrhage</td>
<td>9 (20.9%)</td>
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<tr>
<td>Hemorrhage</td>
<td>2 (4.7%)</td>
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<table>
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<tr>
<th>ASPECTS (mean±SD)</th>
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<tbody>
<tr>
<td>None</td>
<td>9.0 ± 1.0</td>
</tr>
<tr>
<td>Enhancement</td>
<td>5.8 ± 2.6</td>
</tr>
<tr>
<td>Enhancement + Extravasation</td>
<td>7.0 ± 1.6</td>
</tr>
<tr>
<td>Enhancement + Hemorrhage</td>
<td>7.2 ± 1.3</td>
</tr>
<tr>
<td>Extravasation + Hemorrhage</td>
<td>6.4 ± 2.2</td>
</tr>
<tr>
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<td>7.0</td>
</tr>
<tr>
<td>Hemorrhage</td>
<td>2.0 ± 5.5</td>
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</tbody>
</table>

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**Scientific Poster 138**

**Patterns of Hyperdensity on Noncontrast CT After IA Thrombolysis for Acute Ischemic Stroke**

Heran, M.1 Murphy, A.2

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**PURPOSE**
Noncontrast CT (NCCT) imaging is typically performed following IA thrombolysis treatment for acute ischemic stroke (AIS). Hyperdensity visualized on the postintervention NCCT may represent enhancement, extravasation, or hemorrhage. At present, the clinical significance of these changes remains unclear. Knowledge of typical patterns of hyperdensity on postintervention NCCTs may be important when investigating their prognostic significance. We describe patterns of hyperdensity seen on NCCT following IA thrombolysis in AIS patients treated at the Vancouver General Hospital.

**MATERIALS & METHODS**
Images were retrieved from the PACS archives for 48 patients who met the following criteria: (1) AIS in the anterior circulation; (2) treated with IA tissue plasminogen activator (tPA); (3) NCCT completed immediately after IA tPA (postintervention), and 24 hours after IA tPA. Postintervention NCCTs were examined by a staff neuroradiologist for patterns of hyperdensity. Patterns of hyperdensity were classified as enhancement (no hyperdensity present at 24 hours), extravasation (hyperdensity present at 24 hours >90 HU) or hemorrhage (hyperdensity present at 24 hours <90 HU). Hemorrhage was further classified according to the ECASS criteria (PH1, PH2, H11, or H12). The amount of hyperdensity change on postintervention NCCTs was quantified using the ASPECTS template. When present, the severity of contrast enhancement was described as either >1/3 MCA territory or <1/3 MCA territory. The location of hyperdensity was defined as Cortical (present anywhere in the cortical gray matter), or Deep (present in the basal ganglia or thalamus). Differences in ASPECTS scores between groups were determined with one-way ANOVA. Chi-squared analysis was used to determine differences between frequencies in patterns of location, hemorrhage type, and enhancement severity. Results were considered significant at p <0.05.

**RESULTS**
Hyperdensity was identified on 93% (40/43) of the postintervention NCCTs. Patterns of hyperdensity and postintervention ASPECTS values are shown in Table 1. There was no difference in ASPECTS scores between the groups (p <0.05). Enhancement was classified as Cortical, Deep, and both with similar frequency (p >0.05). Contrast enhancement was identified as <1/3 MCA territory more frequently than >1/3 MCA territory (p <0.05). All types of hemorrhage were seen with equal frequency, including PH1 (4/16, 25%), PH2 (2/16, 12.5%), H11 (5/, 31.3%), and H12 (5/, 31.3%) (p >0.05).

**Table 1. Patterns of Hyperdensity**

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</tr>
<tr>
<td>Hemorrhage</td>
<td>2 (4.7%)</td>
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</table>

**CONCLUSION**
Hyperdensity is a common finding on postintervention NCCTs. Most areas of hyperdensity represent contrast enhancement. Hemorrhage and extravasation are present to a lesser extent, with relatively similar frequencies, and usually in conjunction with contrast enhancement. We have identified common patterns of hyperdensity present on postintervention NCCTs after thrombolysis treatment for AIS. Future work is needed to determine the prognostic significance of these patterns in relation to patient outcome following AIS.

**KEY WORDS:** Thrombolysis, noncontrast CT
Management of Internal Carotid Occlusion in the Acute Ischemic Stroke Setting

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PURPOSE

This retrospective study was conducted in an attempt to statistically evaluate risks and benefits associated with stroke intervention in patients with internal carotid occlusion in acute ischemic strokes and provide useful information for the management decision-making process in such individuals.

MATERIALS & METHODS

From February 2002 to November 2008, 130 patients presented with acute stroke and internal carotid occlusion. One hundred twenty-five of these patients underwent intervention including angioplasty and stenting, recanalization by mechanical embolectomy, and emergent carotid endarterectomies. Five patients were managed conservatively. Adjunctive therapy with IV TPA and/or IA TPA was used within 8 hours of onset, in appropriately selected patients. In the 125 patients who underwent acute interventions, there were 76 males and 54 females aged 24 to 95 years (65). Postintervention noncontrast CT heads were done to diagnose secondary hemorrhages which were classified using ECASS I criteria. NIH stroke scale was used to monitor improvement.

RESULTS

Seventy of 130 patients underwent mechanical embolectomy using Concentric Merci retrieval devices. Recanalization with a TIMI score of IIb-III was achieved in 65.7%. Twenty-six of 70 had a drop in NIH score of ≥7 points, with a median decrease in NIH score of 7.5 among 45 surviving patients. Forty of 130 patients underwent angioplasty and stenting followed by mechanical embolectomy using Concentric Merci retrieval devices. Recanalization with a TIMI score of IIb-III was achieved in 62.5%. Sixteen of 40 had a drop in NIH score of ≥7 points, with a median decrease in NIH score of seven among 34 surviving patients. Six of 130 patients underwent angioplasty and stenting. Recanalization with a TIMI score of IIb-III was achieved in 83.3%. Two of six had a drop in NIH score of ≥7 points, with average decrease in NIH score of eight among four surviving patients. Nine of 130 patients underwent emergent carotid endarterectomies. Postprocedure arteriography was not performed to assign TIMI scores. All patients having this procedure survived with a median decrease in NIH score of three. Rates of recanalization, secondary hemorrhages, NIH scores, and mortality as well as adjunctive therapy is summarized in Figure 1.

CONCLUSION

Various options are available in the acute ischemic stroke setting in patients presenting with internal carotid occlusions. Revascularization of acute carotid occlusions in the stroke setting is technically feasible and potentially of great benefit, and is up to the clinician and radiologist to recognize when indicated based on individual case presentations.

KEY WORDS: Carotid, merci

Scientific Poster 140

Endovascular Clot Retrieval and Disruption with the Use of MERCI Retrieval Device in Patients with Vertebrobasilar Territory Acute Ischemic Stroke

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PURPOSE

Vertebrobasilar territory stenosis and thrombosis can evoke serious damages including ischemic stroke. We report our experience of endovascular clot retrieval and disruption with the use of MERCI retrieval device in patients with vertebrobasilar territory acute ischemic stroke.

MATERIALS & METHODS

Ten patients (6 men) between the ages of 22 and 85 years (mean 57.2) with symptoms compatible with acute stroke of vertebrobasilar territory underwent clot retrieval by means of MERCI retrieval device with or without intravenous and/or intraarterial TPA. One patient presented with clot in both vertebral arteries and another patient developed stroke after CGD coiling for subarachnoid hemorrhage. Seven patients (70%) received TPA. Out of these seven patients two patients (28.5%) received only intravenous TPA in emergency room, two patients (28.5%) received both intravenous and intraarterial TPA, and remaining three patients (42.85%) received intraarterial TPA after clot retrieval mostly in the distal territory. Seven out of ten patients (70%) were intervened with L6 device, and rest of the patients (10%) were intervened with L5, LX, and X5 devices respectively. The balloon guide catheter was placed in the subclavian artery and was inflated during clot retrieval for flow arrest. All cases were assessed for complaints, neurologic deficit, initial NIH score, VBI signs, and their alteration after the
procedure by the neurologist. Outcomes were measured with (1) improvement in NIH score (2) technical success (3) post-procedural complications.

**RESULTS**

Initial technical success was achieved in 50% of the cases. In two patients (20%) only partial retrieval was done. There were no significant postprocedural complications except for one patient (10%) who came up with small perforation. Four patients (40%) with NIH scores ranging from 22 to 37 (mean 28.75) expired. Out of these four patients one patient died due to aggravation of subarachnoid hemorrhage, another patient died of pontine hemorrhage, and two patients died of stroke complications. Six patients (60%) with NIH scores ranging from 4 to 33 (mean 19.83) showed profound improvement in their NIH scores that dropped down to a range of 0 to 10 (mean 3.11) and in clinical status at the time of discharge.

**CONCLUSION**

Vertebrobasilar endovascular intervention and treatment with MERCI retrieval device along with intravenous and/or intraarterial TPA appears to be effective for patients with respective territory acute stroke and shows favorable outcome.

**KEY WORDS:** Interventional, radiology

**Scientific Poster 141**

**Spontaneous Intracranial Carotid Dissection in Pediatric Patients: A Pictorial Review of Two Cases**

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**PURPOSE**

We present two cases of spontaneous intracranial arterial dissection in pediatric patients who were admitted with symptoms of acute ischemic stroke. Although spontaneous intracranial carotid dissection is rare in the pediatric population, certain conditions such as antecedent trauma or a history of connective tissue disorder should prompt investigation for intracranial dissection as a cause of neurologic symptoms.

**MATERIALS & METHODS**

Two pediatric patients, a 16-year-old male and 15-year-old female presented to the emergency department with acute onset of hemiplegia. Both patients underwent noncontrast brain computed tomography, MR imaging and CT angiography. Both patients went on to conventional angiography which showed areas of irregularity and occlusive changes at the carotid terminus extending into the A1 and M1 segments.

**RESULTS**

Imaging findings in these two pediatric patients showed tapered luminal narrowing and occlusive changes of the carotid terminus extending into the A1 and M1 segments. Findings of fibromuscular dysplasia also were seen on the angiogram of the 15-year-old female patient. On conventional angiography, differential opacification of peripheral MCA branches could be seen with filling of both true and false lumens on sequential injections.

**CONCLUSION**

We offer a pictorial display of two cases of spontaneous intracranial carotid dissection in pediatric patients. Although rare and therefore unsuspected on initial cross-sectional and multiplanar imaging, conventional angiography was able to demonstrate differential filling of peripheral MCA branches based on inadvertent injection of both true and false lumens on sequential runs.

**KEY WORDS:** Spontaneous intracranial carotid dissection, pediatric, stroke

**Scientific Poster 142**

**Experience of Successful Recanalization of M2 Segment and Distal Branches of the Middle Cerebral Artery with the Help of MERCI Retrieval Device Along with Intravenous and/or Intraarterial Tissue Plasminogen Activator**

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**PURPOSE**

Recanalization of M2 segment and distal branches of the middle cerebral artery is sometimes difficult with administration of tissue plasminogen activator and the success rate is approximately 15% to 20%. We advocate our experience of combination therapy for the recanalization of M2 segment and distal branches of the middle cerebral artery with administration of intravenous and/or intraarterial tissue plasminogen activator as well as endovascular clot retrieval and/or disruption with the use of MERCI retrieval device.

**MATERIALS & METHODS**

Forty-two patients (21 men) and (21 women) aged from 18 to 93 years (mean 71.2) with symptoms compatible with middle cerebral artery stroke underwent clot retrieval and/or disruption with MERCI retrieval device with or without intravenous and/or intraarterial TPA. NIH scores of these patients at the time of presentation were between 6 and 37 (mean 19.07). Thirty-nine patients (92.85%) were treated with clot in M2 segment and three patients (7.14%) were treated with clot in M2 segment extended up to M3 segment. Thirty-five patients (83.33%) received TPA. Out of these 35 patients four patients (11.42%) received only intravenous TPA in emergency room, 11 patients (31.42%) received both intravenous and intraarterial TPA, and 20 patients (57.14%) received intraarterial TPA during the procedure. Initial TIMI scores (reperfusion scoring system) between TIMI 0 and TIMI 1 (mean 0.047) were noticed in these patients before recanalization. Following devices were used for clot retrieval and disruption: X5 in four patients (9.52%), X6 in 11 patients (26.19%), LX in six patients (14.28%), L4 in one patient (2.38%), L5 in two patients (4.76%), L6 in five patients (11.90%), KMINI in 11 patients (26.19%), V2.5 in one patient (2.38%), and V2.0 in one patient (2.38%). All
cases were assessed for complaints, neurologic deficit, initial NIH score, MCA stroke signs, and their alteration after the procedure. Outcome measures were assessed with (1) improvement in NIH score (2) step up in TIMI reperfusion scoring (3) postprocedural complications.

RESULTS
All of the forty-two patients were followed by the neurologist. NIH scores (mean 19.07) of these patients before the procedure came down between 0 and 27 (mean 8.35). TIMI score of these patients changed from TIMI 0 and TIMI I (mean 0.047) to TIMI I and TIMI III (mean 1.97). Five patients (11.9%) developed postprocedural complications. Two out of these five patients developed subarachnoid hemorrhage without any neurologic deficit, one patient developed small parenchymal hemorrhage and the remaining two patients developed petechial hemorrhage.

CONCLUSION
Our observation of forty-two patients reveals that combination therapy with TPA and MERCI retrieval device for the acute thrombosis of M2 segment of the middle cerebral artery is not only technically feasible but also can demonstrate promising results. However, further studies are required to determine the safety and recanalization rates of this therapy.

KEY WORDS: Interventional, radiology

Scientific Poster 143

Intracranial Catheterization Using a Sacral Hiatus Access as an Alternative for Percutaneous Intraspinal Navigation: A Study in Cadavers

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PURPOSE
Intraspinal navigation with catheters and fiberscopes has shown feasible results for diagnosis and treatment of intraspinal and intracranial lesions. The most common approach, lumbar puncture, has allowed access to the spinal cord. This approach, however, comes with the difficulties of fiberscope damage and decreased torque for guidance. Our objective in this study is to demonstrate an alternate access, the sacral hiatus, into the subarachnoid and intracranial structures, with decreasing the angle of entry and improving the torque.

MATERIALS & METHODS
Catheters with guidewires were advanced with fluoroscopy assistance into the sacral hiatus of three cadavers. After entry, the thecal sac was punctured and the catheter with guidewire was advanced rostrally until positioned in the basal cisterns of the brain. We confirmed catheter placement with contrast injection followed by autopsy confirmation.

RESULTS
In our study the sacral hiatus was accessed easily, but resistance was found when attempting to puncture the thecal sac. The advancement of the catheter with guidewire assistance glided easily rostrally until mild resistance was discovered at entry into the foramen magnum. With redirection, all catheters passed with ease into the basal cisterns. Positioning was confirmed with contrast injection of fluoroscopy evidence and direct visualization at autopsy. There was no macroscopic evidence of damage to the spinal roots, spinal cord, or cranial nerves.
CONCLUSION
The sacral hiatus with guidewire assistance is an accessible conduit for uncomplicated entry into the subarachnoid and basal cistern space without damaging surrounding structures.

KEY WORDS: Percutaneous intraspinal navigation, sacral hiatus, access

Scientific Poster 144
Endovascular Stent Placement for Extracranial Carotid Artery Dissection

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PURPOSE
To describe the indications for, technique and outcome of endovascular stent placement for dissection injuries of the extracranial carotid artery.

MATERIALS & METHODS
We performed an IRB approved retrospective review of all cases undergoing extracranial carotid stenting for dissection at two institutions.

RESULTS
Over a 3-year period, 11 patients underwent stenting for 12 extracranial carotid dissection injuries (one bilateral). Mean age was 45 years with M:F ratio of 7:4. The etiology included trauma (n = 5), iatrogenic (n = 1) and idiopathic (n = 5). Five patients underwent stenting for vascular recanalization in the setting of acute stroke. In six patients, stents were placed across the necks of seven symptomatic pseudoaneurysms and in another patient an iatrogenic dissection was stented immediately after coiling a ruptured cerebral aneurysm. Anticoagulation and antiplatelet regimens varied—standard 5 day dual antiplatelet medication and procedural heparinization was employed for subacute cases, whereas a “crash” antiplatelet loading strategy was used in emergencies and tailored to the patient’s relative risk of hemorrhage during or after the procedure. During follow up, one patient with a lesion treated by three overlapping fenestrated stents, had in-stent thrombosis several months posttreatment and there were two documented cases of in-stent stenosis, one involving a fenestrated and the other a covered stent. None of these patients were symptomatic. Of the seven pseudoaneurysms that were stented, two persisted (1 fenestrated, 1 covered stent), two improved (1 fenestrated, 1 covered stent) and three resolved (2 fenestrated, 1 covered). All cases of pseudoaneurysm-related pain resolved but one case of Horner’s syndrome failed to improve.

CONCLUSION
As therapeutic anticoagulation is an effective conservative treatment for most extracranial carotid dissection injuries, our cases were mainly restricted to acute strokes or symptomatic pseudoaneurysms. These lesions can be treated effectively and safely by stenting including in emergency settings if there is effective loading of antiplatelet medication.

KEY WORDS: Carotid, dissection, stent

Scientific Poster 145
Preliminary Study for Optical Analysis for Detecting Vulnerable Plaques Using an Animal Model

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There is increasing recognition of the importance of vulnerable plaque from acute plaque rupture leading to thrombosis, in carotid artery stent placement for patients with carotid artery stenosis. This is fueling a number of developments, including novel imaging modalities. Current clinical techniques (MRI, ultrasound, CT) are limited in their ability to characterize lesion composition and identify lipid-rich lesions. The purpose of this research was to investigate the use of optical methods (Time-Resolved Laser-Induced Fluorescence Spectroscopy; TR-LIFS) and reflection spectroscopy; RS) as a diagnostic tool for assessment of vulnerable atherosclerotic lesions, using a rabbit model of vulnerable plaque. The TR-LIFS method revealed to be a difference of peak levels between normal aorta and lipid-rich aorta. These methods can be used to help diagnosis of vulnerable plaques.

KEY WORDS: Vulnerable plaque, optical analysis
**Scientific Poster 146**

Endovascular Treatment of PTEN-Associated Vascular Anomalies Can Be Augmented by Antiangiogenic Therapy with Thalidomide and Celebrex

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**PURPOSE**

Treatment of vascular malformations consists largely of endovascular therapy (embolization or sclerotherapy) and/or surgery. Traditionally, they have not been thought to be amenable to medical therapy because, unlike tumors, their rate of growth is balanced with the rate of apoptosis for prolonged periods of time. However, vascular malformations can actively proliferate following trauma, during puberty or pregnancy, or following a procedure. Malformations occurring on the background of PTEN mutation are particularly prone to aggressive regrowth. We have examined whether adjuvant antiangiogenic therapy may ameliorate regrowth following surgical or endovascular procedures.

**MATERIALS & METHODS**

Consecutive patients who presented to Vascular Anomalies Center at Children's Hospital in Boston with progressive and recurrent PTEN-associated vascular anomalies were treated with thalidomide 3-23 mg/kg (max 1000 mg daily) and Celebrex 100 mg PO BID (200 mg PO BID if over 20 kg) for a minimum of 6 months, while undergoing interventions. Out of the four, one had a facial lesion, one had upper arm lesion and two had lower extremity lesions. One of the lower extremity lesions extended into the pelvis. All patients were seen monthly by the oncologist for evaluation of side effects and modification of therapy. Clinical and radiologic reevaluation was done using serial angiography and/or non-invasive imaging, such as MR or CT scan every 6 months.

**RESULTS**

All four patients with PTEN-associated lesions were treated with thalidomide/celebrex for a minimum of 6 months. All patients responded with a varying degree of regression in tumor size and significant improvement in pain and physical activity. One of the children, a nine-year-old girl, had a significant improvement in pain, physical activity and mass regression, and never required surgery or an endovascular procedure. This clinical improvement corresponded with radiologic improvement at 12 months. She continues on maintenance daily antiangiogenic therapy. In all four patients, serial angiographies and/or MR images with gadolinium demonstrated stability or decrease in the size and enhancement pattern of the PTEN-associated vascular lesions over time.

**CONCLUSION**

Thalidomide and Celebrex can be used successfully as adjuvant medical therapy in combination with endovascular management of PTEN-associated vascular anomalies. In some cases, where diagnosis is made early, initiation of this therapy may avoid the need for endovascular intervention altogether. For most children with unmanageable PTEN-associated vascular anomalies such as those typical for Bannayan-Riley-Ruvalcaba/Cowden syndrome, thalidomide/celebrex may reduce the number of interventions.

**KEY WORDS:** PTEN-associated vascular anomalies, endovascular treatment, antiangiogenic therapy

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**Scientific Poster 147**

Application of 64-Detector CT Angiography for the Planning of Neurointerventional Treatment of Direct Carotid-Cavernous Fistulae

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**PURPOSE**

To evaluate the impact of CT angiography (CTA) images prior to the embolization procedure of the direct carotid-cavernous fistulae (CCF).

**MATERIALS & METHODS**

During April 2007 to November 2008, we obtained 64-detector CTA in 11 cases of direct CCF before neurointerventional procedure. Using the information from CTA source image, multiplanar reformation, and volume rendering images, we analyzed and tried to identify the size and location of fistulae, the origin of dangerous venous drainage, the compartments of the cavernous sinus, and to plan the possible venous approach route. The subsequent embolization procedure was performed according to the above information.

**RESULTS**

The orientation and size of all fistulae could be clearly demonstrated in CTA images, the compartments of cavernous sinus, the origins of dangerous drainage into cavernous sinus, and the possible venous approach route could all be depicted by using different reconstruction techniques. This information is useful in coil size selection and embolization strategy determination. Optimal embolization results were achieved in all cases.

**CONCLUSION**

CT angiography is a less invasive and useful image modality to detect and demonstrate the details of the carotid-cavernous fistula, adjacent cavernous sinus and related venous structure. All of this information is important and valuable for preembolization procedure planning.

**KEY WORDS:** Carotid-cavernous fistulae, CT angiography, neurointerventional
Scientific Poster 148

Transcatheter Onyx Embolization for Brain Arteriovenous Malformation: A Single Community Center Report

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PURPOSE

Onyx is newly approved liquid embolic agent for the presurgical embolization of intracranial arteriovenous malformations (AVMs). We present our clinical experience at a single community center. The clinical presentation is usually intracranial hemorrhage, headache, seizure, and progressive neurologic deterioration.

MATERIALS & METHODS

A retrospective review of 11 patients (7 male, 4 female) who underwent transcathether embolization of the brain AVM with a new liquid embolic agents (Onyx) from October 2005 to November 2008. The mean age was 42.4 years, range between 12-65 years. four patients presented with hemorrhage, five with seizure, 10 with headache, one with progressive neurologic deterioration and one with visual disturbance. The mean Spetzler grade was III (range I-V) with mean diameter of 3.22 cm (range 2- 4.67 cm). The mean clinical follow up was 7.7 months (range 0-18 months). In all cases we used microcatheter with Marathon but ultraflow in one case. Onyx-18/Onyx-34 was used for embolization of AVM under general anesthesia and systemic heparinization.

RESULTS

A total of 17 procedures were performed in 11 patients. Three patients (27.3%) were angiographically cured with embolization alone. Two patients (18.2%) were cured with subsequent surgery. One patient (9%) underwent subsequent gamma knife radiosurgery. We were unable to treat one patient due to inability to access the target pedicle. Three patients did not undergo any further treatment. One patient is still undergoing treatment. Complications occurred in two patients who had small hemorrhage secondary to vessel ruptured causing ischemic symptoms but completely recovery. One patient had surgery to remove residual nidus and retained catheter. There was no death from Onyx embolization.

CONCLUSION

Onyx is a feasible, relatively safe liquid embolic agent for treatment of brain arteriovenous malformations and permits controlled penetration into the nidus.

KEY WORDS: Malformation, onyx

Scientific Poster 149

Mind the Gap: Experimental Consideration of the Radiolucent Gap (“White-Collar Sign”) in Brain Aneurysm Embolization

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PURPOSE

The radiolucent gap (also known as the “white collar” sign) is defined as the narrow and abrupt band between an embolized aneurysm and a contrast-filled vessel during angiography that appears to have lower x-ray attenuation than the coil mass. This gap is assumed to represent a layer of tissue growth that would signify a complete cure of the aneurysm. The gap has been observed following embolization of aneurysms using both PGLA or PGA “bioactive coils” and bare platinum coils. In the absence of clinical evidence that “bioactive coils” offer improved efficacy, the presence of the gap is used to demonstrate superior healing of the aneurysm. In this work, simple in vitro and in vivo experiments are described to investigate the physical origin of the “white collar” sign.

MATERIALS & METHODS

A phantom containing a platinum embolic coil and a tube of iohinated contrast material (250 mg/ml) immersed in water was imaged using a flat panel x-ray angiography system. With a constant source-to-detector distance, of 120cm the object (e.g., table height) was moved from the detector towards the source in seven different positions through a total travel of 25 cm. All other imaging parameters were maintained constant (e.g., 80 kVp). In a separate experiment, a venous pouch aneurysm was constructed surgically in the common carotid artery of a pig and immediately embolized with coils. Following complete packing of the aneurysm, control angiograms were acquired in a similar fashion as described above in the in vitro experiment. Briefly, the pig was moved at various intervals from the source to the detector, and at each location angiography was performed.

RESULTS

The presence of a radiolucent gap was prominent in the above-described phantom immediately adjacent to both sides of the embolic coil (Figure). The size and contrast gradient of the gap diminished as the object moved away from the detector. A more pronounced radiolucent gap was observed adjacent to the coil mass of the pig aneurysm. However, this halo disappeared on DSA. A possible explanation for these observations is the well known “smoke-ring” effect that may be produced by small angle forward scattering of x-rays as a result of abrupt changes in the coil tissue region.
CONCLUSION
Our experiments demonstrate that one should “mind the gap” with regard to assuming complete cure following coil embolization of cerebral aneurysms. Further mechanisms of the experimentally observed phenomenon currently are being investigated.

KEY WORDS: White collar, coil embolization, aneurysm

Scientific Poster 150

Alternative Option in the Treatment of Very Small Ruptured Intracranial Aneurysms

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PURPOSE
To evaluate the safety and protective effect of relative undersized coil with loose coil core in the clinical dilemma condition, very small (<3.0 mm) ruptured intracranial aneurysm.

MATERIALS & METHODS
We studied 12 patients (4 males, 8 females) who had suffered from acute ruptured small intracranial aneurysms (2-3 mm in size, with SAH presentation). All subjects underwent a single coil embolization procedure. An under-sized coil (equivalent to the neck size or 0.5 mm smaller than the aneurysm diameter) was chosen as the embolizer. Based on the postembolization angiogram, subjects were divided into two groups. One was labeled as the initial complete obliteration group (NR: nonresidual group) and the other as the incomplete obliteration group (SR: small residual group). Fisher’s exact test and the Wilcoxon rank sum test were used for statistical analysis.

RESULTS
The technical success rate was 100% without any procedure-related complication. The follow-up interval ranged from 6 to 32 months. No episode of rebleeding or coil migration could be defined in the admisive and following period. Loose coil core were seen in all patients. The total recurrent rate was 8.3% (1/12). Only one patient suffered from recurrent lesion in SR group.

CONCLUSION
The preliminary result showed that under-sized coil packing with loose coil core could provide the protective effect and prevent further rebleeding for very small ruptured aneurysms. It should be considered as an alternative option in the treatment of acute ruptured very small aneurysms when other conventional strategies are not feasible.

KEY WORDS: Aneurysm, under-sized coil

Scientific Poster 151

Thromboembolic Events Associated with Balloon-Assisted Coil Embolization for Cerebral Aneurysms: Retrospective Case Series

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PURPOSE
Theoretically, the use of balloon-assisted technique (BAT) increases procedural complexity and could raise the risk of thromboembolic complications in coil embolization. The purpose of this study was to evaluate the frequency of thromboembolic events resulting from coil treatment by using MR diffusion-weighted imaging (DWI). Additionally we analyzed the inducible risk factors for the development of thromboembolism after these procedures.

MATERIALS & METHODS
We retrospectively reviewed all aneurysm cases treated with coil insertion in the last 5 years. This consisted of 140 aneurysm coil treatment procedures. Seventy-six of these procedures were not included due to the absence of postprocedure MR imaging, leaving 64 cases (44 ruptured and 20 unruptured). The patients’ demographic characteristics were documented and records were reviewed for abnormalities on postprocedure DWI. In addition we attempted to determine whether any anatomical or technical factor contributed to an increased risk of thromboembolic events during these procedures. Logistic regression modeling was used to determine independent predictors of DWI abnormalities after procedure. For this model, we controlled for the following risk factors by including them: patient age, presentation, aneurysm location (anterior versus posterior circulation), size of the dome, size of the neck, number of coils placed, use of BAT, postprocedure anticoagulation, and volume embolization ratio (VER).
Small DWI abnormalities were present in the treated vascular territory in 31 (48%) of 64 patients. The hyperintense lesions were detected at 61% after the procedure with BAT, which was significantly more frequent than with the simple procedure (39%) by multivariate analysis (odds ratio: 8.353, 95% confidence interval: 1.075 - 64.922). Neither presentation nor postprocedure anticoagulation regimen affected the presence of DWI abnormality.

CONCLUSION
Almost 50% of endovascular procedures are associated with DWI high signal intensity lesions and BAT was a significant risk factor. We noted a strong trend towards an increase in frequency of DWI abnormalities in patients treated for wide or large sized aneurysms, though there could be some statistical biases from BAT. There was no case of persistent neurologic deficits caused by thromboembolic event due to coil embolization with BAT. These findings manifested that BAT is acceptable as an adjuvant technique for aneurysm treatment.

KEY WORDS: Coil embolization, balloon-assisted technique, diffusion-weighted images

Scientific Poster 152
CT and MR Imaging Findings Following Neurointerventional Procedures: What the Neuroradiologist Should Know and Is Afraid to Ask the Neurointerventionalist

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PURPOSE
The purpose of this pictorial presentation is to describe and illustrate the various CT and MR imaging finding in patients who have undergone endovascular brain and spine interventions. Endovascular treatment for cerebrovascular disease has undergone major developments over the last 2 decades. Cerebral neuroradiological procedures include acute stroke therapy, aneurysm coiling, intracranial angioplasty and stenting, as well as AVM and tumor embolization. Patients treated by neurointerventionalists often suffer from co-morbid diseases and are critically ill. Imaging often is required for appropriate follow up and performed frequently. Endovascular interventions can result in significant complications including vessel perforation, thrombosis or distal embolic ischemic events. Imaging studies post interventional procedures often focused on diagnosing new ischemic lesions on diffusion imaging. There are expected imaging findings following any procedure. These stem from the use of iodinated contrast and device materials used during the procedure. It is important for diagnostic neuroradiologists to differentiate those expected postprocedure changes from postprocedure complications in order to avoid unnecessary interventions and misdiagnosis.

MATERIALS & METHODS
Retrospective review of CT and MR imaging studies performed following endovascular brain and spine interventions in the last 3 years. Categorization of imaging findings according to procedure type, immediate and late postprocedural findings and imaging findings implying complications. The study protocol was approved by the institutional IRB who waived the requirement for informed consent.

RESULTS
Following stroke interventions, a common imaging finding is contrast material staining the injured brain parenchyma. This simply represents stagnant contrast in slow flowing and occluded vessels. If the patient is imaged immediately following the procedure, contrast material might still be present within cerebral vasculature and should not be mistaken for pathologic conditions such as parenchymal hemorrhage or intraarterial thrombus. Embolization material following AVM or tumor treatment is found within the vessels supplying the abnormality. Neuroradiologists should be familiar with the vascular supply pattern of different vascular malformations and tumors and correctly identify the embolization material. The coil pack following endovascular aneurysm treatment should be confined to the aneurysm lumen. Coil packs should be assessed for coil migration and compaction. The imaging findings following emergency treatment after spontaneous subarachnoid hemorrhage are complex and include findings related to disease course and evolution, complications and treatment effects. On follow-up studies, assessment for aneurysm remnant or recurrence is essential. Stent placement either in the venous or arterial system should be assessed for stent patency, fracture and correct deployment position.

CONCLUSION
Endovascular brain and spine interventional procedures are commonplace and are growing in frequency and complexity. It is essential that diagnostic neuroradiologists are familiar with the different procedure types and the expected postprocedural imaging findings. Differentiating between complications and postprocedural findings is critical. This pictorial presentation highlights those finding, as well as presenting a neurointerventional perspective in assessing postprocedural studies.

KEY WORDS: Interventional neuroradiology, CT

Scientific Poster 153
Dose Response Study of Intra-Arterial Plasmin to Recanalize the Thrombo-Occluded Rabbit Middle Cerebral Artery

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PURPOSE
Timely arterial recanalization is a major determinant of clinical outcome for thrombolytic treatment of patients with acute ischemic stroke. We report the recanalization efficacy
of a direct-acting fibrinolytic agent, plasmin, administered by intra-arterial (IA) infusion in an animal model of selective middle cerebral artery (MCA) occlusion.

**MATERIALS & METHODS**

After femoral artery cut-down, a microcatheter was advanced via the internal carotid artery (ICA) to the MCA. The MCA was occluded by IA infusion of a thrombin:thromboplastin mixture. Stable occlusion was documented by real time cerebral artery angiography 2 hours later. Plasmin at doses of 1, 2 and 3 mg or saline (3 animals each) was infused into the MCA and recanalization was assessed by follow-up angiography.

**RESULTS**

The terminal ICA was catheterized and the MCA occluded by thrombin in all 12 animals. Angiography at 2 hours showed no spontaneous MCA recanalization. After IA plasmin administration into the MCA, recanalization was documented on the first angiogram performed after infusion. Mean delay after IA plasmin infusion until MCA recanalization was 23, 22 and 21 minutes after starting plasmin, and 7, 6 and 11 minutes after completing the 1, 2 and 3 mg plasmin dosages, respectively. None of the saline-treated animals showed MCA recanalization.

**CONCLUSION**

IA plasmin is an effective thrombolytic agent for recanalization of the thrombo-occluded MCA in an experimental animal model. These results are relevant for treating human MCA ischemic stroke, although further study is needed to optimize the dose and infusion rate of IA plasmin.

**KEY WORDS:** Thrombolysis, animal model, stroke

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**Scientific Poster 154**

**Stent for Symptomatic Atherosclerotic Intracranial Stenosis: A Single Center Study from China**

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**PURPOSE**

Intracranial atherosclerotic stenosis (≥70%) bears a high risk for stroke independent of medicinal treatment. This study was aimed to evaluate the safety and efficacy of angiography and stenting in treating severe symptomatic intracranial atherosclerotic stenosis.

**MATERIALS & METHODS**

Forty-two patients with intracranial atherosclerotic stenosis (≥70%) were treated with angioplasty and stenting. All patients had ischemic stroke and/or TIA associated with severe intracranial stenosis (≥70%).

**RESULTS**

The rates of pretreated stenosis (79.4% ± 10.1%, mean ± SD) compared with residual stenosis (3.0% ± 0%) presented a statistical significant difference (P<0.001). The stent success ratio was 40/42 (95.2%), the total rate of intracranial procedure success was 81.0% (34/42), the complication of intracranial stenting was 6 (6/40, 15.0%, 4 cerebral hemorrhage and 2 cerebral infarction), one patient (stented at Basilar artery) was died of brainstem infarction (mortality rate 2.5%, 1/40). During 12 months follow-up, the restenosis was observed in 2 of 18 patients (11.1%), the recurrence of stroke was 2.5% (1/40) after stenting. Six of 8 lesions (75.0%) were successfully treated with Wingspan stent, 28 of 32 lesions (87.5%) with Balloon-mounted stent (AVE, Medtronic; INVASTENT VOLO, Invatec). The contrast between the Wingspan stent and the Balloon expandable stent about the procedure success did not present statistical significance (χ²=0.78, P>0.05).

**CONCLUSION**

Intracranial angioplasty and stenting can be performed with a high rate of technical success. Stenting treated patients reduce their risk for future stroke.

**KEY WORDS:** Atherosclerosis, Intracranial stenosis, Stent

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**Scientific Poster 155**

**Intra-Sinus Catheter-Directed Heparin in the Treatment of Dural Venous Sinus Thrombosis**

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**PURPOSE**

Dural venous sinus thrombosis is a challenging clinical problem often resulting in delayed diagnosis and treatment. Systemic anticoagulation (SAC) is the treatment of choice but there is a lack of consensus on the best treatment should SAC fail or be contraindicated. We present our institutional experience with 12 patients who either failed or had a contraindication to SAC which were subsequently treated with intra-sinus catheter-directed heparin infusion with or without mechanical thrombectomy.

**MATERIALS & METHODS**

A retrospective review of prospectively-collected clinical data of patients who had intra-sinus catheter-directed heparin infusion from 2001-2007 was undertaken. Twelve patients ranging in age from 16-77 years, 6 males and 6 females, were identified. 4/12 had a contraindication to SAC (trauma, recent craniotomy), 6/12 failed SAC, and 2/12 presented in extremis (obtunded +/- extensive intracranial hemorrhage (ICH)). Technically successful multi-side hole infusion catheter or infusion wire placement was achieved in 12/12 patients. Heparin dose range was 100 units per hour (U/hr) up to ½ total dose to achieve a therapeutic APTT. Mean infusion time was 3.25 days (range: 1-6 days). Adjunctive endovascular balloon thrombectomy/clot angioplasty was performed in 7/12 patients.

**RESULTS**

During initial hospitalization partial sinus recanalization occurred in 7/12 patients (58%) with complete recanalization in 0/12 patients. No procedure-related complications or mortality occurred. Post-treatment disposition was home in 4/12 patients (33%), inpatient rehabilitation in 6/12 patients (50%) and death in 2/12 patients (17%). Delayed imaging
Parenchymal Hematoma Type 2 (PH2) Is Not Associated with Larger Lesion Volume in Combined IV/IA Therapy

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Purpose
In ECASS II, a correlation between large parenchymal hematoma (PH) volume (VPH) and large CT-lesion (infarct + hemorrhage) volumes in subjects treated with IV rtPA as well as placebo controls was suggested. Lesion volumes (Vl) in PH2 patients were significantly larger than those of all other groups, including PH1. The purpose of this analysis is to examine the relationship between PH and lesion volumes in subjects treated with combined IV/IA rtPA in the Interventional Management of Stroke (IMS) studies.

Materials & Methods
VH and Vl were measured digitally (VDig) in 105 subjects from the Interventional Management of Stroke (IMS) Studies I and II, where subjects 18-80 years of age with baseline NIH Stroke Score ≥10 were treated initially with IV rt-PA within 3 hours of onset, followed by additional rt-PA via microcatheter at the site of thrombus. For symptomatic PH (sPH), defined clinically as ICH associated with a change in neurologic condition, attributed to the ICH, linear dimensions of PHs and lesions were also measured, and volumes calculated by AxBxC/2 (VABC/2) method. Vl were dichotomized at 30% of Vh for assignment to PH1 or PH2 groups, and compared using both VDig and VABC/2 methods. sPH2 was compared to the sPH1 group for baseline NIH Stroke Score, baseline ASPECTS score, and treatment recanalization score based on VH.

Results
VABC/2 tended to overestimate Vh by 55% ± 33% and Vl by 34% ± 22% compared to VDig method. One irregularly-shaped PH1 was assigned as PH2 by VABC/2 method. 5 of 6 PH2, and 6/12 PH1, were judged symptomatic. VH of sPH1 and sPH2 were not different by either measurement method. sPH2 exhibited lower Vl compared to sPH1 by both methods (p=0.02), and to all PH1 (p=0.004) and all non-PH (n.s.) by VDig method. sPH2 exhibited higher mean baseline NIHSS score (p=0.05), higher baseline ASPECTS score (p=0.008), compared to sPH1. No differences in Vh or Vl based on recanalization were identified.

Conclusion
In IMS I and II, sPH2 was not associated with larger Vl compared to all PH-1, sPH-1, or to the entire non-PH IV/IA cohort. In contrast to ECASS II, factors other than large baseline hypodensity or large 24-hour VL are associated with PH-2 in combined IV/IA rtPA therapy.

References

Key Words: Thrombolysis, hemorrhage, Infarct
140kV image sets were converted into a virtual non-contrast (VNC) image and a contrast-overlay image, which were then used to prospectively classify each hyperdensity as hemorrhage, contrast, or calcification. These pronouncements were verified by subsequent images acquired with in the next 48 hours.

RESULTS
All cases of intraparenchymal contrast staining in the areas of infarction were correctly classified by DECT. The areas of subdural hemorrhage (which were present because of an antecedent surgery) were also correctly identified, as were the areas of intra-parenchymal calcifications. Two out of four foci of contrast extravasation in the sub-arachnoid space were correctly classified. In the other two foci, the iodinated contrast was mixed in with subarachnoid hemorrhage and the results were ambiguous as the hyperdensity was not completely removed on the virtual non-contrast image. In one region, there was so much contrast in the subarachnoid space that the CT numbers on 80kV image were saturated (approximately 3071HU). These were misclassified, however, there was no ambiguity in this case as these foci were clearly due to iodinated contrast because of their high values. Sensitivity, specificity, and positive and negative predictive values were not computed as they are not meaningful because of the small sample size.

CONCLUSION
Dual Energy CT is an excellent tool for distinguishing intraparenchymal hemorrhage from contrast extravasation or staining due to angiography. Its performance for subarachnoid hemorrhage is equivocal and further studies are needed.

KEY WORDS: Dual energy CT, intracranial hemorrhage, contrast staining

PUPURSE
Intra-arterial (IA) thrombolysis is an accepted treatment strategy for acute ischemic stroke (AIS) beyond the IV thrombolysis window. Non-contrast CT (NCCT) is commonly performed after IA thrombolysis to identify hemorrhagic transformation and/or other complications following IA thrombolysis. Parenchymal hyperdensity is often seen following IA thrombolysis. This may be classified as enhancement, extravasation, or hemorrhage depending on the presence of residual hyperdensity on 24-hour post-intervention NCCTs. The objective of this study is to define the relationship between hyperdensity on NCCT performed immediately after IA thrombolysis and outcome following AIS.

MATERIALS & METHODS
Patients for this study were identified by a retrospective chart review. Forty-eight patients met the following inclusion criteria: (1) AIS in the anterior circulation (2) treated with IA tissue plasminogen activator (tPA); (3) NCCT completed at admission, immediately after IA tPA (post-intervention), and 24 hours after IA tPA. ASPECT scoring was completed on all admission NCCTs by two neuroradiology fellows, blinded to clinical outcome. Contrast staining on post-intervention NCCTs was identified as enhancement (no hyperdensity present at 24 hours), extravasation (hyperdensity present at 24 hours > 90 HU) or hemorrhage (hyperdensity present at 24 hours < 90 HU). The ASPECTS template was used by a staff neuroradiologist to score areas of hyperdensity on post-intervention NCCTs. Vascular risk factors and comorbidities (hypertension, hypercholesterolemia, coronary artery disease, glucose, atrial fibrillation, smoking, diabetes) were identified from the chart review. Retrospective National Institutes of Health Stroke Scale (NIHSS) scoring was applied to the written neurological findings in patient charts. NIHSS scores were obtained for each patient at admission, post-intervention, 24 hours, and discharge. NIHSS improvement was defined as the difference between admission NIHSS and discharge NIHSS. Differences in NIHSS improvement between patients with enhancement, and extravasation or hemorrhage were determined using independent t-tests. Regression analysis was used to determine the relationship between contrast classification and vascular risk factors as well as ASPECTS scores. Differences were significant at p < 0.05.

RESULTS
Hyperdensity was present on 93% (40/43) of the post-intervention NCCTs. Of these, 21 showed evidence of extravasation or hemorrhage, and 18 showed enhancement. NIHSS improvement was significantly greater in patients with enhancement (11.5 ± 9.1) compared to patients with extravasation or hemorrhage (4.1 ± 13.4) (p<0.05). The post-intervention ASPECTS score was not associated with NIHSS improvement for patients with enhancement, or with extravasation or hemorrhage (p>0.05). There was no relationship between the presence of vascular risk factors, and the presence of contrast enhancement, or extravasation and hemorrhage. In addition, admission ASPECTS scores were not significantly different between patients with enhancement (7.5 ± 1.5) and with extravasation or hemorrhage (7.3 ± 1.5) (p>0.05).

CONCLUSION
Hyperdensity is a common feature on NCCTs following IA thrombolysis treatment for AIS. We have shown that contrast enhancement is associated with a better clinical outcome than extravasation or hemorrhage. Evaluation of the 24 hour NCCT for contrast extravasation or hemorrhage is important, as it may provide useful prognostic information regarding patient outcome.

KEY WORDS: Thrombolysis, stroke, non-contrast CT
Scientific Poster 159

The Semi-Jailing Technique Facilitates Treatment of Complex, Wide-Necked and Fusiform/Dissecting Intracranial Aneurysms

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PURPOSE
Endovascular embolization of wide-necked and fusiform/dissecting intracranial aneurysms often requires the use of stent-assisted coiling techniques to prevent coil herniation into the parent artery. Traditional methods are performed either by placing the coil delivery microcatheter between the stent and the parent artery (“jailing”) or through the interstices of a fully-deployed stent. However, traditional approaches impede manipulation of the coil delivery microcatheter and may lead to embolization failure (1). Here we describe a modified jailing technique, not previously described in the literature, to improve catheter maneuverability. We report on the safety and efficacy of this “semi-jailing” technique for the treatment of complex, wide-necked and fusiform/dissecting intracranial aneurysms.

MATERIALS & METHODS
The semi-jailing technique involves the partial deployment of a retrievable stent (Enterprise, Cordis Endovascular, Miami Lakes, FL) across the neck of a wide-necked or fusiform/dissecting aneurysm while leaving space to maneuver and reposition the coil delivery microcatheter (Figure 1A; arrowhead, distal stent struts; arrow, proximal stent catheter tip). Thirty-one complex, wide-necked aneurysms (4 ruptured, 6 fusiform/dissecting) were treated using the semi-jailing technique (21 females, mean age 55 years). The mean aneurysm neck size was 5.6mm (SD 2.1, range 3-10mm) and the mean dome-to-neck ratio was 1.4. Degree of aneurysm occlusion was measured using a modified Raymond score. Clinical outcomes were assessed using a modified Rankin scale.

RESULTS
The semi-jailing technique was successfully applied in all cases. Immediate post-treatment angiograms showed total occlusion of the aneurysm in 26 cases (84%) (Figure 1B), neck remnant in 3 cases (10%) and aneurysm dome filling in 2 cases (6%). Follow-up angiography available in 9 patients (29%) at 6-7 months showed progressive occlusion in 2 aneurysms and 5 remained fully occluded. In 2 cases of dissecting aneurysms, retreatment was required. In 2 cases (7%), thromboembolic events after final stent placement were successfully treated with intra-arterial thrombolysis. No permanent periprocedural morbidity was encountered. One patient died of complications secondary to intracranial hemorrhage 6 days after treatment. No stent migration was seen on follow-up.

CONCLUSION
The semi-jailing technique is a safe and efficacious alternative to traditional methods of stent-assisted coiling for the treatment of complex, wide-necked and fusiform/dissecting intracranial aneurysms.

REFERENCES

KEY WORDS: Aneurysm, stent-assisted coiling

Scientific Poster 160

The Use of a Dual Catheter Technique as an Alternative to Stenting in the Treatment of Wide-Necked Aneurysms

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PURPOSE
Though the treatment of wide-necked intracranial aneurysms remains problematic, the introduction of stents for the coiling of wide-necked aneurysms has increased the number of aneurysms that can be treated with endovascular approaches. Admittedly effective for aneurysm treatment in the short term, the consequences of stent implantation are still unknown, and recent reports have raised the question of the short and long term safety of these stents. At our institution, we have adopted a method of coiling wide necked aneurysms with the use of two catheters, allowing a greater length of coil to be placed in the aneurysm initially, and mitigating against the use of stents in many otherwise untreatable aneurysms. In this study, we evaluate the safety and efficacy of the use of two catheters in the treatment of wide-necked intracranial aneurysms.

MATERIALS & METHODS
We performed a retrospective review of all intracranial aneurysms treated at our institution between January 2006 and August 2008, identifying 24 patients in whom two catheters had been simultaneously employed for coil embolization. We recorded aneurysm size, neck size, percent volume filling, procedural and immediate postprocedural complications, and initial results. Follow-up data was obtained when available, and long term complication and occlusion rate were assessed.
RESULTS
Six of the aneurysms were ruptured, 18 were unruptured. The average neck size in the series was 4.7 mm with an average dome-to-neck ratio of 1.9. Nine of the 24 aneurysms had a dome to neck ratio of 1.5 or less. The average packing volume was 28.5%. Only two of the 24 procedures failed the initial two-catheter attempt and were converted to stent-assisted coiling. All of the remainder of the aneurysms were judged (visually and with packing volume analysis) to be adequately treated. There was one immediate complication, involving a periprocedural aneurysm rupture, resulting in death. No other procedural or immediate post-procedural complications were observed. Fourteen of the 24 patients have had follow-up: seven (50%) have required no additional treatment, and seven (50%) have been retreated, all successfully. Of the seven retreatments, only two received stents as part of their retreatment.

CONCLUSION
The use of two catheters in the coiling of difficult to treat, wide necked aneurysms allows the majority of patients to be treated safely and effectively with out the use of stents. With this technique, two catheters are placed in the aneurysm, and the first framing coil positioned. With the coil still attached, a second framing coil is deployed. If the construct is stable, the second coil is detached, and the first coil remains attached to provide stability as additional coils are placed in the aneurysm. The first coil is only detached at the end of the procedure, or when the operator is confident that the coils will not herniate. Though further study is necessary, this data suggests that the two catheter technique is a potential alternative to the use of stents in difficult to treat, wide-necked aneurysms.

KEY WORDS: Intracranial aneurysm, coil embolization, dual catheter

Scientific Poster 161

Carotid Artery Disease: Comparision between Computed Tomographic Angiography and Digital Substraction Angiography

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PURPOSE
Cerebrovascular disease is the major cause of mortality and morbidity world wide. Effective stroke prevention is must to reduce this burden. Atherosclerotic stenosis of carotid artery is primary pathological entity responsible for cerebrovascular stroke. Carotid bifurcation and proximal ICA is most common site affected by disease. Now-a-days CTA emerged as a modality of choice due to spectacular advance in software technology which has made possible the high resolution VR, SSD and MIP reconstruction of axial images. The purpose of present study were to analyze 16 slice MDCT by using axial MIP, SSD and VR individually and with DSA in patients of extra cranial carotid disease.

MATERIALS & METHODS
This prospective study included 20 symptomatic patients with carotid artery stenosis or occlusion. The patient underwent pre-assessment screening by color Doppler ultrasound followed by CTA and DSA. DSA was taken as gold standard. VR, MIP and SSD images were reconstructed. The data was analyzed for total occlusion, near occlusion and different grade of stenosis using NASCET criteria.

RESULTS
Correlations between angiography and three type of reconstruction were very good. Axial, SSD, VR, MIP images correctly classified 18 of 20 carotid arteries (90%, rs=0.998 k=0.806, p=<.001), 18 of 19 carotid (94%, rs=0.979, k=.864, p=<.001), 17 of 20 carotid arteries (85%, rs=0.976, k=0.739, p=<.001) and 18 of 20 carotid arteries (90%, rs=0.978, k=0.744, p=<.001) respectively. Axial images underestimate only 2 sever stenosis as moderate stenosis by 2% difference. One stenosis was not assessable by SSD in one carotid artery due to heavy calcification VR underestimate two sever stenosis as moderate stenosis by 2-4% difference. The major limitation with MIP was dense calcification which prevented accurate measurement of the stenosis in one carotid artery. All occluded and near-occluded carotid arteries were accurately classified on axial, VR, SSD and MIP images.

CONCLUSION
All carotid arteries are correctly depicted by CTA and axial images provide most accurate evaluation of stenosis, close to DSA. SSD is not statistically significant from VR and MIP in measuring stenosis. CTA with the help of axial, VR, MIP and SSD images can obviate the need of DSA in symptomatic carotid artery stenotic disease.

KEY WORDS: CTA, carotid artery disease, DSA

Scientific Poster 162

Treatment of Stenoses of the Proximal Vertebral Artery Using Short Drug Eluting Coronary Stents, Deployed Strictly Outside the Subclavian Artery: Improved Follow-up Results

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PURPOSE
Stent-PTAs of proximal stenoses of the vertebral arteries (V1) are notorious for recurrence and stent breakage. After using a variety of different techniques and stents, we describe an improved method for the endovascular treatment for these frequent lesions. It was the aim of this study to evaluate the immediate and follow-up results of stent-PTAs of V1-stenoses using short (8 mm) drug eluting coronary stents (Coroflex please).

MATERIALS & METHODS
During a period of 18 months, 42 significant V-stenoses in 38 consecutive patients (31 male, median age 69 years) were treated using short drug eluting coronary stents (Coroflex please 4 mm / 8 mm, B. Braun, Germany). All stents were
deployed within the V1-segment, with the proximal end of
the stent right at the level of the subclavian artery, applying
a controlled inflation pressure of 13 atm. All patients were
under a continuous medication with ASA and Clopidogrel
before and after the treatment. Success- and complication
rates of the treatment as well as vessel patency at angiog-raphic follow-ups and the clinical course were evaluated.

RESULTS
In all 42 procedures, a sufficient lumen reconstruction with
a residual stenosis <40% was achieved. No procedural com-
pliations were encountered. A total of 37 stenoses had
angiographic follow-up examinations. Re-treatment was
required in 3 patients and was success- and uneventful. No
patient experienced a cerebral or cerebellar ischemia related
to a treated V1-segment.

CONCLUSION
The stent-PTA of V1-stenoses using short drug eluting
stents, intermediate inflation pressures and accurate stent
placement is safe and yields good mid-term patency rates as
well as excellent protection from ischemia of dependent sup-
ply territorries.

KEY WORDS: Vertebral artery stenosis, stent-PTA, drug elut-
ing stents

Scientific Poster 163

Stent Grafts Treatment for Carotid Cavernous Fistulas
and Extra- and Intra-cranial Aneurysms

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PURPOSE
Coronary covered stent grafts have been recently sporadically
used to treat carotid cavernous fistulas (CCFs) and extra-
and intra-cranial aneurysms. We present 7 cases with 8 CCFs
and 8 cases of extra- and intra-cranial aneurysms treated by
the placement of covered stent grafts to evaluate the tech-
nical feasibility and efficiency of stent grafts placement for
CCFs and aneurysms.

MATERIALS & METHODS
Between May 2005 and May 2007, coronary stent grafts
were used to treat 4 internal carotid artery (ICA) aneurysms;
2 extra-cranial aneurysms of vertebral artery (VA); 2
pseudoaneurysms of VA, and 8 direct CCFs. 6 CCFs in 5
patients and 2 pseudoaneurysms in 2 cases occurred post-
traumatically.

RESULTS
Stent grafts were deployed successfully in 2 extra-cranial VA
aneurysms, 3 ICA aneurysms, 2 pseudoaneurysms of VA,
and 7 direct CCFs. In 1 case of ICA aneurysm, an endoleak
into the aneurysm cavity was observed immediately after
treatment. Detachable coils had to be used to completely
occlude the aneurysm. In 1 case of CCF, ICA was occluded
during the treatment (without clinical consequence). 12
cases have a clinical and angiographic follow-up over 1 year.
Angiographic follow-up (available in 14 patients; average,
16 months) revealed that all the stent grafts were patent.
There were no mortality or morbidity developed during or
after the procedure, including the follow-up period.

CONCLUSION
Stent grafts placement is a promising tool for the endovas-
tural treatment of extra- and intra-cranial aneurysms and
CCFs in selected patients. However, because of the current-
ly available stent grafts' lacking of mechanical flexibility,
further research and development are needed to optimize the
stent graft technology for the cerebrovascular system.

KEY WORDS: Stent graft, carotid cavernous fistula, aneurysm

Scientific Poster 164

Imaging of Intracranial Stent Deployment Using Ultra-
high Resolution MicroCT

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PURPOSE
Treatment of intracranial aneurysms and atherosclerotic
lesions with small metallic stents has become increasingly
popular. Accurate evaluation of potentially significant post-
deployment characteristics such as wall malapposition, strut
misalignment, and strut prolapse into the lumen, has been
limited by the resolution of current clinical imaging modal-
ties. In our study, ultra-high resolution MicroCT was used to
accurately visualize and assess deployment characteristics of
four different intracranial stents.

MATERIALS & METHODS
A 4 x 20mm Neuroform Treo stent (NF3) (Boston Scientific,
Fremon, CA), a 4 x 25mm Enterprise stent (Cordis
Endovascular, Miami Lakes, Fl), a 3 x 20 mm Leo stent (Balt
Endovascular, France), and a 3 x 8mm Pharos stent (Micrus
Endovascular, San Jose, CA) were deployed in a straight
polytetrafluoroethylene (PTFE) tube (WL Gore &
Associates, Inc., Newark). MicroCT images were acquired
using an eXplore Locus SP (GE Healthcare, USA) scanner.
Image processing was performed using volume renderings
with Amira 4.1 (Mercury Inc., USA) and additional unwrapping
of the datasets in Matlab (Mathworks).

RESULTS
The open-cell design NF3 stent exhibited cell vertex mis-
alignments at the distal end, uniform cell area, and intralu-
mal strut prolapse. The closed-cell design Enterprise stent
showed no strut prolapse in the midsection but the struts car-
ying the markers prolapsed into the lumen due to the flaring
of the stent ends. The Leo stent showed minor strut prolapse
in every cell due to the braiding design, while major strut
malapposition was present where the struts and the markers
cross. The Pharos stent exhibited irregular cell alignments
and skewed connectors but no strut prolapse.
CONCLUSION
The 3D stent reconstructions acquired by ultra-high resolution MicroCT provide highly accurate visualizations of stent deployment characteristics and adverse mechanics such as cell misalignment, strut malapposition, and intraluminal strut prolapse. Detection and evaluation of even minimal strut asymmetries, which are not identifiable using currently available clinical imaging modalities, is of potentially significant importance as they have been shown to have a strong influence on the stents' hemodynamic performance.

KEY WORDS: Imaging, stent, micro CT

Scientific Poster 165
Vertebroplasty: Material Flow Distribution and Leak Detection in a Prospective Randomized Controlled FDA Study in PVP Comparing Cortoss to PMMA

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PURPOSE
To present vertebroplasty study results for osteoporotic vertebral compression fractures (VCFs). Distribution patterns differ with the hydrophilicity and viscosity of the material. Theoretically, materials that re-establish physiologic load bearing may be beneficial. Leaks are expected events in vertebroplasty, the majority are asymptomatic. Reported rates vary widely, which may be due to underlying pathology and detection methodology used. Literature shows the lowest detection rates for fluoroscopy; the highest for CT; plain films fall in-between.

MATERIALS & METHODS
256 osteoporotic VCF pts were enrolled in a prospective randomized IDE study comparing Cortoss (C, 162 pts) and PMMA (P, 94 pts). 354 levels were treated (227 C and 127 P). Fractures with height loss up to 30% of original height were treated, vertebra plana were excluded. Biplanar fluoroscopy was required during material placement. Procedure CT scans reviewed by a blinded radiologist assessed any material outside the cortical boundaries on post-op CTs. Leaks were classified as intradiscal, epidural, or paraspinal, and whether they were intravascular or not.

RESULTS
On average, 2.3cc's of C and 3.6cc's of P were used per level. The lower volume needed with C may be explained by the trabecular fill pattern demonstrated; P showed a more bolus-like fill. 68.5% of C and 68.1% of P patients had leaks, one third of those were detected by CT, only three leaks were asymptomatic. Preliminary calculations show the volume of C leaks to be smaller than those seen with P. Discal leaks were common, occurring in 31.4% of C pts and 37.3% of P pts. Disc leaks may result from the desire to completely fill the fracture extending into the endplate(s). There were 48 epidural leaks, 1 C and 1 P were symptomatic. Localized venous leaks are asymptomatic, but are associated with pulmonary embolism (PE) risk. No PEs were reported in our study.

CONCLUSION
The more physiologic distribution pattern seen with C may offer biomechanical advantages over P's bolus fill and explain the lower volume of C used in our study. The overall incidence of leaks in general, and of symptomatic leaks in particular, were similar in our study. The lower volume C injected theoretically might improve the safety of PVP.

KEY WORDS: Vertebroplasty (PVP), vertebral compression fractures (VCF), material fill patterns

Scientific Poster 166
The Utility of Xper Guide in Treatment of Head and Neck Vascular Malformations and Tumors

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PURPOSE
The primary focus of this project was to evaluate the accuracy and ease of needle placement of the Xper Guide system in accessing head and neck vascular malformations and tumors, and to determine its contribution in treatment.

MATERIALS & METHODS
Twenty five needle placement procedures using the Xper Guide system were performed in 14 patients: 6 cavernous venous malformations, 3 arteriovenous malformations, 3 juvenile nasopharyngeal angiofibromas, one capillary malformation and one lymphovenous malformation. Number of needle passes, success of access, procedure times, and clinical follow up were assessed.

RESULTS
Needle placement was successful with a single needle pass in 24 of 25 procedures to a superficial location in 8, the hypopharyngeal/ pyriform sinus/ paratracheal spaces in 6, the sphenoid sinus via trans-nasal approach in 3, intra-orbital in 2, pterygo-palatine fossa in 3, external auditory canal and intra-laryngeal in 1 each. The one failure was in a superficial lesion due to poor fluoroscopic visualization. Needle placement was within 2 mm of planned target in four cases where
post placement Xper CT was obtained. These patients had CVMs with no blood return, and contrast injection confirmed correct location. Fluoroscopy times averaged 98 seconds per needle placement, including injection times. Procedure time was decreased by 50 to 70% in 3 patients with prior procedures.

**CONCLUSION**

Xper Guide allowed access to deep, nearly inaccessible, regions with ease using a single needle pass, resulting in improved treatment with decreased procedure times.

**KEY WORDS:** CT guided, vascular, malformation

**Scientific Poster 167**

**Runaway Dural Arteriovenous Fistulas**

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**PURPOSE**

Dural arteriovenous fistulas (DAVF) are relatively rare. There are effective endovascular occlusion procedures and surgical interventions for the treatment of these potentially dangerous vascular lesions. However, some patients present with multiple DAVFs that cannot be cured with standard interventions. These patients suffer progressive neurologic deterioration with enlargement of existing fistulas, formation of new fistulas, and development of high risk features associated with increased chance of intracranial hemorrhage. We present three patients with multiple difficult to treat progressive intracranial DAVFs with associated intracranial venous hypertension.

**MATERIALS & METHODS**

Retrospective and prospective review of institutional neurovascular database, medical records and patient interviews.

**RESULTS**

The first patient, a girl first diagnosed at age 9, presented to our tertiary care hospital at age 13 with multiple intracranial DAVFs. Despite multiple embolization procedures and a craniotomy, the patient continued to sprout de novo fistulas, and developed worsening neuro-cognitive deficits in the setting of intracranial venous hypertension. She died at age 26 due to an intracranial hemorrhage.

The second patient, a young woman, was first diagnosed at 18 years of age and presented to our hospital with an extensive skull-based DAVF and multiple cranial neuropathies. She too underwent several endovascular embolizations. Nevertheless her disease progressed as she developed multiple de novo fistulas, hydrocephalus, intracranial hypertension, and a fatal basal ganglia hemorrhage at age 25.

Our third patient, an 11 year-old girl diagnosed at nine months of age with a forehead angioma, first presented to our hospital with a history of multiple treatment-refractory high-risk fistulas. She too underwent numerous embolizations and surgical interventions and developed new fistulas over time, including an orbital fistula.

Conventional cerebral angiogram: injection of the right external carotid artery demonstrates fistulas involving enlarged superficial temporal, middle meningeal, occipital arteries shunting to meningeal and cortical veins and the superior sagital sinus (SSS). Injection of the left internal carotid artery demonstrates multiple diffuse DAVFs to the SSS and cortical veins through a venous varix.

**CONCLUSION**

The runaway DAVF represents a subset of patients with difficult to treat DAVFs with enlargement of pre-existing fistulas, de novo fistulas, and development of high risk features. The precise pathological process leading to intracranial DAVFs remains unknown. Persistent intracranial venous hypertension is thought to represent a major contributing factor in the pathogenesis of DAVFs. The three patients presented in this report likely experienced prolonged uncontrolled venous hypertension leading to stimulation of angiogenic factors resulting in the runaway DAVF.

**KEY WORDS:** DAVF, runaway, fistula

**Scientific Poster 168**

**Dynamic Nature of Dural Arteriovenous Fistulas (DAVF): Progression from Low-Grade to High-Grade Lesions in Three Angiographic Observations**

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**PURPOSE**

To illustrate the dynamic nature of dural arteriovenous fistulas (DAVF) by documenting angiographic progression from low-grade to high-grade lesions in three patients.

**MATERIALS & METHODS**

Angiography was performed in patients with known DAVFs after an acute change in symptomatology.

**RESULTS**

In three cases, the DAVFs’ venous drainage pattern changed between angiograms. These progressions from “so-called” benign types to more malignant types were associated with worsening of symptoms, progressive neurological dysfunction, or life-threatening intracranial hemorrhage. Case 1. A 55-year-old woman with a left condylar DAVF draining into the internal jugular vein and cavernous sinus experienced intracranial hemorrhage one day after diagnos-
tic angiography. Repeat angiography showed exclusively retrograde drainage into the cavernous sinus and basal vein of Rosenthal.

Case 2. A 58-year-old woman with a right transverse sinus DAVF draining into both transverse sinuses underwent transarterial embolization without immediate complications. Four months later, she developed bilateral tinnitus. Angiography showed occlusion of the right sigmoid sinus with retrograde drainage in the right temporal veins, which were previously draining antegrade.

Case 3. A 50-year-old woman with a right cavernous sinus DAVF draining to the right inferior petrosal sinus (IPS) noted increasing orbital pain and tinnitus a few weeks after diagnostic angiography. Repeat angiography showed closure of the right IPS and retrograde drainage via the superior ophthalmic vein.

CONCLUSION
Our observations emphasize the need to consider DAVFs' potential for progression after a modification in the venous drainage pathway, and avoid being falsely reassured by their benign appearance at a given moment in their evolution. Caution is particularly warranted whenever patients experience a change in clinical presentation.

KEY WORDS: DAVF

Scientific Poster 169

Long-term Outcome in the Repair of Spinal Cord Perimedullary Arteriovenous Fistulas

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PURPOSE
The goal of this study was to evaluate the long-term outcome of patients with perimedullary arteriovenous fistulas (PMAVFs) treated by embolization or surgery at a single tertiary care center for a 25-year time period.

MATERIALS & METHODS
A retrospective study was undertaken at our university hospital. Patients diagnosed with PMAVFs were evaluated and followed after surgical or endovascular treatment.

RESULTS
Between 1983 and 2006, our institution diagnosed 29 patients with PMAVFs (mean age 43; 11 male, 18 female). The most common presenting symptoms were progressive myelopathy (67%), acute paraplegia (19%), and subarachnoid hemorrhage (15%). 27 patients underwent treatment; 3 by embolization alone, 9 by surgery alone, and 15 patients received a combination of surgical and endovascular treatment. Mean follow-up period was 42.5 months (range 1-120). Pre-operative and post-operative evaluation of neurological function with the Aminoff and Logue scale demonstrated that correcting PMAVF resulted in improvement in ambulation but not micturition. In addition, residual fistula at the time of follow-up angiogram was associated with stable or worsening neurologic status. Younger patients were shown to recover more function compared with older patients.

CONCLUSION
PMAVFs present most commonly with symptoms of progressive myelopathy, and correction of the vascular malformation results in significant improvement in ambulation scores. Complete obliteration of the fistula and younger patient age are associated with improved outcome.

KEY WORDS: Perimedullary arteriovenous fistula, embolization, outcome

Scientific Poster 170

Internal Carotid Artery Aneurysm Model in Swine

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PURPOSE
To simulate the vascular structure of an aneurysm originated from internal carotid artery, a new surgically created aneurysm model was made using swine.

MATERIALS & METHOD
A total of 5 experimental aneurysms were surgically created in 3 swine by following procedure. After the creation of venous pouch side wall aneurysm on the right side of common carotid artery, distal portion of the artery was extended by using ipsilateral internal jugular vein. Then three dimensional vascular structure of intracranial carotid artery was reproduced by using a pre-designed casting-mold that is made of polyurethane foam. Angiography was performed to assess the postoperative vascular structure and patency of created aneurysm.

RESULTS
Every surgery was performed without complication related to the procedure. Post operative angiography showed the patency of parent arteries as well as created aneurysms. Angiographical reproducibility of 3 dimensional vascular structures (carotid siphon) was confirmed by 3-D angiogram.
CONCLUSION
Given the reproducibility of three dimensional structure of internal carotid artery, and its feasibility of designing the location of the aneurysm, this animal model can be useful for various applications such as new device evaluation or study of flow dynamics related to the intracranial aneurysm.

KEY WORDS: Internal carotid aneurysm, endovascular treatment, swine model

Scientific Poster 171
Endovascular Treatment of Complex Cerebral Aneurysms with Assistance of the Cordis Enterprise Stent: Single Center Clinical Experience with Midterm Follow up Results

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PURPOSE
We present our single center clinical experience with Enterprise stent-assisted coil embolization of complex cerebral aneurysms.

MATERIALS & METHODS:
The records of all patients with cerebral aneurysms treated with Enterprise stent-assisted coiling were entered prospectively into a database. We assessed the clinical history, indication for stent use, aneurysm size, technical details of the procedure, including any difficulties with stent placement or deployment, degree of aneurysm occlusion, procedure related complications, as well as post treatment follow up results.

RESULTS
A total of 40 Enterprise stents have been deployed in 38 patients for treatment of cerebral aneurysms. Of the 38 patients, 8 presented with subarachnoid hemorrhage (6 acute, 2 subacute). Indications for stent use included wide aneurysm neck (n=33), fusiform aneurysm (n=6), and salvage for coils prolapsed into parent vessel (n=1). The Enterprise stent was successfully deployed in satisfactory position in all 40 cases. In 5 cases the distal or proximal tines of the stent did not open completely; however in only one case did this require delayed coiling of aneurysm for fear of inadequate vessel apposition. In one case the stent demonstrated slight movement while trying to advance the microcatheter through the stent. In one case the stent demonstrated small stable neck remnant not requiring further treatment.

CONCLUSION
The Enterprise stent is a useful device for stent-assisted coil embolization of complex cerebral aneurysms. The stent was easily navigable and can be repositioned if needed allowing for accurate placement. The closed cell design allows for satisfactory coil packing density of the aneurysm. In our series, we had one post procedural complication of retinal ischemia resulting in partial visual field defect. This could be related to the proximity of the proximal tines of the Enterprise stent to the ophthalmic artery. Six month follow up demonstrates no delayed stent related complications.

KEY WORDS: Aneurysm, stent, coiling

Scientific Poster 172
Healing of Narrow and Broad Neck Aneurysms Embolized with Platinum Coils: Gene Expression Pattern using Microarrays

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PURPOSE
We explored the healing mechanism of embolized aneurysms using an animal model. Since in clinical practice durability of occlusion is superior in densely-packed, narrow-necked aneurysms as compared to wide-necked, loosely packed aneurysms, we simulated these features in the animal experimentation. We compared using microarrays the gene expression associated with these two types of aneurysms, to probe the mechanism associated with good versus poor healing.

MATERIALS & METHODS
Elastase-induced saccular aneurysms with narrow neck (∆3 mm) and broad neck ≥4 mm) were created in 24 rabbits. Aneurysms were allowed to mature for 8 weeks, after which narrow neck aneurysms (n=12) were tightly embolized (packing density >30%) and broad neck aneurysms (n=12) were loosely embolized (packing density<20%) with platinum coils by endovascular means. After 2 weeks (n=6 for each group) and 4 weeks (n=6 for each group) of implantation, aneurysm samples harboring coils were harvested. RNA was isolated separately from the necks and domes of aneurysms and analyzed using a microarray containing 294 rabbit genes of interest. Genes with a statistically significant difference between narrow neck and broad neck (P<.05) and a fold change ≥1.2 and ≤0.8 to represent up- and down- regulation to identify pathways for further investigation.
**RESULTS**

Mean neck size was significantly lower and the mean percentage of packing density was greater in the narrow neck group compared with broad neck group (1.9±0.7 vs 5.0±1.5 for neck size and 41.4±14.05 vs 13±4.12 for packing density). Of the 294 genes analyzed, 22 (7.5%) genes at neck and 16 (5.4%) genes in the domes of 2 weeks aneurysms and 26 (8.8%) genes at neck and 19 (6.5%) genes at dome of 4 weeks aneurysm were differentially expressed in narrow neck aneurysms compared to broad neck aneurysms. Specific pathway analysis revealed that increased gene expression in narrow neck aneurysms was associated with adhesion molecules, proteases and chemoattractant molecules. Conversely, wide neck aneurysms showed an elevated expression of structural molecules.

**CONCLUSION**

These findings may focus efforts on specific targets aimed at improving the long term healing of intracranial, saccular aneurysms.

**KEY WORDS:** Aneurysm healing, gene expression, microarray

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**Scientific Poster 173**

**Creation of Three Different Shape of Aneurysms by Adjusting the Position of Inflated Balloon: A Retrospective Study**

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**PURPOSE**

To explore the possibility to create aneurysm with different shape by adjusting the position of inflated balloon.

**MATERIALS & METHODS**

Sixty-six elastase-induced aneurysms in rabbits were retrospectively analyzed, including fluoroscopic images during creation showing the position of inflated balloon and digital subtractive angiography (DSA) pictures after creation indicating the shape of the aneurysms. Three types of aneurysms were defined according to the ratio of aneurysm width versus neck (W/N): Group 1 (n=17) comprised cases where W/N is bigger than 1 (aneurysm width was larger than aneurysm neck); Group 2 (n=24) comprised cases where W/N equals 1 (aneurysm width equals aneurysm neck); Group 3 (n=25) comprised cases where W/N is smaller than 1 (aneurysm width is smaller than aneurysm neck). Three different positions of inflated balloon were classified as following: Position A, the balloon was completely in the origin of right common carotid artery (RCCA); Position B, the balloon located in both the origin of RCCA and brachiocephalic trunk (BT) / right subclavian artery (RSA); Position C, the balloon located completely in BT/RSA. Occurrences of different positions in different groups were calculated and analyzed. Proportions were compared using the Fisher's Exact test.

**RESULTS**

Position A was shown in 14 (82%) cases in group 1, the other 3 (18%) cases indicated position B (Figure 1). In group 2, 17 (71%) cases showed position B, 7 (29%) cases appeared as position C (Figure 2). All the 25 cases in group 3 indicated position C (Figure 3). Proportions between groups were significantly different (P<.001).

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**Scientific Poster 174**

**Withdrawn**
Scientific Poster 175

Three-Dimensional Ventricular Volume Reconstruction of the Hydrocephalic Brain in Children: Relationships with Cognitive Function

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PURPOSE
There have been conflicting findings regarding the relationship between neurobehavioral outcomes and lateral ventricle size in children with congenital hydrocephalus. Fletcher et al (1996) documented regional brain tissue composition correlated with cognition in children with shunted hydrocephalus. In contrast, Hommet et al (2002) found no correlation between ventricular volumes and cognition. In the present study, we further investigate the relationship between cognition and brain volumes by using three-dimensional CT reconstruction.

MATERIALS & METHODS
CT scans were obtained from 28 children aged 6-16 years with communicating hydrocephalus shunted within the first year of life. All children completed a comprehensive neuropsychological battery of tests. Three-dimensional volume reconstruction of the whole brain and ventricles was performed with the Phillips Extended Brilliance Workspace. The ventricle/whole brain volume ratio (V/C) was used as a normalized measure of ventricular volume. Volumes were correlated with neuropsychological tests.

RESULTS
Patients consistently performed over a standard deviation below peers on measures of intelligence, attention, verbal memory, and visual memory (p = .01). Whole brain volume correlated with attention (r = .52, p = .004) visual memory (Rey Complex Figure; r = .40, p = .04), and verbal memory (California Verbal Learning Test r = .558) p = .002). V/C ratio was correlated with slower motor speed (r = .61, p = .001), but not cognitive performance.

CONCLUSION
Using this new technology, whole brain volume was found to correlate with cognitive functioning in this sample, while ventricular volume ratio was not found to correlate with cognition. Reasons for disparate findings across studies, including inclusion criteria, sample size, choice of assessment technology, and regions of interest will be discussed. Further studies utilizing diffuse tensor imaging may prove beneficial in understanding the adverse impact hydrocephalus has on cognitive development in this population.

KEY WORDS: Hydrocephalus, cognition, ventricles

Scientific Poster 176

External Validation of the Canadian CT Head Rule, the National Emergency X-Radiography Utilization Study II (NEXUS II), and the New Orleans Criteria for CT Scanning in Pediatric Patients with Minor Head Injury, in a Nontrauma Center

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PURPOSE
To validate use of three clinical decision instruments for utilization of computer tomographic scans in pediatric patients with minor head trauma in a nontrauma center setting. Three independently validated decision aids: Canadian CT head Rule(CCHR), National Emergency X-Radiography Utilization Study II(NEXUS II), and New Orleans Criteria(NOC) have been introduced to limit use of cranial CT scans in patients with minor head trauma. We aim to validate these aids in a pediatric population of a nontrauma center to explore whether a strict application of these criteria could have substantially reduced the number of cranial CT scans in the more radiosensitive pediatric population with minor head trauma without missing clinically significant intracranial injury (ICI).

MATERIALS & METHODS
Using our RISC-IC database, we identified the cohort of all pediatric patients(0-21) seen in the Montefiore Medical Center ED from January 1, 2001 to the present who received a cranial CT and presented with a history of minor head trauma. We retrospectively analyzed the charts of these patients for each of the clinical criteria defining the CCHR, NEXUS II, and the NOC - identifying which patients would have been classified as high risk for significant ICI requiring cranial CT scanning and those who would been classified as low risk, not requiring a scan. We determined the sensitivity and specificity of each decision aid for discriminating clinically relevant injury diagnosed via cranial CT(injuries requiring neurosurgical intervention, intubation, or likely associated with significant neurologic impairment) from normal or scans with findings not requiring clinical intervention or follow up. We then compared the criteria in our population and determined the number of potentially avoidable cranial CTs employing a strict application of these decision aids.

RESULTS
In our pediatric cohort of 2414 patient who receive a cranial CT for minor trauma 105 patient(4.3%) had positive head CT findings based on criteria of the original studies. The percentage of scans that would have been recommended based on the three decision aids was 75% as per the NOC, 30% as per the CCHR(high and med risk), and 60% as per the NEXUS II criteria. The sensitivities for predicting a positive head CT were 100%(95%CI 95%-100%) for the NOC, 98%(95%CI 94%-100%) for the NEXUS II and 95%(95% CI 92%-100%) for the CCHR. In contrast the specificities for these decision aids were 25%( 95% CI 22%-29%) for the NOC, 80%(95% CI 75%-83%) for the CCHR and 48%(95% CI 45%-50%) for the NEXUS II criteria. Therefore in our
population it was possible to scan at least 25% fewer patients during period of study without missing clinically significant ICI.

CONCLUSION
While the sensitivities and specificities of the three decision criteria vary and we are not able to demonstrate a statistically significant difference between the sensitivity of the three rules, it is clear that even adoption of the most liberal NOC with the highest sensitivity and the least specificity would significantly reduce the number of cranial CT scans in our pediatric population without missing clinically significant intracranial injury, ultimately saving radiation dose and medical expense.

KEY WORDS: Pediatric, head CT, utilization

Scientific Poster 177

Attenuation of Cerebral Venous Contrast in Susceptibility-Weighted Imaging in Pediatric Patients under General Anesthesia

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PURPOSE
Susceptibility-weighted imaging (SWI) is known to depict the cerebral vascular system in great detail and seems to be a promising tool in children for early detection of cerebrovascular pathologies and better clarification of diagnosis (1). Pediatric patients frequently are anesthetized for MR imaging. During anesthesia a considerable attenuation of the SWI-contrast of cerebral veins has been observed (2). Anesthesia may raise the blood CO2 level and thus increase cerebral blood flow (CBF) (3). Furthermore, it has been shown that an increased level of CO2 in the breathing gas causes a loss of venous contrast in SWI (4). In this study we investigate the impact of anesthesia on the venous contrast in the SWI signal by analyzing basic physiologic parameters measured during anesthesia and correlating these with the observed venous SWI-contrast.

MATERIALS & METHODS
One hundred eight SWI scans of pediatric patients (age: 3-17 years) were analyzed. Venous contrast was classified into two groups, one demonstrating weak and the other strong contrast between veins and parenchyma. Infusion of Propofol (150-300mcg/kg/min) was used for anesthesia in all patients. Records of physiologic parameters during MR imaging, in particular the acquisition of SWI data, such as pulse, blood pressure (BP), respiration rate (RR) and end-tidal (et)CO2 were reviewed.

RESULTS
Figure 1 shows examples of SWI data sets which were classified into the two groups of different venous contrasts. Fluctuation of venous contrast has been observed in the same subjects at different follow-up exams. Significant differences between physiologic measures between groups with weak and strong SWI-contrast were found by paired t-test in the systolic and diastolic BP with moderate significance (0.05<p<0.001) and the etCO2 with high significance (p<<0.001).

CONCLUSION
Our results show venous contrast in SWI correlates with BP and etCO2. Both parameters are indicators of the depthness of anesthesia, with low BP and high etCO2 in case of deep anesthesia, and high BP and low etCO2 for weak anesthesia. Due to this correlation between depth of anesthesia and CBF (3) the venous contrast in SWI is most likely modified by changes in the CBF induced by the anesthetic. Therefore, caution is advised for diagnostic interpretation of the venous contrast in SW images and the actual physiologic parameters during acquisition need to be taken into consideration if the patient was anesthetized.

REFERENCES
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KEY WORDS: Anesthesia, SWI, CBF

Scientific Poster 178

Withdrawn

Scientific Poster 179

Contrast-Enhanced T1-Weighted Fluid-Attenuated Inversion-Recovery BLADE Magnetic Resonance Imaging of the Brain: An Alternative to Spin-Echo Technique for Detection of Brain Lesions in the Unsedated Pediatric Patient?

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PURPOSE
We compared contrast-enhanced T1-weighted magnetic resonance (MR) imaging of the brain using different types of
data acquisition techniques: periodically rotated overlapping parallel lines with enhanced reconstruction (PROPELLER, BLADE) imaging versus standard k-space sampling (conventional spin-echo pulse sequence) in the unsedated pediatric patient with focus on artifact reduction, overall image quality, and lesion detectability.

MATERIALS & METHODS
Forty-eight pediatric patients (aged 3 months to 18 years) were scanned with a clinical 1.5 T whole body MR scanner. Cross-sectional contrast-enhanced T1-weighted spin-echo sequence was compared to a T1-weighted dark-fluid fluid-attenuated inversion-recovery (FLAIR) BLADE sequence for qualitative and quantitative criteria (image artifacts, image quality, lesion detectability) by two experienced radiologists. Imaging protocols were matched for imaging parameters. Reader agreement was assessed using the exact Bowker test.

RESULTS
BLADE images showed significantly less pulsation and motion artifacts than the standard T1-weighted spin-echo sequence scan. BLADE images showed statistically significant lower signal-to-noise ratio but higher contrast-to-noise ratios with superior gray-white matter contrast. All lesions were demonstrated on FLAIR BLADE imaging, and one false-positive lesion was visible in spin-echo sequence images.

CONCLUSION
BLADE MR imaging at 1.5 T is applicable for central nervous system imaging of the unsedated pediatric patient, reduces motion and pulsation artifacts, and minimizes the need for sedation or general anesthesia without loss of relevant diagnostic information.

KEY WORDS: Pediatric, brain, BLADE

Scientific Poster 180

Diffuse Fibrillary Astrocytoma in Infants: Unusual Imaging Features

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PURPOSE
To discuss the unusual imaging features of two cases of diffuse fibrillary astrocytoma in infants.

MATERIALS & METHODS
Case 1: A full-term 7-day-old girl with apneic episodes during feeding was referred for a stroke work up due to the suggestion of a porencephalic cyst diagnosed by head ultrasound and MR imaging. MR imaging showed enlargement of almost the entire right hemisphere with markedly abnormal morphology of the involved brain, including absence of the gyral and sulcal pattern with a fairly smooth, thickened cortex surrounding expanded white matter. There was associated abnormal signal intensity with minimal linear peripheral enhancement, multiple intraparenchymal cysts, scattered foci of intrinsic mineralization, and numerous extraaxial cystic lesions of different sizes. Mild mass effect upon the cerebellum was evident. The differential considerations were desmoplastic infantile ganglioglioma (DIG) and severe congenital dysplastic malformation. The patient was discharged for further observation but at 3 months developed seizures and increased head circumference (HC). Follow-up MR imaging revealed interval progression of the cystic components. Due to clinical and imaging changes, a diagnosis of a neoplastic process was favored, and the patient underwent surgical removal of the tumor at 4 months of age. Histopathologic examination revealed features of low-grade fibrillary astrocytoma of gemistocytic morphology. The associated cortical abnormality was thought to be due to a chronic, long-standing pressure effect, rather than a primary developmental malformation.

Case 2: A 3-month-old girl with enlarged HC and abnormal gaze was referred after a diagnosis of cystic encephalomalacia versus DIG by head ultrasound. MR imaging revealed almost complete replacement of the right cerebral hemisphere by a complex cystic and solid mass, very similar to the lesion described in Case 1 (see graphic). The lesion was resected, and histopathologic examination showed features of low-grade fibrillary astrocytoma and cortical dysplasia (Palmini grade I).

RESULTS
Two cases of supratentorial brain tumors, similar in clinical presentation and imaging appearance, were originally diagnosed as DIG with concurrent cortical dysplasia. Histopathologic examination revealed both as fibrillary astrocytomas, one with a congenital cortical abnormality. These results may support a point of view that both types of tumor, DIG and desmoplastic astrocytoma of infancy, may have a common origin with different histologic differentiation.
CONCLUSION
Diffuse fibrillary astrocytoma is one of the mimics of congenital cerebral malformations. Familiarity with the imaging appearance of diffuse fibrillary astrocytoma in infants may lead to prompt and accurate diagnosis of this uncommon pathology, resulting in timely surgical intervention.

KEY WORDS: Pediatric, brain, tumor

Scientific Poster 181
Leukemic Infiltration of Multiple Cranial Nerves and MR Imaging Anatomy of Cranial Nerves Using 3D-FIESTA Sequence

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PURPOSE
Our purpose is three-fold. 1. We would like to present the unusual radiographic features of diffuse thickening and enhancement of multiple cranial nerves in a case of acute lymphoblastic leukemia without leptomeningeal or parenchymal involvement. 2. We use this case to illustrate MR imaging anatomy of cranial nerves using three-dimensional fast imaging employing steady-state acquisition (3D-FIESTA) sequence images. 3. Also, we discuss the differential diagnosis of enhancing cranial nerves in children.

MATERIALS & METHODS
Eleven-year-old girl with acute lymphoblastic leukemia presented with leukemic relapse after 3 years of remission. She underwent treatment and was off chemotherapy for 3 months before she presented with bilateral decreased hearing. MR imaging demonstrated multiple enhancing cranial nerves. Hence, 3D-FIESTA sequence was performed using 1.5 T MR imaging equipment (General Electric-LX, Milwaukee).

RESULTS
MR imaging demonstrated diffuse enhancement of bilateral optic nerves, bilateral trigeminal nerves (Figures 1b and 1c), bilateral facial and vestibulocochlear nerves (Figure 1c). The right oculomotor was thickened and showed enhancement (Figure 1a). There was no involvement of brain parenchyma. MR imaging demonstrated multiple enhancing cranial nerves. Hence, 3D-FIESTA sequence was performed using 1.5 T MR imaging equipment (General Electric-LX, Milwaukee).

CONCLUSION
Knowledge of anatomy of cranial nerves and its appearance on MR imaging important. In cases of intracranial pathologies, description of extent of involvement of cranial nerves is crucial. Differential considerations for cranial nerve enhancement in children include infections particularly tuberculous, vasculitis, leptomeningeal carcinomatosis, leukodystrophies like Krabbe’s disease, post-radiation changes and tumors like schwannomas and neurofibromas. Isolated cranial nerve involvement in leukemia is rare as presented in this case.

KEY WORDS: Leukemia, cranial nerves

Scientific Poster 182
Pictorial Essay of Neurocutaneous Melanosis: Experience in a Pediatric Hospital

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PURPOSE
Neurocutaneous melanosis is a rare phakomatoses of the skin and leptomeninges. MR imaging of brain and spine is requested routinely to delineate central nervous system (CNS) involvement. The objectives are 1) to review the MR findings of neurocutaneous melanosis and 2) to evaluate whether multiplicity of skin lesion is a risk factor for CNS involvement.

MATERIALS & METHODS
MR imaging of all patients with the diagnosis of giant/multiple congenital melanocytic naevi referred for evaluation of CNS involvement in a pediatric hospital were retrieved for detailed review. Retrospective chart review was performed to examine the extent of cutaneous involvement. Multiplicity was defined as the presence of three or more cutaneous naevi in physical examination. Central nervous system involvement was defined as abnormal T1 hyperintensities and/or leptomeningeal enhancement in MR imaging of brain or spinal cord using a 1.5 T magnet. Other associated findings were documented.

RESULTS
A total of 25 complete MR studies of the neuraxis were available for review in the imaging database. There were 16 males and 9 females, age ranged from 5 days to 13 years old (median = 9 months old). Twelve of the 25 patients had CNS involvement, among those nine had multiple naevi. For those with only one or two pigmented naevi, only three out of 13 had CNS involvement. Three patients had T1 hyperintense lesions in the brain, four patients had leptomeningeal enhancement in spinal cord, three had leptomeningeal enhancement in brain and spinal cord. Two other patients...
had both T1 hyperintense lesions in the brain and leptomeningeal enhancement in the spinal cord. Chi square test showed a highly significant association between multiplicity of skin lesions and CNS involvement (6.74, p value of 0.009 with 99% C.I.).

CONCLUSION
MR imaging is an essential part of the evaluation for patients with giant/multiple congenital melanocytic naevi. Limited set of patients with multiple skin lesions appear to have a three-fold increase in risk for neurocutaneous melanosis when compared to those with one or two isolated naevi. This further supports and estimated the relative risk of CNS involvement.

KEY WORDS: Melanosis

Scientific Poster 183
CT and MR Imaging Findings of Central Nervous System Atypical Teratoid-Rhabdoid Tumors in Children

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PURPOSE
Atypical teratoid-rhabdoid tumors (ATRT) are a unique tumor seen in early childhood. The purpose of this study was to review the CT and MR characteristics of atypical teratoid-rhabdoid tumors and correlate with clinical outcomes.

MATERIALS & METHODS
A retrospective review of the preoperative MR and CT examinations of patients with ATRT was done by two pediatric neuroradiologists. Analysis included tumor location, tumor signal characteristics, assessment of enhancement, gender, age at presentation, cytogenetics, pathologic analysis, treatment received, and survival rate.

RESULTS
There were 19 patients identified: 13 females and 6 males. The age at presentation ranged from 2 months to 19 years with a mean age of 34 months. Eleven cases were supratentorial, four of these in the tectal region. Of the infratentorial tumors, two were located at the cerebellopontine angle. One case was intraspinal. CT exams were available in 13 patients and MR exams available in 19 patients. The majority of the tumors were of increased density on CT, hypointense on both T1 and T2 images and hemorrhage was present in eight of 19 patients. Diffusion-weighted imaging was available in 13 patients and all tumors had restricted diffusion. Tumor volume ranged from 1.2 cc to 194 cc. Intratumoral hemorrhage was present in eight cases. Five patients had leptomeningeal dissemination at presentation. Four patients have survived more than 2 years, seven have deceased and six are on active therapy. Chromosome 22 deletion was confirmed in five patients.

CONCLUSION
Atypical teratoid rhabdoid tumors are a unique tumor type seen in early childhood. The imaging features reviewed here in our series include hypointensity on T1 and T2 images, restricted diffusion within the tumors, and heterogeneous enhancement. Intratumoral hemorrhage was also a frequent finding. The prognosis is poor with few long-term survivors.

KEY WORDS: Central nervous system tumors, pediatric neuroradiology

Scientific Poster 184
Investigating Spontaneous “Fluctuations” of Contrast Enhancement in Childhood Pilocytic Astrocytomas: Our Preliminary Experience

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PURPOSE
Childhood pilocytic astrocytoma (PA) accounts for 10% of supratentorial astrocytomas and for 85% of infratentorial astrocytomas. The tumor patterns could be solid, cysts with a single mural nodule or multilocular cysts and the solid part may enhance in a homogeneous or a heterogeneous fashion. It has been demonstrated that the assessment of contrast enhancement (CE) pattern is essential for the diagnosis and follow up. After partial PA removal we observed CE modifications in absence of residual dimensional changes in patients who have not received neither chemotherapy nor cortison therapy. The purpose of this study is to investigate changes of the residual PA with serial MR contrast enhancement in absence of dimensional variation of the residual tumor, in patients off therapy.

MATERIALS & METHODS
We retrospectively evaluated 860 MR studies of 130 patients (58 F, 72 M) with histologically proved diagnosed PA (biopsy or partial removal); the mean age at initial presentation was 8 years (range 2-19 years). All patients were followed for an average of 4.5 years with serial MR imaging (mean of seven MR studies for each patient). All patients underwent partial removal or stereotactic brain biopsy of the PA. MR studies were performed on the same 1.5T scanner (Excite - GE) with different precontrast sequences but all the time with three orthogonal FSE T1-weighted postgadolinium sequences, acquired not later than 15 minutes after contrast injection, with the same plane acquisition protocol (coronal, sagittal, axial). Each patient received a single dose of gadolinium-DTPA. We measured the single largest diameter or two orthogonal diameters on the T1-weighted post-Gd sections of each enhancing focus and the single largest diameter or two orthogonal diameters on the correspondent T2-weighted FSE of the residual tumor.

RESULTS
Sixty of 130 pilocytic astrocytomas were infratentorial, 53/130 supratentorial, 17/130 had multiple locations. Of 130 PA we selected 36 patients off therapy (chemotherapy and cortison therapy), without evidence of NF1 and without dimensional changes of the residual tumor in the serial MR imaging. Eleven of 36 showed CE changes in terms of increase/appear and/or decrease/disappear of the contrast
enlargement. Three of 11 were infratentorial, seven of 11 supratentorial (six optic-diencephalic, one hemispheric astrocytoma) and one of 11 endoventricular.

**CONCLUSION**
In our experience residual pilocytic astrocytomas may show a variable CE during the years, in absence of residual tumor dimensions change. Thus, the CE fluctuation alone is not directly correlated with an increase or decrease of residual tumor size. This fluctuation is probably correlated with the peculiar histologic feature of PA and it remains in absence of clear interpretation.

**KEY WORDS:** Pilocytic, contrast enhacement

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**Scientific Poster 185**

**Fibrovascular Tissue Ingrowth Degree within Hydroxyapatite Ocular Implants after Enucleation of the Bulbus in Patients with Retinoblastoma**

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**PURPOSE**

Following enucleation, an intraorbital implant provides good volume augmentation and improves the range of movement of the ocular prosthesis. Gadolinium-enhanced magnetic resonance imaging (MRI) provides a noninvasive evaluation of the progressive fibrovascular ingrowth, and of possible foreign-body reactions; moreover, MRI is also important to exclude recurrent tumor. MR imaging can identify implants that fail to vascularize, alerting the physicians of possible risks of extrusion, migration, and infection. The purpose of this study was to assess the usefulness of gadolinium-enhanced magnetic resonance imaging to evaluate and characterize the temporal progression of fibrovascularization in patients with retinoblastoma who received synthetic hydroxyapatite implants after enucleation of the affected bulbus.

**MATERIALS & METHODS**

Thirty-four patients received a hydroxyapatite orbital implant after enucleation between 2001 and 2008. Postenucleation MR studies were performed on all 34 patients. From each T1-weighted, enhanced axial examination, the image depicting the center (equator) of the implant was identified. The time intervals between enucleation and MRI were arbitrarily divided in early (4 to 8 months), middle (9 to 12 months), and late (> 13 months) groups. A masked review of the MR images was performed by two experienced neuroradiologists; five increasing levels of implant enhancement degrees were evaluated.

**RESULTS**

There were no cases of clinically evident orbital infection, implant migration or implant extrusion during the follow-up period. No second tumor, optic nerve invasion, orbital extension, tumor relapse, and leptomeningeal brain seeding were noted. In six cases a little nodular lesion at the level of the section cut of the optic nerve was shown on MRI examination, consistent with inflammatory foreign-body reaction (granuloma); in three out of those cases, a subsequently performed MRI showed disappearance of the nodule. The early group consisted of 20 implants, the middle group of six implants, and the late group of 21 implants, respectively. There was a correspondence between high-grade (4-5) enhancement patterns and lack of therapy (Kruskal-Wallis test p<0.0001), and a tendency through a higher grade of enhancement within implants received by patients submitted to pre-enucleation therapies in comparison with those submitted to postenucleation therapies (Wilcoxon two-sample test p= 0.0166). New generation hydroxyapatite orbital implants permits host fibrovascular ingrowth, reducing the risks of extrusion, migration, and infection. MRI scanning with intravenous gadolinium, especially with fat-saturation sequences, is considered to be a good noninvasive method for evaluating vascularization of hydroxyapatite implants. After intravenous administration of gadolinium-DTPA on T1-weighted images, variable hyperintense signal areas in the hydroxyapatite implant suggested again the presence of fibrovascular ingrowth.

**CONCLUSION**

In our series, implants that were not submitted to chemotherapy and radiotherapy showed a statistically significant higher grade of enhancement. Moreover, patients submitted to preenucleation therapies showed a trend to a higher grade of enhancement in comparison with those submitted to postenucleation therapies. Middle-high (3-5) grades of enhancement prevailed in the “early” group (14 out of 20 implants). Finally, we found six focal lesions at the level of the section cut of the optic nerve, consistent with inflammatory foreign-body granulomas.

**KEY WORDS:** Retinoblastoma, orbital implants, MR imaging

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**Scientific Poster 186**

**Diffusion MR Imaging Findings in Monochorionic Twin Pregnancies after Selective Reduction by Bipolar Coagulation of the Cord**

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**PURPOSE**

Selective reduction in monochorionic (MC) twin pregnancies is offered in cases of an anomalous twin or severe TTTS. Unlike dichorionic twin pregnancies, selective reduction in MC twins is performed by US-guided bipolar coagulation of the umbilical cord in order to avoid shifting of blood from the living fetus into the dead co-twin. However, this procedure might be complicated by ischemic insult to the CNS of the living fetus. This study aims to share our experience with diffusion-weighted imaging (DWI) in monochorionic (MC) twins after bipolar coagulation of the cord, to both treated and nontreated fetus.

**MATERIALS & METHODS**

Five cases of bipolar coagulation of the cord in MC pregnancies during 09/2006-09/2008 at Sheba Medical Center. All cases were analyzed by fetal sonography before the pro-
RESULTS
Five cases were analyzed by the three modalities. Median gestational age at the procedure was 21 weeks. US-Doppler evaluation of the brain of the living fetus showed normal MCA-PSV with no signs of fetal anemia. In all cases the reduced fetus that underwent selective termination by bipo-
lar coagulation had a high signal in the DWI of the entire brain and low signal by ADC calculation, compatible with restriction of diffusion and global ischemia to the brain. The second fetus demonstrated normal signal with no ischemic changes.

CONCLUSION
Diffusion-weighted imaging is able to detect acute cerebral ischemic lesions during fetal life as in pediatric and adult brain.

KEY WORDS: Twin-to-twin transfusion, fetal MRI, DWI

Scientific Poster 187

MR Imaging Study Using Spectroscopy and Diffusion Tensor of HIV-1-Infected Pediatric Patients Receiving Antiretroviral Therapy

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PURPOSE
During the last decade, the number of HIV infections in chil-
dren has raised exponentially. There are estimations that almost 70% of infected children have some kind of neuro-
logic compromise, even with active antiretroviral therapy. Neuroimaging plays an important role in the diagnosis, moni-
toring and prognosis of these patients. The objective of this study is to assess the usefulness of magnetic resonance imag-
ing (MRI), magnetic resonance spectroscopy (MRS), perfu-
sion MRI (pmMRI) and diffusion tensor (DTI), in medically
stable, ambulatory HIV-1 infected pediatric patients and to establish associations between clinical features and neuroim-
age.

MATERIALS & METHODS
Prospective study of VIH-infected children, through blind clinical neurology testings, cerebral magnetic resonance image (1.5T), angio MR, multiple voxel spectroscopy, DTI, pmMRI and immunologic stages under CDC’s classification.

RESULTS
Twenty-two patients (13 girls), 10.2 years average age (range 1-15), mostly infected by vertical transmission. Twenty-two of them are receiving tritherapy. Six patients presented altered neurologic examination results, characterized by motor deficits, as spastic tetraparesis (4/6), spastic diplegy (1/6), hypotonic syndrome with psychomotor developmental delay (1/6) and pseudobulbar syndrome (1/6). Five of them presented altered neuroimages. From the group of 16 patients with normal neurologic examination results, seven presented altered conventional MR imaging, involving cerebral atrophy (2/7), white matter changes (4/7) and P1-P2 posterior cerebral artery stenosis (1/7). An association in the limit of statistical significance between neurologic findings and neuroimages was observed. However, there was a positive correlation between the white matter abnormalities and cerebral atrophy and stage C3 of the CDC classification. Diffusion tensor imaging and MRS were performed in all HIV-1 patients and four controls. Abnormal fractional anisotropy was found in the white matter of the frontal lobes and internal capsules and decreased N-acetylaspaspartate/creatine and N-acetylaspartate/coline ratios were found in frontal white matter of the HIV-1 patients.

CONCLUSION
Advanced neuroimaging techniques proving to be reliable surrogate markers for CNS involvement would offer great advantages in monitoring disease progression. Diffusion tensor imaging and MRS are more sensitive than conventional MR imaging methods for detecting white matter abnormalities in VIH-1 pediatric infected. The association degree between neurologic examination and neuroimages was fair. This association could be more evident in a larger-scale study.

KEY WORDS: VIH-1 infected

Scientific Poster 188

MR Spectroscopy of Premature Newborns with Correlation to Age

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PURPOSE
MR imaging techniques recently have demonstrated the ability to provide valuable anatomical imaging in the newborn brain, but additional metabolic markers would be important to provide improved assessments of neonatal brain injury. Three-dimensional point-resolved spectroscopic imaging (PRESS-MRSI) can provide accurate measurements of metabolite levels throughout the brain. In this study, lactate-edited 3D-PRESS was used to acquire MRSI in neonatal subjects, in order to better define the extent of normal and abnormal metabolite distributions.

MATERIALS & METHODS
A series of MR scans was performed for clinical assessment of the neonatal patient on 1.5 T GE Signa scanner (GE Healthcare, Milwaukee, USA) that include 1) T1-weighted sagittal and axial spin-echo images; 2) T2-weighted axial dual echo, spin-echo. Three-dimensional MR spectroscopy scan was performed to obtain metabolite levels covering most of the brain using PRESS with band selective inversion with gradient dephasing (BASING) lactate editing method (1-3). The uniformity of the selected region was obtained by slightly overexciting the prescribed region and shaped with very selective saturation (VSS) pulses (4). The acquisition parameters are 144ms/1s TE/TR, 1cc, 8x8x8, 17 minutes. Regions...
of interests (ROIs) were drawn on T2 images for thalamus, basal ganglia, visual association tract, central gray matter, corticospinal tract, parietal white matter, and frontal white matter. A total of 55 newborn subjects (34.2 ± 3.0 weeks gestational age), a total of 104 scans were studied. The studies were performed in an MR compatible incubator with a specialized neonatal head coil with informed consent (5). The study was approved by our institutional review board. Motor outcome was assessed at 1 year of age using a neuromotor score (NMS) of 0-5 as previously defined (6); cognitive outcome was measured using the mental development index (MDI) of the Bayley’s Scales of Infant Development II. For the compilation of a normative developmental MRSI database, we only included newborns with normal neurologic outcome (NMS=0; MDI>85). The included 55 subjects were among a population of 217 potential subjects.

RESULTS
The NAA to Cho ratio increased significantly with age for all regions in the premature infants with normal outcome. Lac to NAA ratio decreased significantly with age in the regions of THAL, BG, CST, and PWM, and showed a decreasing trend in the other regions. Lac to Cho ratio decreased statistically with age for CST, and varied differently for other regions.

CONCLUSION
This study demonstrated the feasibility of the new 3D lactate-edited MRSI methods to analyze the spatial and temporal variations of brain cellular metabolite levels in preterm infants. We established a dataset of normative metabolite levels, which may be used to assess patients with injuries at similar age. We observed the significant increase in NAA/choline with age due to brain maturation.

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KEY WORDS: Newborn, MRSI, normative

Scientific Poster 189

Dependence of Central Auditory Processing on White Matter Organization as Investigated by Diffusion Tensor Imaging

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PURPOSE
Previous studies have shown that fractional anisotropy (FA), a measure of white matter organization, increases in the developing brain (ages 5-18)(1). Here we investigate the relation between FA and performance on a central auditory processing task, interpretation of speech in noise, in a population of normal children.

MATERIALS & METHODS
Diffusion tensor imaging (DTI) data were obtained from 16 children (6F, 10 M; Mean age = 10.2 +/- 1.0 years; Mean full-scale IQ = 112 +/- 9.5) scanned on a Siemens 3T Trio system. Scan parameters were: TR/TE = 6000/87 ms, FOV = 25.6 X 25.6 cm, matrix = 128 X 128, slice thickness = 2 mm, NEX = 3. One scan without diffusion weighting and 12 scans with diffusion weighting (b = 1000 s/mm² were obtained). Whole-brain T1-weighted MP-RAGE images also were obtained for white matter segmentation and anatomical coregistration. Outside the scanner, the Bamford-Kowel-Bench (BKB) speech-in-noise test was administered, which consists of sentences spoken by a male talker over four-talker babble; scores of the test are the SNR level at which the subjects achieve half correct identification. Normal hearing was verified via standard audiometry. Data analysis was conducted using in-house routines written in IDL (ITT Systems Inc., Boulder, CO) and in SPM5 (Wellcome Dept. of Cognitive Neurology, London, UK). The FA maps were normalized into standard (MNI) space, using parameters derived from normalization of the white matter probability maps to a pediatric template. A voxelwise analysis with multivariate regression was used. The FA values were the dependent variable with independent variables of age, sex, IQ, and SIN score; the model also contained age-X-SIN, sex-X-SIN, and IQ-X-SIN interactions. Only those voxels with FA > 0.25 and white matter probability > 0.9 were retained for analysis, to account for possible confounds resulting from imperfect spatial normalization or morphometric differences. Using a Monte Carlo technique, regions were found with p < 0.05 (corrected for multiple comparisons).

RESULTS
There was a significant correlation between task performance and age (R = 0.6, p < 0.05) but not with sex or IQ. Main effect of task performance on FA, and also a task-X-sex interaction (girls > boys), was shown in superior frontal regions bilaterally (adjoining BA 44/9), and a region adjoining BA 45 in the right hemisphere. Regions which showed negative task-X-age interactions on FA values included white matter adjoining the anterior cingulate bilaterally and posterior cingulate in the right hemisphere, and language association regions in the left hemisphere. Results indicate dependence on connectivity with classical language processing regions, greater in girls, perhaps due to differing developmental trajectories; as well as decreased dependence on connectivity with attentional and language association regions with age, likely due to diminished task difficulty.

CONCLUSION
Results indicate developmental effects on the relation of brain organization to central auditory processing, which are moderated by sex differences.

REFERENCES

KEY WORDS: Children, diffusion magnetic resonance imaging
Scientific Poster 190

Pediatric Normative Database in Basal Ganglia Magnetic Resonance Spectroscopy

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PURPOSE
To develop a normative pediatric database for magnetic resonance spectroscopy (MRS) utilizing basal ganglia voxel placement. In vivo metabolite concentrations via MRS provide valuable diagnostic information.

MATERIALS & METHODS
A retrospective analysis was conducted of clinical and imaging data of children who received MRS at CNMC. Each patient was rated by a neurologist blinded to imaging data, and neuroradiologist blind to clinical data, for normal neurologic status and structural imaging, respectively. Peak heights of N-acetyl aspartate (NAA), creatine (Cre), choline (Cho), were measured at 35 ms (short TE) and 288 ms (long TE) echo times via single voxel MRS. Short TE was 35 ms and long TE was adjusted to 288 ms for all studies. Peak height ratios of NAA/Cre and NAA/Cho were calculated.

RESULTS
Two hundred eighty-two children had spectra acquired from the basal ganglia; 204 had both short and long TE data. Of these, 40 (ages 11 months to 21.2 years; mean 59 months) were classified as both normal on clinical and radiographic scales.

CONCLUSION
N-acetyl aspartate/Cre and Cho/Cre ratios were derived from a normal pediatric population studied with single voxel basal ganglia MRS. Ratios using long TE spectra were NAA/Cre 2.35 ± 0.30 and Cho/Cre 1.39 ± 0.18. This data may serve as a reference point for interpretation of pediatric MRS.

KEY WORDS: Magnetic resonance spectroscopy, pediatric basal ganglia, normative database

Scientific Poster 191

Diffusion Tensor Imaging of Deep Gray Matter in Children Receiving Brain Radiation Therapy

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PURPOSE
Radiation therapy has improved survival among children with brain malignancies. However, brain radiation therapy (RT) can generate a spectrum of acute, early delayed, and late adverse effects, including demyelination(1). Late effects have been associated with clinical brain toxicities, including neurocognitive deficits. Diffusion tensor imaging (DTI) is a noninvasive method that has provided unique information on the normal maturation of white matter tracts and gray matter, which show dramatic changes in apparent diffusion (ADC) and fractional anisotropy (FA) throughout childhood and adolescence(2). Diffusion tensor imaging also has been used to demonstrate radiation-induced white matter pathology(3). The aim of this prospective study was to evaluate whether changes in FA and ADC values in specific gray matter regions could be detected among children who have received brain RT.

MATERIALS & METHODS
Five pediatric patients (all boys, 12.5-14.9 years) were examined 27 months following completion of brain RT. The control group was comprised of five healthy children (4 girls, 13.3-14.4 years, and one boy, 14.6 years). All subjects were evaluated with neuropsychologic tests. MR imaging was performed at 1.5 T. Diffusion tensor imaging data were acquired with a single-shot spin-echo planar sequence. FA, ADC, and color maps were calculated from raw data(4). Each region of interest (thalamus, globus pallidus, putamen, caudate head, and parahippocampal region) was drawn on the color maps two times and the measurements were averaged. GLM ANOVA was applied for statistical evaluations, using the SPSS software.

RESULTS
Overall analysis revealed a statistically significant difference in ADC between patients and controls (p=0.004). The mean ADC value (calculated from all regions in both hemispheres) was 8.9% higher in patients. In individual regions, mean ADC was 10.4% higher in the parahippocampal region in patients (p=0.007). There were no statistically significant differences in mean FA between the controls and the patients, although there was a trend towards a relative increase in FA among the patients (p=0.081). For both ADC and FA, there was a trend to wider range of values within regions among patients. Compared to controls, patients tended to have a better performance on the memory test (Woodcock-Johnson Memory Test of Words; p<0.08 for both raw and standard scores).

CONCLUSION
Significantly higher mean ADC values calculated from five gray matter regions among patients receiving RT compared with age-matched controls suggests that DTI may detect delayed changes in deep gray matter integrity associated with RT. This suggests that radiation may cause damage which could lead to a failure of these structures to mature normally, possibly before this damage becomes clinically apparent.

REFERENCES

KEY WORDS: Diffusion tensor imaging, radiation, gray matter
Combined Functional Mapping of Eloquent Cortex and White Matter Tracts in Pediatric Epilepsy Surgery

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PURPOSE
Diffusion tensor imaging (DTI) tractography can be used to identify the location of eloquent white matter tracts such as corticospinal tracts and optic radiations. The aim of this study is to determine the role of DTI tractography in combination with presurgical mapping of eloquent cortex for planning pediatric epilepsy surgery.

MATERIALS & METHODS
Ten children with intractable epilepsy underwent DTI tractography and functional mapping of eloquent cortex using magnetoencephalography (MEG) that was subsequently fused to anatomical MR. MEG also was performed to assess the location of epileptogenic zone. Six patients had low-grade tumor, two had encephalomalacia in one hemisphere, one had large heterotopion and one had meningioangiomatosis. Diffusion tensor imaging was fused to the MEG data and the location of eloquent cortex was used to initiate tractography using streamline approach. Diffusion tensor imaging tractography then was projected onto MEG data to visualize the relation of lesion and MEG dipoles to eloquent white matter tracts.

RESULTS
The eloquent white matter tracts assessed included the corticospinal tracts (6 cases), optic radiations (3 cases) and arcuate fasciculus (1 case). Six of the 10 patients underwent surgery. Of the six patients, one had improvement in visual field defects following tumor resection and one had slight improvement of the hemiplegic arm following resection of encephalomalacia and repair of growing skull fracture. The remaining four patients had stable neurologic status postoperatively.

CONCLUSION
Combined functional mapping of eloquent cortex and white matter tracts is useful for presurgical planning of epilepsy surgery in selected cases, so as to minimize neurologic deficit from epilepsy surgery.

KEY WORDS: Diffusion tensor imaging, pediatric epilepsy, magnetoencephalography
CONCLUSION
Based on our preliminary experience, prospective use of Colombo et al.'s MR imaging criteria for non-Taylor type FCD seems not strictly associated with the neuropathologic finding of cortical disorganization.

REFERENCES

KEY WORDS: Cortical dysplasia, non-Taylor type, epilepsy

Scientific Poster 194

Malformations of the Midbrain and Hindbrain: Review of the Literature

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PURPOSE
We have reviewed midbrain and hindbrain malformations with advances in embryology and molecular neurogenetics.

MATERIALS & METHODS
Magnetic resonance and computed tomography images obtained in 45 patients with a diagnosis of mid-hindbrain malformation were studied retrospectively.

RESULTS
Amongst 45 patients with mid-hindbrain malformations; 16 molar tooth malformation, 12 cerebellar hypoplasia, 10 posterior fossa cyst and cerebellar vermian hypoplasia, 3 rhombencephalosynapsis, 2 Fukuyama congenital muscular dystrophy, and 2 isolated cerebellar dysplasia were identified. Twenty-five patients presented with motor-mental retardation, which was the most common clinical finding. Eleven patients were born to consanguineous parents.

CONCLUSION
Correct diagnosis of the cerebellar malformation is important to inform the family with regard to prognosis, recurrence risks and genetic counseling. Integrated classification of malformations based on morphology, embryology and molecular neurogenetics may be the most useful.

KEY WORDS: Cerebellum, malformation, MR

Scientific Poster 195

Prenatal Diagnosis of Central Nervous System Malformations with Magnetic Resonance Imaging

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PURPOSE
Twenty percent of congenital malformations in the newborn affect the CNS. Development of fast MR imaging sequences has revolutionized their prenatal study, improving diagnosis accuracy, perinatal handling and complications treatment. Objective: To show our experience with MR imaging in the prenatal diagnosis of CNS malformations.

MATERIALS & METHODS
A retrospective study of seventy women and seventy-three fetuses, with prenatal ultrasonographic diagnosis of diverse malformations of the SNC. HASTE and T1 GRE sequences were used.

RESULTS
Maternal average age was 25 years (range 15-44 years), mean gestational age was 33 weeks (range 22-37 weeks). The most common diagnoses at fetal MR imaging were: supratentorial hydrocephalus (14 cases, 13 of whom had aqueductal stenosis), ventriculomegaly (11 cases), agenesis or hypoplasia of the corpus callosum (9 cases), interhemispheric cysts (9 cases), megacisterna magna (6 cases), intracranial tumors (4 cases), hydranencephaly (4 cases), encephalocoele (4 cases), Galenus Vein malformations (3 cases), Chiari malformation (3 cases), choroidal cysts (2 cases), holoprocencephaly (2 cases), acrania (1 case) and Dandy Walker syndrome (1 case). The prenatal diagnosis with MR imaging was discordant with prenatal US findings in 30/73 cases. In 2/73 studies MR imaging ruled out CNS pathology suspected at US.

CONCLUSION
Fetal MRI is superior to prenatal US to visualize CNS structures and malformations, allowing accurate and timely prenatal diagnosis of CNS pathologies, which is essential for planning medical strategies of these complex cases.

KEY WORDS: Fetal MRI

Scientific Poster 196

White Matter Structural Abnormalities in Congenital Brain Malformation: Evaluated with Diffusion Tensor Imaging of Fiber Tracts at 1.5 T

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PURPOSE
Diffusion tensor imaging (DTI) is based on the ownership of preferential movement of water protons within the brain
along the axis of the axons. The information contained within the diffusion tensor data can be used to create 3D mathematical renderings of white matter or tractography (DTT), allowing the larger individual white matter tracts to be visualized as anatomical structures and may be used to evaluate a variety of brain malformations. Objective: To investigate the ability of DTT to visualize white matter tract involvement in different brain malformation.

**MATERIALS & METHODS**

Diffusion tensor tractography data (1.5 T) were analyzed retrospectively in eight patients with congenital cerebral malformation (6 schizencephaly, 2 cortical dysplasias and 1 agenesis of corpus callosum).

**RESULTS**

Diffusion tensor tractography revealed altered patterns of white matter tracts including deviation, deformation, infiltration, and apparent tract interruption.

**CONCLUSION**

Diffusion tensor tractography (DTT) is a promising technique for estimating the course, extent, and connectivity patterns of the white matter structures in brain malformations. Compared with the information provided by conventional MR imaging, DTT provided superior visualization of lesion involvement in eloquent fiber tracts of the brain and expands our understanding of these malformations.

**KEY WORDS:** Diffusion tensor tractography

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**Scientific Poster 197**

**MRS Imaging Follow Up in Two Brothers Affected by X-Linked Adrenoleukodystrophy: Comparison between Different Clinical and MR Imaging Stages and Different Therapies**

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**PURPOSE**

X-linked adrenoleukodystrophy (X-ADL) is a rapidly progressive disorder including ataxia, spasticity and focal neurologic deficits. Hemopoietic stem cell transplantation (HSCT), hydrocorticoid drugs and hypolipidic diet are the therapeutic options. Early disease diagnosis and precocious MR imaging and MRSI changes may guide the choice of treatment. The aim of our study is to demonstrate early metabolic changes on MRSI analysis in a patient without clinical evidence and MR imaging alterations.

**MATERIALS & METHODS**

Two young males (average 7.5 years; range 6-9 years) were investigated with genetic, laboratory, MR imaging and MRSI examinations. MR imaging and MRSI were performed at baseline and follow-up MR imaging over a period of 2.5 years. One brother had a positive clinical pattern and an abnormal MR imaging-MRSI at baseline and worsened on follow-up evaluation. On the contrary, the younger brother had normal findings on MR imaging-MRSI at baseline examination and no evidence of clinical neurologic disorders. On MRSI, voxels were analyzed in the normal and abnormal MR imaging appearing occipital white matter. The concentration ratios of N-acetylaspartate (NAA) to choline (Cho) and to creatine (Cr) were investigated. Inositol/Cr, Inositol/Cho and Creatine/Cho ratios also were considered. Proton MRSI follow up was performed in the occipital white matter in both patients.

**RESULTS**

In the younger brother that was initially negative, we demonstrated a significant decrease of NAA/Cho ratio in normal appearing MR imaging occipital white matter. After 6 months we were able to show an initial signal intensity alterations in neighboring regions to the voxels previously analyzed on MRSI. The patient was still asymptomatic. The association of clinical pattern (asymptomatic patient), the precocious spectroscopic changes and initial MR imaging alterations led to HSCT. Today (5 months after HSCT) we do not have modifications of metabolic ratios but we demonstrate a progressive alteration of occipital white matter. The patient is still asymptomatic.

**CONCLUSION**

We describe our experience in two young males with confirmed X-ADL. One of these, asymptomatic, underwent HSCT in early stage disease. MRSI examinations demonstrated a precocious decreased ratio of NAA/Cho, NAA/Cr and showed the presence of lactate in a normal appearing occipital white matter. We did not report significant spectroscopic changes in the child observed for a period of 5 months following treatment but we demonstrate a diffuse occipital white matter alteration. However, the described MR imaging changes after HSCT might be caused by immunosuppressive therapy or be correlated to the X-ADL typical progressive pattern, started before the treatment. In conclusion, we believe that MRSI seems to be a useful technique in diagnostic, prognostic and follow-up assessment of X-ADL.

**KEY WORDS:** Adrenoleukodystrophy, MRI, X-linked

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**Scientific Poster 198**

**Pediatric Choroid Fissure Arteriovenous Fistulas: Differentiation between Vein of Galen Aneurysmal Malformation and Dilatation**

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**PURPOSE**

Pediatric choroid fissure arteriovenous fistulas (PCFAVFs) usually are associated with dilated central vein and classified as vein of Galen aneurysmal malformation (VGAM) and vein of Galen aneurysmal dilatation (VGAD). VAGM is supposed to have the persistent embryonic choroidal vein in the midline (median prosencephalic vein) as its draining vein which is the precursor of the vein of Galen and has no connection to the cerebral veins. In contrast, VGAD is supposed to have the dilated true vein of Galen as its drainer which shares drainage of the brain. However, there are several reports describing VGAMs with the co-existing internal cerebral vein (ICV) and some cases are difficult to classify.
MATERIALS & METHODS
We retrospectively reviewed 57 PCFA VFs with dilated Galenic system which were treated by endovascular embolization in our institution from 1996 to 2008 and have enough angiographic data for review. Lesions were classified into VGAM (choroidal and mural types) and VGAD (choroidal, quadrigeminal, combined, and mural types) depending on the feeders and fistula sites. All cases that had visualization of ICV or cortical venous reflux were classified as VGAD.

RESULTS
There were 24 VGAMs (5 mural and 19 choroidal). Mural VGAMs presented between newborn and 11 months of age with mild congestive heart failure (CHF), or macrocephaly/hydrocephalus. The average treatment age was 5 months. All choroidal VGAMs except for two cases presented with CHF within 2 weeks of life. Many of them were treated within 1 month of life. There were 33 VGADs (11 quadrigeminal, 9 choroidal, 5 combined and 8 murals). They presented with variety of symptoms including CHF, macrocephaly, seizures, incidental, prominent facial veins, developmental delay, and headaches. The age of presentation widely ranged from fetus to 19 years old. Three mural and 3 choroidal type VGADs had the same angiographic findings as mural and choroidal VGAM, respectively, except for visualization of ICV or cortical venous reflux.

CONCLUSION
PCFA VFs have various degrees of development of the vein of Galen ranging from the median prosencephalic vein without connection to the cerebral veins to the fully developed vein of Galen connecting to the ICV and other cortical veins. Internal cerebral vein can co-exist with persistent median prosencephalic vein in some cases. PCFA VFs are located in the subarachnoid space of the choroid fissure and distinct from other subpial brain AVMs with dilated vein of Galen. They are created in the earlier phase of development than other brain AVMs and supplied by choroidal and quadrigeminal arteries and drained by the vein of the choroid plexus which is originally the median prosencephalic vein and eventually becomes the vein of Galen. Occlusion of the draining vein should not be performed as the initial treatment even for the apparent VGAM, because connection of the draining vein to the cortical veins may not be angiographically visualized due to high flow shunts and can cause hemorrhage after occlusion of the draining vein.

KEY WORDS: Vein of Galen, arteriovenous malformation, angiography

Scientific Poster 199
Role of CT Angiography in the Management of Suspected Intracranial Aneurysms in Children
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London, UNITED KINGDOM

PURPOSE
Intracranial aneurysms in children are uncommon and have a varied etiology. Although CT angiography (CTA) is used extensively in the adult context, its role in evaluating suspected aneurysms in children has not been widely studied. We attempted to evaluate the role of CTA in the management of suspected intracranial aneurysms in the pediatric population.

MATERIALS & METHODS
Eight children with suspected intracranial aneurysms underwent CTA on a Siemens Sensation 16 slice scanner following the administration of Omnipaque 300 (1ml/kg), injected at a rate of 2-3ml/sec via a 20G/22G canula in the upper limb. Postprocessing and 3D reconstructions were done on a dedicated workstation (Siemens Leonardo). The raw data and the reconstructed 3D data set then were evaluated to look for the presence of an aneurysm. If an aneurysm was found, its site, size, shape, neck and relationship with adjacent vessels was evaluated. When presence of an aneurysm was suspected or established on the CTA, or when an aneurysm was strongly suspected, a conventional digital subtraction angiogram (DSA) was performed followed by endovascular treatment if appropriate (Figure).

RESULTS
The presentation was variable; four children presented with subarachnoid hemorrhage (SAH) and one each with headache, 3rd nerve palsy and trauma. CT angiography showed an aneurysm in six children. Findings were concordant in all. Five of these children underwent a DSA and subsequent endovascular coil embolization. In one SAH patient, CTA, MRA and DSA were all negative for an aneurysm but showed transverse sinus thrombosis. In one patient, CTA
demonstrated focal ectasia of intracranial vessels, which was concordant with MRA and this patient did not undergo catheter angiography. In our short series of eight patients with suspected aneurysms, CTA was concordant with DSA in all six patients who underwent DSA, although aneurysm morphology was better seen on DSA. No aneurysm was demonstrated on catheter angiography when the CTA was negative.

CONCLUSION
CT angiography is valuable in managing children with suspected intracranial aneurysms.

KEY WORDS: Intracranial aneurysms, pediatrics, aneurysms

Scientific Poster 200

Thalamic Damage in Perinatal White Matter Injury: Assessment with Diffusion Tensor Imaging

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PURPOSE
Survivors of prematurity have a high incidence of childhood cognitive deficits. We hypothesize that cognitive deficits are related to abnormal development of thalamo-cortical connections, which are thought to be disrupted in both focal and diffuse perinatal white matter injury. The purpose of this study was to compare volume with both diffusivity and anisotropy diffusion tensor metrics in the thalamus of children with a history of prematurity and evidence of perinatal white matter injury (PVL) on conventional MR imaging.

MATERIALS & METHODS
The institutional review board at our medical center approved the study protocol. Our study included 68 controls (age range 1.8 yr to 13 yrs) and 11 PVL patients (age range 1.6 yr to 11 yrs;) for the DTI analyses. All PVL children had a history of prematurity (gestational ages of 24 to 36 weeks) with evidence of PVL on FLAIR imaging. All the controls were full term subjects with normal MRI. A 1.5T (GE-Medical Systems, Milwaukee, WI) magnet was used. The DTI protocol consisted of an echo-planar imaging (EPI) sequence with 25 directions. Manual placement of region of interests on T2-weighted were used to calculate thalamic volume. DTI Studio was used for diffusivity (mm2/sec) (mean, axial and radial) and anisotropy (fractional, relative and volume ratio) measurement. ANOVA was used to compare the DTI metrics between the two groups.

RESULTS
In all PVL children, thalamus showed no focal signal abnormalities including infarcts on conventional MR imaging pulse sequences. The post-conceptional ages of both groups were similar (p=0.43). The volume of thalamus in PVL patients was significantly decreased compared to control cases adjusted for postconceptional age (Table 1, p<0.00001). The mean diffusivity of the thalamus was higher in PVL group (Table 1, p=0.036) than in controls. Thalamic radial diffusivity (Table 1, p=0.02) was increased in the PVL group compared to controls. In comparison, the anisotropy metrics (Table 1) were not different between the two groups. There were no strong correlations between thalamic volume and diffusion metrics for both groups (Pearson correlations in range -0.22 to 0.29).

| Age (months) | 52 (38.2) | 63 (41.1) | 0.43 |
| Volume (mm³) | 24,411 (15,471) | 53,629 (16,722) | <0.00001 |
| Mean Diffusivity (x 10⁻³ mm²/sec) | 0.84 (0.10) | 0.79 (0.06) | 0.036 |
| Axial Diffusivity (x 10⁻³ mm²/sec) | 1.05 (0.11) | 1.01 (0.07) | 0.07 |
| Radial Diffusivity (x 10⁻³ mm²/sec) | 0.73 (0.10) | 0.69 (0.05) | 0.02 |
| Fractional Anisotropy | 0.25 (0.02) | 0.25 (0.02) | 0.07 |
| Relative Anisotropy | 0.21 (0.02) | 0.22 (0.02) | 0.09 |
| Volume Ratio | 0.07 (0.01) | 0.08 (0.01) | 0.12 |

CONCLUSION
Despite normal signal intensity, the volume of the thalamus was decreased in PVL children compared to age-matched controls. Significant differences were observed in select diffusivity measurements of the thalamus in PVL children, which likely reflects combination of axonal injury (axial diffusivity) and demyelination (radial diffusivity). Future work is aimed at studying correlative cortico-thalamic connections and neurocognitive outcome in survivors of prematurity and perinatal white matter injury.

KEY WORDS: Diffuse tensor imaging, white matter injury

Scientific Poster 201

Metabolic Maturation of White Matter is Different in Prematurely Born Neonates When Compared With Age-Matched Term-Born Neonates

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PURPOSE
To compare age-dependent changes of metabolites in white and grey matter of term-equivalent premature neonates with normal MR compared to age-matched term neonates using quantitative proton MR spectroscopy.

MATERIALS & METHODS
Control data for “term” metabolic maturation of the human brain were generated from 223 spectra of parietal white matter (WM) and occipital grey matter (GM) obtained from 159 subjects (age < 5 yrs). 35 spectra (19 WM, 16 GM) from 29 prematurely born subjects born at gestational age (GA) 31-38 weeks were analyzed. All control subjects were born term (GA=40 weeks). MRI (including diffusion imaging) was reported normal, and clinical follow-up (where available) was unremarkable for all subjects. Clinical indications for MR studies were equivalent and included suspicions of encephalitis, metabolic disorders, seizures (retrospectively classified as febrile seizures), hypoxic-ischemic episodes, and others. Single-voxel PRESS (TR/TE = 1500ms/35ms) spectra were acquired. Spectra were processed with LCModel software (Stephen Provencher Inc., Oakville, Ontario, Canada, LCModel Version 6.1-4F) and absolute
metabolite concentrations were determined. Control concentrations as function of post-conceptional age were obtained by fitting functions to the metabolite concentrations measured in term.

RESULTS
In white matter (Figure) N-acetyl-aspartate (NAA) concentrations increased rapidly within the first few months of life whereas ml decreased. For 15/19 prematurely born subjects, NAA levels were higher (preceding) than in term born babies at equivalent age. Myo-inositol (ml) levels in 14/19 premature born subjects were lower (also preceding) than those observed in term subjects at equivalent age. Consistent observations were made for creatine and glutamate (13/19 and 14/19 preceding). The measurement of these metabolites is independent (no covariance) and the combined distribution (56 preceding vs. 20 lagging) is significantly asymmetric (p<0.01). In contrast, there was no difference in metabolite concentration between the preterm and term groups in grey matter.

CONCLUSION
There are subtle but significant differences in the biochemical maturation of white matter in premature infants with no evidence of white matter injury when compared to control term infants. The observations are consistent with accelerated white matter development in premature brain possible from increased sensori-motor stimulation in the extrauterine environment. Prematurity appears to have comparatively less of an impact on biochemical maturation of grey matter.

KEY WORDS: MRS, prematurity, neonates

Scientific Poster 202
Middle Ear Cavity Dimensions on CT as a Predictor of Surgical Outcome in Patients with Congenital Aural Atresia

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PURPOSE
A number of grading systems have been developed for surgical selection of patients with congenital aural atresia. None of these studies assessed the importance of middle ear cavity dimensions, as a predictor of surgical outcome. The purpose of this study was to ascertain the correlation between the middle ear cavity measurements on temporal bone CT and surgical outcome based on audiometric data.

MATERIALS & METHODS
Twelve children (7 girls and 5 boys; mean age, 6 years) who were treated surgically for congenital aural atresia were enrolled. Twelve age-matched children (n = 24 ears) with normal temporal bone CT scans served as a control group. Temporal bone CT was performed, and coronal and axial measurements of the middle ear cavity were obtained using definite landmarks. Measurements in the coronal plane were made between the oval window and the scutum, whereas the distance from the round window to the descending facial nerve canal was measured on axial images. The measurements in patients with congenital aural atresia were compared with the control group. Comparisons were also made between the normal and the atretic sides in patients with unilateral canal atresia. Audiologic tests were performed on all patients after surgery. Speech reception threshold or air-bone conduction gap of 30 dB or less was considered as poor surgical outcome.

RESULTS
The mean distance between the scutum and oval window on coronal images in normal subjects was 5.9 mm (+/- 0.8 mm). The corresponding measurement in patients with aural atresia (affected ear) was 4.2 mm (+/- 1.5 mm). This difference was statistically significant with p-value < 0.01. Comparison between the normal subjects (mean 5.9 mm) and the normal ear measurements in patients with unilateral canal atresia (mean 5.7 mm) was not statistically significant with p-value more than 0.1. Significant differences (p<0.01) were also found between the normal and affected sides in patients with unilateral atresia. The mean distance between the round window and facial nerve canal on axial images in normal subjects was 5.0 mm (+/- 0.8 mm). The corresponding measurement in patients with aural atresia (affected ear) was 4.8 mm (+/- 1.8 mm). This difference was not statistically significant (p > 0.1). The extent of narrowing of the tympanum correlated with the surgical outcome based on audiometric data. Four patients with narrowing of the middle ear cavity had unsatisfactory post-surgical outcome. Five patients had borderline hearing improvement which was significantly less than expected. The two patients with the most severely reduced middle ear dimensions had the worst outcome.
CONCLUSION
Single measurement on coronal CT images can be used to assess the severity of middle ear cavity narrowing in patients with congenital aural atresia. This measurement may be a useful predictor of hearing improvement following surgery.

KEY WORDS: Aural, atresia, CT

Scientific Poster 203
Imaging of Third Branchial Anomalies: Are We in the Correct Path?

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PURPOSE
Third branchial anomalies are reported to be rare and widely misrepresented in the radiology literature. They result from failure of obliteration of third branchial apparatus and in theory may follow a frequently quoted complex course along the carotid sheath. However no such lesion with histopathology proof has ever been reported and commonly they present in young children with recurrent neck abscesses or iatrogenic fistula formation following repeated incision and drainage. Several recent studies have shown that they rather go along the course of the embryological 'thymopharyngeal duct', frequently passing through the thyroid gland, most often on the left side. So this study retrospectively reviews imaging features and clinical presentations in anomalies of the third branchial apparatus.

MATERIALS & METHODS
Institutional and diagnostic imaging data bases from 1998 to 2008 for reported cases of third branchial cleft anomalies were reviewed. All patient records were examined for clinical presentation, pharyngoscopy results, imaging features and also surgical findings in patients who underwent surgical excision of the abscess and tract.

RESULTS
17 cases of third branchial cleft anomalies were identified. There were 8 females and 9 males, with an age range of 9 months to 10 yr 7 months. The most common presentation was a left sided inflammatory neck swelling (15/17). All cases, but one had undergone contrast enhanced CT study of the neck, 7 had gadolinium enhanced MRI, and 8 had ultrasonography of the neck also. The commonest imaging finding was a contrast enhancing mass involving the left thyroid gland with surrounding inflammatory changes (15/17). The lesion size ranged from small inflammatory lesion confined to the upper thyroid pole to large abscesses tracking from the pyriform sinus to the thoracic inlet along the anterior margin of the sternocleidomastoid muscle. Two cases were not seen to be inflammed, both on the right side and two were not traversing through the thyroid lobe, but remained adjacent to it. Two cases had recurrent abscesses due to previous inadequate excision of the lesion. All the cases had a sinus opening at the piriform fossa on pharyngoscopy.

CONCLUSION
Pediatric third branchial anomalies are uncommon lesions which present with inflammatory neck masses involving the thyroid lobe most often on the left side. Imaging studies are important, to assess the size and extent of the lesion accurately. Complete excision along with hemithyroidectomy is necessary to prevent recurrence of infection. Imaging and surgical findings suggest that third branchial anomalies usually follow the course of the embryonal thymopharyngeal duct, rather than the expected theoretical course of the 3rd branchial arch lesions.

KEY WORDS: Third branchial anomaly, imaging, embryology

Scientific Poster 204
Diagnostic Value of Shunt Series Radiographs in Conjunction with Cranial CT in Evaluation of Children with Suspected Ventriculo-Peritoneal Shunt Malformation

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PURPOSE
To determine and compare the sensitivity, specificity and positive predictive value (PPV), negative predictive value (NPV) and accuracy of shunt series radiographs and cranial CT in diagnosis of ventriculo-peritoneal shunt malfunction in children visiting ED with clinically suspected shunt malfunction.

MATERIALS & METHODS
Retrospective review of 109 consecutive children from January 2006 to June 2008 age newborn to 18 years referred from ED for suspected ventriculo-peritoneal shunt malfunction. Patients without base line CT were excluded. There were 69 boys and 40 girls with mean age of 6.3 years and SD of 4.7 years. Imaging studies were interpreted by board certified radiologists. Outcome was determined by medical record review. Sensitivity, specificity, PPV, NPV and accuracy of shunt series and cranial CT for shunt malfunction were calculated. Surgical shunt revision following documentation of raised intracranial pressure was considered the gold standard for the diagnosis of shunt malfunction.

RESULTS
The most common clinical symptoms were headache, vomiting and altered mental status. Shunt malfunction was present in 35 (32%) patients. Fifteen children had disconnected shunt tube on shunt series. Eleven of those patients required urgent surgical intervention. Shunt series had 31% sensitivity, 95% specificity, 73% PPV, 74% NPV and 75% accuracy. CT had 96% sensitivity, 90% specificity, 81% PPV, 93% NPV and 89% accuracy. Neither CT nor shunt series showed features of shunt malfunction in 5 of 35 (14%) children.

CONCLUSION
Neither shunt series nor cranial CT showed any imaging findings of shunt malfunction in 14% of patients with shunt malfunction that required shunt revision. Although CT has better sensitivity, PPV, NPV and accuracy compared to shunt
series radiographs, radiographs have better specificity. Although recent articles have questioned the utility of shunt series in children with suspected shunt malfunction, our study showed that 73% of patients with disconnected shunt catheters on shunt series required urgent surgical intervention. Considering the low radiation dose of shunt series and time constraints in ED, both CT scan and shunt series radiographs in conjunction with clinical evaluation are important in evaluation of suspected acute shunt malfunction in children. Larger studies and multiple center studies are required.

**KEY WORDS:** Malformation, shunt, cranial CT

### Scientific Poster 205

**Acute Stoke is Associated with Increased Prominence of Cerebral Deep Medullary Veins on Susceptibility Weighted Imaging in Patients with Moyamoya**

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**PURPOSE**

Ischemic penumbras are areas of hypoperfused tissue at the periphery of acute brain infarcts. After autoregulatory failure, hypoperfusion results in a higher oxygen extraction fraction from the blood with consequent rise in venous deoxyhemoglobin concentration. Deoxyhemoglobin is paramagnetic and appears dark on Susceptibility Weighted Imaging (SWI), a specific MRI sequence. This study tests the hypothesis that deep medullary veins (DMV) are more prominent in the presence of diffusion-restricted infarct in patients with moyamoya disease.

**MATERIALS & METHODS**

Under IRB approval, a retrospective cohort study was conducted of all patients with moyamoya disease and SWI imaging. Six patients (four male and two female) with a total of 13 SWI studies were identified ranging in age from 1.7 years to 22 years. Two neuroradiologists reviewed the MRIs and scored each hemisphere for presence or absence of a significant diffusion restricted infarct and rated DMV prominence per hemisphere using a 7-point ordinal scale. Hemispheres were divided into various study groups: stroke on either side versus no stroke on either side; and, ipsilateral stroke versus contralateral stroke versus neither. DMV prominence per hemisphere was analyzed by the various groups using Kruskal-Wallis and Mann-Whitney U.

**RESULTS**

Median DMV prominence was different (p = 0.001) in hemispheres of patients with acute stroke (6.0) versus in hemispheres of patients without acute stroke (3.0). The difference in mean rank of DMV prominence per hemisphere between the Ipsi, Contra, and Neither study groups was statistically significant (Kruskal-Wallis, p = 0.003). In post hoc comparisons (Table), the difference in mean ranks in DMV between Ipsi (median 6.0) vs Neither (median 3.0) was statistically significant (Mann-Whitney U, p = 0.001). The other comparisons were not statistically significant, but suggestive given the low power: Ipsi vs Contra (Mann-Whitney U, p = 0.250), Contra vs Neither (Mann-Whitney U, p = 0.080).

**CONCLUSION**

In patients with moyamoya, DMV prominence on SWI is markedly increased both ipsilateral and contralateral to acute stroke compared to in the absence of acute infarct. SWI appears to allow visualization of altered metabolism in ischemic brain (i.e. increased deoxyhemoglobin concentration).

**KEY WORDS:** Susceptibility weighted imaging, deep medullary veins, moyamoya

### Scientific Poster 206

**Cyanotic Heart Disease is Associated with Increased Prominence of Cerebral Deep Medullary Veins on Susceptibility-Weighted Imaging in Children Undergoing Evaluation for Heart Transplantation**

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Loma Linda, CA

**PURPOSE**

To test the hypothesis that cerebral deep medullary veins (DMV) are more prominent on Susceptibility Weighted Imaging (SWI) of the brain in cyanotic heart disease than acyanotic heart disease among children with heart failure.

**MATERIALS & METHODS**

With local IRB approval, a retrospective cohort of pediatric patients evaluated for cardiac transplantation at LLUMC from 02/2001 to 02/2008 was identified (n = 201). All patients who underwent head MRI with adequate quality SWI were included (n = 72). A pediatric cardiologist blinded to DMV prominence and patient identity classified each patient as cyanotic (arterial O₂ saturation <90%; n = 43) or acyanotic (arterial O₂ saturation >90%; n = 29) by cardiac
diagnosis. DMV prominence on SWI was scored by two neuroradiologists blinded to cardiac diagnosis using a 7-point ordinal scale. (Figure: axial SWI images: (left) acyanotic 18-month-old male with DMV prominence of 2; (right) cyanotic 16-year-old female with DMV prominence of 6). DMV scores were dichotomized into high prominence (>3) and low prominence (≤3) groups. Odds ratios for high DMV prominence were calculated.

**RESULTS**

Mean DMV prominence was significantly higher among cyanotic patients: 3.81 versus 2.55 in the acyanotic group (p < 0.0001). (Table 1) Cyanotic patients were much more likely to show a high DMV prominence (OR_unadjusted 3.61, 95%CI 1.23, 10.2). Although sex and age were significant confounders (negative and positive, respectively), the elevated risk for high DMV prominence with cyanosis remained. (Table 2)

**CONCLUSION**

Deep medullary veins are more prominent on SWI in patients with cyanotic heart disease than acyanotic heart disease among a 7-year cohort of children evaluated for heart transplantation at LLUMC. The effect is stronger in males than in females. SWI appears to be a useful tool to visualize hypoxemia in the brain.

**KEY WORDS:** Susceptibility-weighted Imaging, deep medullary veins, pediatric heart disease

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**Scientific Poster 207**

The Effect of Intracranial Arterio-venous Malformation (AVM) on Cerebral Blood and CSF Flow Dynamics.

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**PURPOSE**

AVM leads to a dramatic increase in total cerebral blood flow (tCBF). The effect of increased tCBF on arterial, venous, and CSF flow dynamics and MR-derived estimate of intracranial compliance and pressure (MRICP) are described.

**MATERIALS & METHODS**

Waveforms of volumetric flow rates of total cerebral arterial inflow (the sum of volumetric flow rate through the internal carotid and vertebral arteries), venous outflow (the sum of flow through the internal jugular, vertebral and epidural veins) and oscillatory CSF flow between the cranium and the spinal canal were obtained by MRI velocity-encoding scans and automated lumen segmentation in two 8-year old subjects, one with AVM and one healthy. These waveforms were then used to derive total and pulse amplitudes of arterial inflow, venous outflow, and craniospinal CSF stroke volume. The intracranial pressure, which is inversely related to intracranial compliance, was then estimated from the ratio of the systolic intracranial volume change (ICVC) and CSF pulse pressure gradient as previously described [1].

**RESULTS**

Table 1. Children undergoing evaluation for cardiac transplantation at LLUMC

<table>
<thead>
<tr>
<th></th>
<th>Cyanotic Heart Disease</th>
<th>Acyanotic Heart Disease</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>43</td>
<td>29</td>
<td>--</td>
</tr>
<tr>
<td>Age in years</td>
<td>1.17 ± 3.56</td>
<td>2.98 ± 5.00</td>
<td>&lt; 0.002</td>
</tr>
<tr>
<td>M/F</td>
<td>26:17</td>
<td>11:18</td>
<td>0.06</td>
</tr>
<tr>
<td>DMV prominence</td>
<td>3.81 ± 1.24</td>
<td>2.55 ± 1.06</td>
<td>&lt; 0.0001</td>
</tr>
<tr>
<td>Male(n = 37)</td>
<td>3.69 ± 1.19</td>
<td>2.27 ± 0.905</td>
<td>0.002</td>
</tr>
<tr>
<td>Female (n = 35)</td>
<td>4.00 ± 1.32</td>
<td>2.72 ± 1.13</td>
<td>0.011</td>
</tr>
</tbody>
</table>

Table 2. High DMV prominence in cyanotic versus acyanotic patents.

<table>
<thead>
<tr>
<th></th>
<th>Odds ratio</th>
<th>95% Confidence Interval</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>OR, unadjusted</td>
<td>3.61</td>
<td>1.23, 10.2</td>
<td>0.016</td>
</tr>
<tr>
<td>OR_age, sex-adjusted</td>
<td>4.48</td>
<td>1.45, 13.8</td>
<td>0.009</td>
</tr>
<tr>
<td>OR_age, age-adjusted</td>
<td>3.16</td>
<td>1.06, 9.43</td>
<td>0.039</td>
</tr>
</tbody>
</table>

Total CBF and arterial flow pulse amplitude were considerably elevated in the AVM as expected (2.06 vs. 1.01 L/min and 2.6 vs. 1.6 L/min). Yet, the pulse amplitude of the venous outflow in the AVM was similar to that of the normal subject (0.75 vs. 0.65 L/min). The increase in CSF flow resulted with significantly higher CSF stroke volume (1.7 vs. 0.83ml), which partly compensated for the lack of increased in the venous pulsatility and increase in CSF pressure gradient amplitude. The peak-to-peak CSF pressure gradient and the systolic ICVC were increased by similar ratios, 0.132 vs. 0.087mmHg/cm (1.52:1), and 1.9 vs. 1.2 mL (1.56:1), respectively. Consequently, intracranial compliance and therefore ICP remained largely unchanged and within the normal range (9.1mmHg). Regardless of the increase in arterial pulse amplitude the venous pulse amplitude in AVM remains similar to that in healthy control. The lack of corresponding increase in the venous outflow pulse amplitude is compensated by a more than two-fold increase in the amount of CSF that flows into and back from the spinal canal (CSF stroke volume (SV)) with each heart beat. In addition, the systolic volume change and the pulse pressure gradient increase by a similar ratio. Therefore the ratio of the two, which is an estimate of the intracranial compliance, remains within the normal range.

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**Hemodynamic and hydrodynamic measurements in AVM and in healthy control**

<table>
<thead>
<tr>
<th></th>
<th>AVM</th>
<th>Healthy</th>
<th>AVM</th>
<th>Healthy</th>
</tr>
</thead>
<tbody>
<tr>
<td>CBF (L/min)</td>
<td>2.1</td>
<td>1.0</td>
<td>2.6</td>
<td>1.6</td>
</tr>
<tr>
<td>Amplitude L (L)</td>
<td>0.75</td>
<td>0.65</td>
<td>1.72</td>
<td>0.83</td>
</tr>
<tr>
<td>SV (L)</td>
<td>1.32</td>
<td>0.83</td>
<td>1.9</td>
<td>1.2</td>
</tr>
<tr>
<td>MRICP (mmHg/cm)</td>
<td>9.1</td>
<td>7.4</td>
<td>9.1</td>
<td>7.4</td>
</tr>
</tbody>
</table>
CONCLUSION
MRI measurements of dynamic volumetric flow rates to and from the cranium during the cardiac cycle provide insight into the cerebral adaptation occurring to accommodate a two-fold increase in blood flow and large increase in volume change with only a small reduction in compliance and increase in ICP.

REFERENCE

KEY WORDS: Arteriovenous malformation, cerebral blood flow, CSF flow dynamics

Scientific Poster 208

Cerebral Deep Medullary Venous Prominence Correlates with Spetzler-Martin AVM Grade

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PURPOSE
To investigate the association between the Spetzler-Martin grade of supratentorial arteriovenous malformations (AVMs) and prominence of deep medullary veins (DMV) on Susceptibility Weighted Imaging (SWI).

MATERIALS & METHODS
Under IRB approval, the cohort of patients at Loma Linda University Medical Center from 2001 through 2007 with supratentorial AVM who underwent head MRI with SWI were retrospectively reviewed (n=20). Exclusion criteria were postoperative state or infratentorial AVM. Demographic data was obtained from the medical record. SWI images were reviewed by two neuroradiologists. The Spetzler-Martin grade was obtained from the radiology report or calculated if not mentioned. DMV prominence for each hemisphere was scored using a 7-point ordinal scale (Figure: 4-year-old male with left-sided AVM; ipsi DMV 5, contra DMV 4). The DMV prominence for each hemisphere was analyzed for association with AVM grade using Spearman correlation, stratified by laterality (ipsilateral or contralateral to the AVM). The patients were divided into two groups based on DMV prominence: high prominence (DMV > 3) or low prominence (DMV <= 3). For ipsilateral then contralateral hemispheres, the effects of age, sex, and hemorrhage were analyzed by DMV prominence group using Mann-Whitney or chi-square.

RESULTS
Ipsilateral DMV prominence showed a weak but statistically significant correlation with Spetzler-Martin grade ($R^2 = 0.233$, p = 0.031). A weaker correlation between contralateral DMV prominence and SM grade was suggestive but not statistically significant ($R^2 = 0.127$, p = 0.122). From analysis of the ipsilateral hemispheres, the mean age in the the high DMV prominence group was a statistically suggestive 24.3 years younger than in the low DMV prominence group (p = 0.130); sex and presence of hemorrhage were not associated with DMV prominence (Table). The contralateral hemispheres showed similar results.

CONCLUSION
In brain AVMs, ipsilateral deep medullary vein prominence on SWI shows a weak positive correlation with Spetzler-Martin grade, suggesting local elevation in venous deoxyhemoglobin concentration, such as from increased oxygen extraction. The contralateral hemisphere exhibits a weaker, statistically suggestive positive correlation between DMV prominence and AVM grade as well. Pediatric patients with AVM may be more likely to show increased DVM prominence in association with AVM than adult patients.

KEY WORDS: Susceptibility weighted imaging, arteriovenous malformation, deep medullary veins

<table>
<thead>
<tr>
<th>Low DMV Prominence</th>
<th>High DMV Prominence</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Years of age, (mean ± SD)</td>
<td>39.3 ± 26.4</td>
<td>15.0 ± 11.5</td>
</tr>
<tr>
<td>Sex (M:F)</td>
<td>10:6</td>
<td>4:0</td>
</tr>
<tr>
<td>Presence of hemorrhage (%)</td>
<td>7 (43.8%)</td>
<td>3 (75%)</td>
</tr>
</tbody>
</table>
Scientific Poster 209

Immediate MR Imaging of Patients Who Present with Clinical Symptoms Strongly Suggestive of Stroke Is Cost-Effective and Improves Quality of Life: A Decision Analysis

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Purpose
Recommendations have been made that all patients with symptoms strongly suggestive of stroke should undergo a “baseline”, i.e., immediate, MR imaging or CT study upon presentation to a healthcare centre. Immediate CT scanning of these patients has been demonstrated to be cheaper and more effective yet, for these patients, it remains unclear whether immediate CT or MR imaging scanning yields a difference in long-term outcomes or costs. The objective of this study was to evaluate the cost-effectiveness of baseline computed tomography (CT) imaging versus magnetic resonance (MR) imaging in patients who present with symptoms strongly suggestive of stroke.

Materials & Methods
A Markov decision analysis model was used with a target population of any patient eligible to receive thrombolytic therapy who presents on any time of day and any day of the week to a healthcare facility, with symptoms strongly suggestive of stroke. The time horizon measured was 30 years and the study perspective was that of health policy. The interventions studied were CT or MR imaging scan at baseline, i.e., within 3 hours of presentation to a facility that is capable of providing CT or MR imaging without delay. The outcomes measured were costs (adjusted to 2008 dollars), quality-adjusted life years (QALYs), and incremental cost-effectiveness.

Results
Compared with CT, the MR imaging strategy has an incremental cost-effectiveness ratio (ICER) of $4,765 per QALY gained. The MR imaging strategy gains more QALYs than the CT strategy and incurs lower incremental costs; therefore, the MR imaging strategy dominates the CT strategy. Over a wide range of variables, the ICERs of the MR imaging strategy were less than $50,000 per QALY gained, except for the cost associated with stroke-related life-years lost. Varying the prevalence of acute ischemic stroke, the costs of MR imaging and CT scans and the sensitivity and specificity of CT and MR imaging had no effects on outcomes.

Conclusion
On the basis of this model, the most cost-effective strategy for baseline imaging of patients presenting with symptoms strongly suggestive of stroke is MR imaging. Clinically significant benefits accrue from imaging patients with MR imaging at baseline. If implemented, this strategy can greatly reduce the burden of costs and outcomes among stroke patients.

Key Words: Cost-effectiveness, ischemic stroke, MRI

Scientific Poster 210

Prospective Diagnosis of Vertebral Artery Fistula with CTA: A Quantitative Analysis of Relative Vascular Attenuation

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Purpose
The prospective diagnosis of arteriovenous fistula (AVF) by CTA or MRA can be difficult in the early posttraumatic period when the fistula may be small. We present a case of AVF diagnosed following a comminuted C2 fracture, and demonstrate how analysis of relative attenuation within the vertebral artery and adjacent venous structures in the setting of posttraumatic vertebral artery fistula yields predictive diagnostic information. These findings would allow for a prompt definitive diagnosis and therapeutic angiographic procedure while the fistula is small.

Materials & Methods
Quantitative analysis of a vertebral artery fistula resulting from a comminuted C2 vertebral fracture was performed. On CTA, mean region of interest attenuation measurements of the vertebral arteries, epidural venous plexus, bilateral paravertebral venous plexus, and bilateral internal jugular vein were obtained in the example fistula case and in 10 CTA controls with variable bolus timing. The control CTAs were divided into two groups: 1) well-timed predominantly arterial phase scans and 2) later acquisition scans with significant venous enhancement. Within each scan the attenuation values were normalized to allow for comparison of relative attenuations.

Results
In the case of high vertebral artery fistula to the adjacent venous plexus, the attenuation within the injured vertebral artery and the adjacent epidural and ipsilateral paravertebral venous plexus is identical. The attenuation within these fistulized venous structures is 1.75 times greater than the ipsilateral jugular vein. The jugular vein is nearly identical in attenuation bilaterally. Additionally, the paravertebral venous structures on the side of the arterial injury were greater than two times the density of the contralateral side. In well-timed arterial phase control scans, mean normalized arterial attenuation is three times that of the jugular veins and four to eight times that of the venous plexus structures. The jugular veins were one and a half to three times denser than the epidural and paravertebral plexus in all cases. Paravertebral venous attenuation was not significantly asymmetric in any of the cases. In later acquisition control scans
with more venous timing, mean normalized arterial attenuation is approximately equal to jugular veins. The mean normalized jugular venous attenuation ranged from 1.0 to 1.7 times denser than the epidural and paravertebral plexus in all of these cases. It was never less than that of the epidural or paravertebral plexus. Paravertebral venous attenuation was not significantly asymmetric in any of the cases. Venous reflux from contrast injection was observed in some scans of both control groups, but was easily identified.

CONCLUSION
Vertebral artery fistula produced a quantifiable pattern of relative vascular attenuation on CTA that was not reproducible on normal control scans, regardless of timing of the contrast bolus. In the setting of trauma, if venous plexus attenuation is equal to that of the vertebral artery or greater than that of the jugular veins, or if there is asymmetry of the paravertebral venous plexus at the level of a vertebral fracture, a fistula should be suspected. Noninvasive diagnosis of this lesion may allow for prompt treatment with endovascular therapy.

KEY WORDS: Vertebral artery fistula, CTA, quantification

**Scientific Poster 211**

Is Severe Pain Immediately Following Spinal Augmentation a Predictor of Short- and Long-Term Outcome?

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PURPOSE
Severe, immediate postprocedural pain and need for analgesics following vertebroplasty can be a discouraging experience for patients and caregivers. Despite the literature establishing vertebroplasty as a technique for management of painful compression fractures, the short- and long-term outcomes in patients with severe, immediate postprocedural pain has not been investigated.

MATERIALS & METHODS
Retrospective chart review of patients undergoing vertebroplasty was performed to categorize patients regarding pain and medication requirements within 3 hours of vertebroplasty. Additional data recorded included preprocedure descriptors including demographics, pain severity, prescribed analgesics, number of fractures, and benign or malignant nature of the fracture(s); procedural descriptors including unilateral versus bi-pedicular approach, number of augmentations performed, distribution of cement, and complications; immediate postprocedural descriptors including pain severity and medications administered within 3 hours, at 1 month, and at 1 year follow-up. Medications scores were recorded as follows: (0) no medications (1) over-the-counter analgesics (2) nonnarcotic prescription medication as needed (3) oral narcotic analgesic as needed (4) scheduled oral narcotic or analgesic patches (5) intravenous narcotics. Chi-squared statistical analysis was performed, comparing patients receiving immediate postoperative analgesics from those that did not, and also comparing patients with immediate postprocedure pain scores ≥8 from those whose pain scores were <8.

RESULTS
Between 2005 and 2007, 155 patients underwent vertebroplasty who had adequate documentation and follow up for inclusion. A total of 214 levels were treated. Ninety-eight of the patients (63%) were female, and the mean age was 74 years. Average medication score prevertebroplasty was approximately three, with an average pain scale 3.7/10 (rest) and 8.0/10 (activity). The average pain score at 1 month follow-up was 0.7/10 (rest) and 3.2/10 (activity), with a mean medication score of approximately two. At 1 year, the average pain score was 0.9/10 (rest) and 3.2/10 (activity), with a mean medication score of approximately 1.5. Eighteen (12%) of 155 patients had severe pain following the procedure (ranking ≥8), 8 (44%) of whom received analgesics within 3 hours. At 1-month and 1-year follow up, there was no significant difference in pain or medication scores between the group of patients with severe pain compared to those without (p=.3 and .2 at 1 month and 1 year, respectively, see Table). Additionally, there was no significant difference in outcome comparing patients receiving analgesic medication immediately following vertebroplasty compared to those who did not receive medications immediately following the procedure (p=.2 and 0.6 at 1 month and 1 year, respectively).

<table>
<thead>
<tr>
<th>Kind</th>
<th>Rest</th>
<th>Activity</th>
<th>Med</th>
<th>Rank</th>
<th>Rest</th>
<th>Activity</th>
<th>Med</th>
<th>Rank</th>
<th>Rest</th>
<th>Activity</th>
<th>Med</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preprocedure</td>
<td>3.3</td>
<td>7.8</td>
<td>2.9</td>
<td>8</td>
<td>1.0</td>
<td>2.6</td>
<td>0.4</td>
<td>8</td>
<td>3.3</td>
<td>1.9</td>
<td>0.6</td>
<td>8</td>
</tr>
<tr>
<td>Pain Scale</td>
<td>&lt;8</td>
<td>18</td>
<td>6.2</td>
<td>9.0</td>
<td>2.9</td>
<td>4.8</td>
<td>8.6</td>
<td>0.7</td>
<td>2.6</td>
<td>2.6</td>
<td>1.6</td>
<td>3.4</td>
</tr>
<tr>
<td>Follow-Up</td>
<td>0.7</td>
<td>3.2</td>
<td>1.4</td>
<td>8</td>
<td>3.2</td>
<td>1.4</td>
<td>8</td>
<td>3.2</td>
<td>1.4</td>
<td>8</td>
<td>3.2</td>
<td>1.4</td>
</tr>
</tbody>
</table>

CONCLUSION
Severe, immediate postprocedural pain following vertebroplasty is not a predictor of short- or long-term outcomes. Patients experiencing severe pain following vertebroplasty can be reassured that the presence of severe, medication-requiring pain immediately following the procedure is not a predictor of their potential short- and long-term good outcomes.

KEY WORDS: Vertebroplasty, outcomes, pain management

**Scientific Poster 212**

Radiographic Evaluation of a Biologic Option for Vertebral Augmentation

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PURPOSE
Demonstrate long-term maintenance of vertebral body integrity and bone graft incorporation following treatment of compression fractures using porous mesh filled with bone graft.

MATERIALS & METHODS
IRB approved retrospective study conducted to review clinical and radiographic outcomes of consecutive patients implanted with porous polyester mesh filled with corticocancellous allograft. CT scans and x-rays of patients more than 6 months post-op were evaluated for maintenance of restored vertebral body height and evidence of graft incorporation.
RESULTS
Between 11/05 and 4/07, 37 consecutive patients treated (15 excluded, lacking immediate post-op comparison films). Remaining 22 patients had 39 levels treated. Demographics: 16 females, 6 males, average age 69.7 years (range 33-88 years). Fracture pathologies: 17 osteoporotic, 3 traumatic, 2 scoliosis. No procedure-related complications or deaths. Adjacent level fractures identified in three of 22 patients (13.6%). Only one of 22 (4.5%) showed minimal (3 mm) loss of restored height and CT scans show evidence of progressive graft incorporation within mesh.

CONCLUSION
Vertebral augmentation using conformable mesh tightly filled with bone graft offers effective treatment option for painful osteoporotic and traumatic fractures. Restored vertebral height is maintained at long-term follow up and bone graft incorporates even in osteoporotic patients.

KEY WORDS: Biologic vertebral augmentation, vertebral compression fracture, porous graft container

Scientific Poster 213
Long-Term, Single Center Outcomes for CT-Guided Percutaneous Sacroplasty for Sacral Insufficiency Fractures

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PURPOSE
To evaluate the clinical outcomes of CT-guided sacroplasty in patients with sacral insufficiency fractures.

MATERIALS & METHODS
Retrospective chart review and follow-up phone interview was performed for 12 patients who underwent CT-guided sacroplasty after failing medical management. Various pre-procedure studies were performed with a minimum MR imaging or thin-section CT of the sacrum. CT was performed for injection site localization purposes at the time of sacroplasty on a 64-slice GE Lightspeed CT, with CT fluoroscopy technique used during the procedure. A postprocedure CT also was performed, with multiplanar reformations and 3D reformations. Sacroplasties were performed using a standard kit(s) of Kyphex brand Methylmethacrylate (MMA) cement, injected in 0.2-0.3 cc aliquots, for a total of up to 3 cc at each site. Postprocedure, patients were placed supine for a minimum of 3 hours, activity then was encouraged as tolerated.

RESULTS
Twelve patients, 9 females and 3 males, underwent CT-guided sacroplasty, all successfully. Mean patient age was 78.6 years with the range being 59-93 years. Mean time to diagnosis of insufficiency fracture was 12.6 weeks (range 1-104 weeks), with a mean time to procedure of 31.1 days (range 1-120 days) after diagnosis. Eleven were unable to walk or required assistance/use of a cane/walker prior to the procedure, with all returning to baseline ambulation afterwards. Sixty-six percent of patients had little residual pain or were pain free within 2 days of the procedure, with the remainder improving over the next few weeks to months. Pain medication was reduced over all, with an overall increase in activities of daily living postprocedure. In some instances, other pain patterns, such as low back pain, were unmasked following the procedure. No major complications were noted; two patients had minimal extravasation of cement outside of the sacrum, however none were symptomatic. Overall, 10 patients were satisfied by the procedure, one was neutral about the procedure. Nine would recommend it to a friend,
with two people neutral on the subject. No patients were dissatisfied with the procedure. One sacroplasty patient was lost to follow up.

**CONCLUSION**

Percutaneous CT-guided sacroplasty is a safe and effective procedure for the treatment of sacral insufficiency fractures and prevention of potential complications related to medical management.

**KEY WORDS:** Sacroplasty, sacral insufficiency fracture

**Scientific Poster 214**

Utilization of Contrast-Enhanced MR Imaging in Stratifying Percutaneous Vertebroplasty in Patients with Chronic Back Pain

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New York, NY

**PURPOSE**

Percutaneous vertebroplasty (PV) is largely employed and of proved efficacy in acute and subacute benign and malignant vertebral body compression fractures. The level for vertebroplasty is usually site of pain, anatomical deformity, and hyperintense signal on T2-weighted and STIR MR imaging sequences. We illustrate several cases of efficacy with PV in select patients with chronic back pain due to chronic vertebral body compression fractures based on MR imaging gadolinium enhancement pattern and variable T2-weighted and/or STIR signal.

**RESULTS**

All of our patients underwent PV for treatment of affected vertebral levels based on site of back pain and positive contrast enhancement on MR imaging. All eight patients demonstrated near complete pain relief following the procedure and on follow up.

**CONCLUSION**

Percutaneous vertebroplasty can be effective for chronic back pain with patients with long standing vertebral compression fractures which demonstrate positive gadolinium enhancement on MR imaging. Contrast-enhanced MR imaging evaluation of the spine may be used to direct treatment of vertebral body abnormality in patients with chronic back pain.

**KEY WORDS:** Vertebroplasty, spine, back pain

**Scientific Poster 215**

Intradural Extramedullary Capillary Hemangioma of the Thoracic Spine

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**PURPOSE**

We report a case of a thoracic intradural extramedullary capillary hemangioma which is a rare lesion with only a handful of cases having been reported in the literature. This case report aims to make radiologists aware of the existence of this lesion and the imaging findings which may lead one to consider the diagnosis so that they could be better characterized preoperatively with MRA or spinal arteriography.

**MATERIALS & METHODS**

Case report of a 46-year-old right-handed male who presented to our institution complaining of rapidly progressive difficulty with ambulation and voiding over the prior 48 hours. The patient also complained of mid thoracic pain that had increased in intensity over the last 2 months, and gait disturbance with multiple episodes of fall. MR images showed a well circumscribed mass occupying the dorsal portion of the spinal canal at the T6 level. Consistent with prior reports, the mass was isointense to the spinal cord on T1-weighted images, homogenously hyperintense on T2-weighted images, and showed intense homogenous enhancement on contrast T1-weighted images.

**Table 1: Summary of possible differences between thoracic capillary hemangioma and other intradural extramedullary tumors**

<table>
<thead>
<tr>
<th>Schwannoma</th>
<th>Meningioma</th>
<th>Paraganglioma</th>
<th>Hemangioblastoma</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heterogenous MR signal - cysts, hemorrhage, xanthoma</td>
<td>Isointense to slightly hyperintense on T2</td>
<td>Hyperintense on T2</td>
<td>Location in cauda equina or filum</td>
</tr>
<tr>
<td>Peripheral enhancement</td>
<td>Lack of nodularity</td>
<td>Equine or filum</td>
<td>Heterogenous MR</td>
</tr>
<tr>
<td>Lateral location</td>
<td>Lateral location</td>
<td>Terminates</td>
<td>Signal - hemorrhage</td>
</tr>
<tr>
<td>No cephalad draining vessels</td>
<td>No cephalad draining vessels</td>
<td></td>
<td>MR signal voids</td>
</tr>
</tbody>
</table>
Recognition of the imaging appearance of this mass could allow for further preoperative characterization of these rare masses by MRA or spinal arteriography.

RESULTS
At surgery, laminectomy over the involved levels was performed and intradural exploration revealed a reddish, vascular lesion that was closely adhering to the dorsal aspect of the thoracic spinal cord. Microscopically, the tumor was characterized as a lesion with multiple vascular channels with extensive hemorrhage. The endothelial lining showed multiple foci of extensive papillary formation. The tissue was sent to The Armed Forces Institute of Pathology where the diagnosis of capillary hemangioma was confirmed.

CONCLUSION
Given the close similarity in MR appearance to the much more common schwannoma, most cases are misdiagnosed preoperatively; however, in retrospect, there are radiologic findings which could lead one to consider the diagnosis of capillary hemangioma.

KEY WORDS: Capillary hemangioma, intradural, extramedullary

Scientific Poster 216
DynaCT Angiography as an Adjunct in the Anatomical Delineation of Spinal Dural Arteriovenous Fistulas

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PURPOSE
Spinal dural arteriovenous fistula represents a specific type of spinal arteriovenous malformation in which a small low-flow fistula is located with the dura of the spinal canal. Localization and anatomical delineation remains challenging despite conventional catheter spinal angiography, MRI/MRA, and high-resolution CT imaging. To our knowledge, the use of cone-beam volume CT (DynaCT) used in conjunction with conventional catheter-based angiography has not been described in the clarification of spinal dural arteriovenous fistulas in preoperative planning. We present a case series of seven patients describing our initial experience with an Artis zee biplane system (Siemens Medical Solutions; Erlangen, Germany) using conventional catheter-based angiography together with cone-beam volume CT (DynaCT) for localization and anatomical clarification of spinal dural arteriovenous fistula, thus providing a more focused surgery and less extensive dissection by the neurosurgical team.

MATERIALS & METHODS
Following confirmation on conventional digital subtraction angiography (DSA), rotational cone-beam volume CT (DynaCT) acquisition was performed during contrast material (Omnipaque 200) injection either manually administered using a syringe or using a power injector. Depending on the level of the dural AVF, the volume and injection rate of contrast material was determined based on work performed previously in the DSA so that the feeding artery was fully opacified and the draining vein was clearly seen. Imaging parameters were as follows: Projection images were acquired with an Artis zee biplane system (Siemens Medical Solutions; Erlangen, Germany) using a 30x40 cm flat panel detector. Image acquisition covered 100° left anterior oblique to 100° right anterior oblique in a propeller axis rotation of the C-arm with the x-ray tube traveling under the patient. The total acquisition time was 8 sec for a total of 397 projection images using the 360 mgY/frame dose mode. Multiplanar reconstructions were performed using an external postprocessing workstation (syngo X-Workplace, Siemens Medical Solutions) to produce slices with 0.34 x 0.34 mm pixel size and slice thickness of 0.34 mm.

RESULTS
Prior to surgical intervention, the neuroradiologist that performed the combined spinal angiography/DynaCT reviewed the 3D data set with the neurosurgeon prior to surgical ligation of the fistula. In each of our seven cases, the spinal dural arteriovenous fistula was better delineated on the DynaCT data set than on the conventional angiogram. There were no complications.
CONCLUSION
We have found DynaCT to be a powerful adjunct to conventional catheter-based angiography in the localization and anatomical representation of spinal dural arteriovenous fistula. We believe this technology has the potential to precisely localize the arteriovenous fistula allowing for more targeted surgery.

KEY WORDS: Spine, arteriovenous malformation, DynaCT

Scientific Poster 217

Common and Uncommon Clivus Tumors

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Purpose
The clivus is the surface portion of the occipital and sphenoid bones at the base of the skull. It is surrounded by the neurovascular structures of the brainstem, as well as the internal carotid arteries. Clival tumors are uncommon and can be incidental findings on CT and MR imaging of the head. Clinical symptoms are nonspecific and variable including headache and cranial nerve palsies. The incidence, radiographic features and differential diagnoses of clivus tumors will be discussed.

MATERIALS & METHODS
Imaging spectrum of eight cases of pathology-proved clival tumors are divided into three groups: (1) primary clival lesions; (2) aggressive intracranial tumor invasion; and (3) extracranial tumor extension. All patients had either CT examination and/or MR imaging of the skull base. Retrospective review of our cases was compared with radiographic features described in the literature.

RESULTS
Primary clival tumors include chordoma, chondrosarcoma and plasmacytoma. Chordomas are rare tumors of embryonal notochordal remnants along the length of the neuraxis at developmentally active sites. Chordomas comprise less than 1% of CNS tumors origin that commonly involves the clivus. They are expansile destructive lesions. Chondrosarcomas are the second most common primary bone tumors commonly affecting long bones. Skull base and clivus involvement are much rarer than chordoma and comprise about 0.1% of all intracranial tumors. The calcification of tumor matrix frequently is identified by CT scan. Primary craniocebral plasmacytoma are extremely rare, with no clinical or radiologic signs of systemic involvement. Only few case reports exist in the English literature. Intracranial tumors demonstrating invasion of the clivus include aggressive pituitary adenoma, craniopharyngioma, and meningioma. Large aggressive pituitary adenomas with bone invasion have been described as invasive adenoma, malignant adenoma and carcinoma. They account for approximately 6% of all adenomas. The craniopharyngiomas are typically located at the suprasellar region, and also may exhibit infra-sellar extension into the nasopharynx. Only 22 case reports are documented in the available literature. Meningiomas are the most common extraaxial brain tumor; 50% occur at the parasagittal/facial region. Approximately 10% involves parasellar region and can commonly affect the skull base. Extragranial tumors include nasopharyngeal carcinoma (NPC) and radiation-induced osteogenic sarcoma. Nasopharyngeal carcinoma is the most common primary lesion to involve the skull base. Osteosarcoma infrequently involves the skull base with literature documenting de novo and radiation-induced cases. Metastatic disease to the clivus is uncommon but in the setting of known primary malignancy, should be considered.

CONCLUSION
Clival tumors are relatively rare and have not been emphasized. Skull base tumors can be classified based on their histologic characteristics, common anatomical locations, and radiographic appearances.

KEY WORDS: Clivus, base of skull, tumors

Scientific Poster 218

Trouble Shooting Intrathecal Baclofen Pumps: Radiologic Findings and Surgical Correlation

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PURPOSE
To demonstrate the imaging findings on plain radiography, CT and nuclear medicine studies of specific causes of intrathecal Baclofen (Lioresal) pump complication/malfunction. Intrathecal baclofen therapy (ITBT) delivered by an implantable, programmable pump is a reliable established treatment for intractable spasticity of spinal and cerebral origin; however, the pumps are not free of complication/malfunction. The radiologist’s role in determining the specific cause of pump complication/malfunction is essential in identifying which patients may require surgical revision.

MATERIALS & METHODS
There have been a total of 119 patients over the past 10 years who have received an implanted programmable pump for intrathecal baclofen therapy and currently are managed at our institution. Thirty-one of these patients have undergone radiologic pump investigation in our radiology department for potential complications, and 16 patients had imaging findings that explained the pump dysfunction. We reviewed the imaging findings (plain radiography, CT and nuclear medicine studies) of these patients with pump failure and correlated them with findings at surgery.

RESULTS
The specific causes of pump malfunction were found to be related to the catheter which extends from the subcutaneous pump to the intrathecal compartment (tube disconnection, tube kinking, tube breakage, tube dislodgement from the subarachnoid space) and the pump itself (pump rotor malfunction). There was excellent correlation of imaging and surgical findings.
CONCLUSION
Imaging investigation is accurate and reliable for detecting specific causes of intrathecal baclofen pump/catheter system complications/malfunctions and is important for directing surgical treatment.

KEY WORDS: Intrathecal, Baclofen

Scientific Poster 219
Diffusion Tensor Imaging of the Healthy Human Spinal Cord

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PURPOSE
The goal of this study was to characterize the diffusion parameters of the healthy human spinal cord in vivo. This data is essential for the characterization and comparison of pathologic conditions. It can also be used to compare different pulse sequences for Diffusion Tensor Imaging (DTI).

MATERIAL AND METHODS
A total of 25 healthy subjects with no neurological disorders and no recent history (within the last 6 months) of back pain were enclosed. We used an axial single-shot GRE-EPI-sequenz with ECG-trigger on every second pulse. Other imaging parameters included TE 86ms, TR 3000ms slice thickness 3mm, Number of averages 1, FOV 140mm, in-plane resolution 2.2x2.2x3mm and b-values of 0 and 700. Acquisition time for each slice was 1.29min. We acquired axial slices from the level of the cranio-cervical junction to the level of vertebral L2/3. Mean diffusivity (MD) and fractional anisotropy (FA) were calculated with an in-house developed software and color-coded parameter maps were calculated. Diffusion parameters were evaluated by placing a region-of-interest (ROI) within the whole diameter of the myelon.

RESULTS
In 25 volunteers a total of 328 diffusion weighted images were acquired. There were slight geometric distortions, especially in the upper cervical spine. However, cerebrospinal fluid (CSF) and spinal cord as well as gray and white matter contrast were observed in all slices. Fractional anisotropy averaged 0.46 ± 0.06 x10-3 mm2/s and MD averaged 0.69 ± 0.05 x10-3 mm2/s.

CONCLUSION
This study provides normal diffusion parameters of the healthy human spinal cord in vivo. This data can be used for the comparison of different pathologic conditions of the cord or to compare and improve pulse sequences used for DTI.

KEY WORDS: DTI, spinal cord

Scientific Poster 220

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PURPOSE
CLOVES syndrome is a recently described sporadic phenotype comprised of congenital lipomatous overgrowth, vascular malformations, epidermal nevi and scoliosis-spinal-skeletal anomalies. Our purpose is to characterize the paraspinal involvement of CLOVES syndrome and report its association with arteriovenous malformations (AVM).

MATERIALS & METHODS
Clinical data and imaging studies of 26 patients with CLOVES syndrome were analyzed to determine the presence of paraspinal fast-flow lesions. We documented the location of the truncal masses and shunts, arterial supply, venous drainage pattern, and intraspinal extension, and clinical behavior. The diagnosis of paraspinal shunt was based on neuroangiography, MRI, or intraoperative and/or histopathological findings.

RESULTS
Six patients had metameric spinal arteriovenous shunts associated with an adjacent truncal overgrowth and/or a cutaneous “birthmark”; either capillary malformation (n=4) or congenital pigmented nevus (n=1). Extension of the truncal overgrowth into the spinal canal was noted in 4 patients. Spinal angiography in five patients and demonstrated a major spinal/radicular arterial supply and epidural venous drainage. All 6 patients had severe permanent neurologic deficits.

CONCLUSION
The complex spinal-paraspinal fast-flow lesions in CLOVES syndrome are associated with parasitization of spinal arteries and veins in a metameric fashion; resulting in significant morbidity. The presence of truncal overgrowth in association with a vascular or pigmented birthmark should alert clinicians to the potential for an underlying neuraxial fast-flow vascular malformation associated with CLOVES syndrome.

KEY WORDS: Spinal cord vascular diseases, neurocutaneous syndromes

Scientific Poster 221
Withdrawn
Scientific Exhibits 1–65
Exhibition Hall C
Monday, May 18 – Wednesday, May 20
6:30 AM – 9:00 PM
Thursday, May 21
6:30 AM – 3:00 PM
Note: A missing Scientific Exhibit number indicates an abstract has been withdrawn.

Scientific Exhibit 1
CT Perfusion Imaging in the Optimization of Patient Selection for Tissue Plasminogen Activator in Acute Ischemic Stroke

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Purpose
Intravenous tissue plasminogen activator (IV tPA) is the only FDA therapy for acute ischemic stroke. However, it is associated with a high risk of reperfusion hemorrhage and, therefore, generally is only administered within 3 hours of symptom onset. Many patients with signs/symptoms of acute ischemic stroke present to the emergency department at or beyond the 3-hour window. CT perfusion imaging may distinguish between infarcted brain parenchyma and potentially viable tissue, known as the penumbra. The penumbra may appear as a halo of viable tissue surrounding an infarcted core. Patients with a viable penumbra who present beyond the 3-hour window may nonetheless benefit from tPA administration. The specific aim of the present study is to review the literature to understand the potential role of CT perfusion imaging in the optimization of patient selection for tPA.

Approach/Methods
The peer-reviewed published literature was reviewed critically. An emphasis was placed on studies describing: 1) the utility of CT perfusion imaging in acute ischemic stroke, 2) patient selection and clinical outcomes in patient treated with tPA 3 to 6 hours after symptom onset, and 3) post-tPA imaging.

Findings/Discussion
There are substantial clinical studies supporting the use of tPA beyond the 3-hour window. However, rigorous patient selection is critical. CT perfusion may identify patients with a viable penumbra of “at risk” tissues, who potentially would benefit the most from tPA administration.

Summary/Conclusion
CT perfusion may be a vital diagnostic test in optimizing the clinical process of patient selection for tPA administration beyond the 3-hour window. Further studies are merited to evaluate the benefits of CT perfusion imaging in patients presenting 3 to 6 hours following symptom onset.

Keywords: CT perfusion, tPA, acute stroke

Scientific Exhibit 2
Volume Shuttle CT Perfusion for Cerebrovascular Diseases: Technique, Advantages, and Clinical Applications

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Purpose
The purpose of this exhibit is to discuss volume shuttle CT perfusion (CTPvolsh) technique, discuss its advantages over standard cine CT perfusion (CTPcine), and to demonstrate its clinical applications for evaluation of brain perfusion and vasculature in patients with cerebrovascular diseases. Using volume shuttle technique for CT perfusion (CTPvolsh), the brain can be scanned repeatedly by axial acquisitions at two adjacent positions using a 64-slice CT scanner (VCT; GE Medical Systems, Milwaukee, WI). Hence, in addition to providing 8 cm of total coverage of the brain, it also generates 4D CT angiography of the scanned region without any additional radiation or contrast administration.

Approach/Methods
Volume shuttle CT perfusion scanning protocol: 16 x 5 mm thick axial images, 0.4 second rotation time, 17 passes acquired over a total acquisition time of 46.6 seconds using 100 kVp and 300 mA. Contrast injected: 50 mL of nonionic (350mg/ml) contrast is injected at a rate of 4 mL/second using a 20 gauge IV line and an automatic power injector. 4D CT angiography: Immediately after acquisition, any phase out of the 17 phases could be used for reconstruction of CT angiogram or venogram images by reconstructing the raw data into 0.625 mm axial sections. Acetazolamide challenge test: CTPvolsh is repeated 20 minutes after IV injection of 1gm of acetazolamide for evaluation of cerebrovascular reserve (CVR) in patients with steno-occlusive disease.
FINDINGS/DISCUSSION
First, we will demonstrate relevant cases from our institution using CTPvolsh for evaluation of acute stroke as well as for evaluation of CVR in patients with chronic steno-occlusive disease. Second, we will show its utility for acute stroke diagnosis as well as its role in thrombolysis decision making. Relevant cases of CVR evaluation for steno-occlusive disease as well as its role in decision making for revascularization procedures and as a follow-up tool will be discussed. Finally, we will show a significant reduction in radiation dose of CTPvolsh in comparison to CTPcine as well as with CTPcine + CTA (CT angiogram brain).

SUMMARY/CONCLUSION
Volume shuttle CT perfusion can double the total coverage of brain (8 cm using a 64-slice CT scanner), which was formerly a major limitation to brain perfusion evaluation using standard nonvolume shuttle cine techniques. This new method of scanning retains the original clinical applications of CTPcine as well as augmenting them to create additional CTA images without any added radiation dose or contrast injection as might be needed for a separate CTA acquisition, if CTPcine is used for evaluation of brain perfusion and vasculature in patients with cerebrovascular diseases.

KEY WORDS: CT perfusion, cerebrovascular disease, volume shuttle

Scientific Exhibit 3
Characteristic Topographic Patterns of Disease on MR Imaging from Both Deep and Superficial Cerebral Venous Occlusions

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PURPOSE
The imaging appearance of cerebral venous occlusions can be mistaken for the sequela of other vascular disease, infection, or malignancy. Our goal is to illustrate the typical patterns of brain involvement due to the occlusion of a variety of deep and superficial cerebral veins.

APPROACH/METHODS
Selected cases were included from three institutions (Hospital of the University of Pennsylvania, Barrow Neurological Institute, and Dartmouth-Hitchcock Medical Center) that illustrate typical patterns of involvement from cerebral venous disease.

FINDINGS/DISCUSSION
Establishment of the diagnosis of venous occlusion is essential, since it dictates a specific course of therapy and consideration of emergent intervention in both de novo cases and those following surgical or radiation treatment. Unfortunately, the diagnosis often is delayed because venous occlusion is both less common than arterial pathology and the patterns of brain involvement may be confusing with both T2 prolongation and hemorrhage on occasion. We present selected cases that demonstrate the typical findings of venous occlusions in the distribution of the vein of Labbe, internal cerebral (both bilateral and unilateral), unilateral thalamostriate, cortical, and superficial middle cerebral veins. In addition, to illustrate other manifestations of venous disease, we include two venous hypertension cases: acute occlusion of developmental venous anomaly and a case of an arteriovenous fistula in deep venous distribution. For each case we will review the differential diagnoses for the findings and the specific features of each entity that should allow the interpreting physician to make the correct diagnosis.

SUMMARY/CONCLUSION
Cerebral venous occlusions, while uncommon, may have typical imaging features that should suggest to the radiologist the diagnosis of venous disease. Due to the treatment implications and the need to avoid unnecessary procedures, it is essential to make a diagnosis of venous occlusion early. We expect that our review of typical appearances of the cerebral venous occlusions will help interpreting physicians establish the correct diagnosis when they encounter these uncommon patterns of venous disease in their practice.

KEY WORDS: Venous, occlusion, MRI

Scientific Exhibit 4
Intracranial Imaging Manifestations of Acute Cocaine Including Patterns of Acute Encephalopathy

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PURPOSE
The purpose of this study is 1) to summarize the spectrum of intracranial imaging findings secondary to acute cocaine, and 2) to specifically focus on the imaging findings of abnormal white matter and cocaine encephalopathy.
**APPROACH/METHODS**
We retrospectively reviewed the imaging studies of 97 patients who presented acutely in the emergency department after ingesting cocaine, with neurologic symptoms requiring a CT or MR imaging of the brain as part of their work up. Symptoms could include: acute headache, focal neurologic deficit, seizure, and various manifestations of encephalopathy. Of these 97 patients, 25 (17 men and 8 women) ranging in age from 28 to 81 years were identified as having an acute abnormality on brain CT and/or MR imaging. Findings were categorized broadly as infarcts, hemorrhages, and white matter changes.

**FINDINGS/DISCUSSION**
Of the 25 patients with an acutely positive CT or MR, there were nine infarcts, eight hemorrhages, and eight with predominantly white matter changes. Further analysis of the nine infarcts showed three patients with MCA occlusions, two patients with a watershed pattern, and four patients with one or more small branch, deep white matter or brainstem infarcts. Of the eight patients with hemorrhages, four were parenchymal and four were subarachnoid or intraventricular in location. An AVM and an aneurysm were found to be the cause in two of these patients. There were eight patients with predominantly white matter abnormalities. Four of eight patients had lesions suggesting a focal or diffuse multifocal acute demyelinating process such as acute disseminated encephalomyelitis. All of the remaining four patients were exhibiting severe encephalopathic signs early in their presentation. Two patients had diffuse abnormal white matter changes with diffuse brain swelling. Two patients had predominantly abnormal white matter significantly affecting the cerebellum, brainstem, internal and external capsule in a pattern similar to that described from heroin as “Chasing the Dragon”.

**SUMMARY/CONCLUSION**
In addition to the well described abnormalities of infarct and hemorrhage, a surprising number of patients presented with acute white matter abnormalities in association with cocaine abuse. Two patterns that were identified in patients with symptoms of an acute cocaine encephalopathy are described that should raise the question of acute cocaine toxicity in the appropriate setting.

**KEY WORDS:** Cocaine, imaging, brain

**Scientific Exhibit 5**

**Multimodal Morphologic and Physiologic Serial Brain MRI Imaging in MELAS: Elements for New and More Thorough Understanding of this Metabolic Encephalopathy**

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**PURPOSE**
MELAS (mitochondrial encephalomyopathy, lactic acidosis, stroke-like events) is a mitochondrial disorder characterized by sudden neurologic deficits (SND), similar to vascular strokes. Mitochondrial angiopathy and metabolic neuronal dysfunction might be the cause of stroke-like events. MELAS brain lesions generally are reported as displaying vasogenic edema, and therefore to be completely reversible. Using morphologic and physiologic serial MR imaging we found new elements of understanding of this rare disease.

**APPROACH/METHODS**
During 4 years we studied six consecutive patients (F/M:3/3, age range 8-54 years) with MELAS A3243G-mutation and SND. MR imaging included FSE T2-W, FLAIR, DWI, 3D TOF MRA, enhanced T1-W images, and MR spectroscopy (MRS). One patient underwent perfusion MR (pMR). Apparent diffusion coefficient (ADC) maps were generated from DWI data. Patients underwent serial MR imaging, at admission, in the following weeks and months, with follow up at 4 years in two cases.

**FINDINGS/DISCUSSION**
All patients showed large T2-bright lesions, with focal swelling, in supratentorial cortical and subcortical areas, with no vascular distribution. The lesions were DWI-bright, with patchy mixed pattern of restricted and increased diffusion on ADC maps. MR angiography showed no vascular occlusion. MR spectroscopy found high lactate and low NAA in the lesions, compared to contralateral hemisphere used as control. The patient undergone pMR had signs of hyperperfusion in the affected regions. Follow-up MR imaging showed only partial reversibility of the brain lesions, with residual scattered gyral enhancement, and subsequent development of patchy cortical gliosis and atrophy, that led to extensive areas of cortical and subcortical brain volume loss in younger patients. Restricted diffusion areas were noted, and eventually turned into increased diffusion on ADC maps. Progressive brainstem atrophy was noted in the patients with longer follow up.

**SUMMARY/CONCLUSION**
Pathophysiology of SND in MELAS is still unclear. We observed signs of metabolic impairment, with lactate increase, patent vessels and hyperperfusion; restricted diffusion suggested presence of cytotoxic edema, but unlike in true ischemic infarcts, it was partially reversible. Only the most severely affected areas experienced blood-brain barrier disruption and gliotic changes. We suggest a reversible metabolic neuronal dysfunction as the primary mechanism of SND in MELAS; when the metabolic impairment is very severe or prolonged, neuronal death and irreversible changes may occur. The disease appeared to have a more severe evolution of brain lesions in younger patients.

**KEY WORDS:** Metabolic encephalopathy, MELAS, DWI
Scientific Exhibit 6

Bottom-of-Sulcus Dysplasia: Imaging Features

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PURPOSE
Malformations of cortical development (MCD) are a common cause of intractable epilepsy. In the 2005 revision of the Barkovich classification (1), a new type of MCD was proposed; bottom-of-sulcus dysplasia (BOSD). This type of focal cortical dysplasia (FCD) is classified in the group of malformations due to abnormal proliferation, FCD with balloon cells and has not been described fully in the literature. Knowledge of the imaging features is important for the recognition of this type of MCD, as its imaging characteristics are subtle easily and may be missed. Detection of these lesions has clinical consequences in patients with intractable epilepsy because resection may be the only therapeutic option for control of seizures. Histopathologically there is probably an overlap with Taylor-type dysplasia; however, this histologic description does not do justice to the specific imaging features. A second reason to distinguish this specific type of focal cortical dysplasia is the possible distinct pathogenesis of this lesion. In this exhibit the imaging features of this entity are described and a hypothesis of the pathogenesis of BOSD is proposed.

APPROACH/METHODS
Typical cases of BOSD were extracted from the files of comprehensive epilepsy surgery programs. The imaging features are described.

FINDINGS/DISCUSSION
In total, 20 cases were identified. The most common imaging features were typical of focal cortical dysplasia. The essential feature is the location of the focal dysplasia at the bottom of a sulcus. A second typical feature is the funnel shape extension of the lesion towards the ventricular surface (Figure 1a). In five cases a deranged gyral pattern was found (Figure 1b). The pathology of the resected lesions was typical for focal cortical dysplasia.

SUMMARY/CONCLUSION
We suggest that BOSD is due to an injury (or abnormal gene expression) to the smooth developing cortical surface. Abnormal apoptosis results in the wedge-shaped abnormal tissue remaining in the white matter, extending from the cortical lesion to the ventricular surface and that these abnormal glial and axonal bundles tether the convoluting cortex and keep the FCD at the bottom of a sulcus during brain growth. This should be distinguished from the heterotopia in transmantine dysplasia. A correct classification of this type of MCD is clinically important and will allow further recognition of its specific neuropathologic and clinical features.

REFERENCES

Scientific Exhibit 7

Diffusion Tensor Imaging as a Diagnostic Tool in Evaluating Brain Pathologies: Review of Clinical Experience with over 170 Cases

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PURPOSE
The white matter tracts cannot be identified individually by MR imaging or postmortem slices due to similar chemical composition. White matter tracts variable orientation gives them different diffusion properties which is applied by diffusion tensor imaging (DTI). Diffusion tensor imaging is the technique used to measure diffusion in series of different spatial directions in order to evaluate white matter cytoarchitecture. We perform DTI routinely in all brain MR imaging performed in one of new MR scanners. We reviewed all the cases which were performed from June 2008 to September 2008. One hundred seventy-nine cases had DTI.

APPROACH/METHODS
Diffusion tensor imaging offers an overall view of brain anatomy, including the degree of connectivity between different regions of the brain. We will demonstrate the usefulness of daily clinical application of DTI in the evaluation of the common brain pathologies.

FINDINGS/DISCUSSION
Key anatomical or physiologic issues, imaging findings or imaging technique the proposed exhibit will address: DTI is helpful adjunct in daily practice. Characterization of sensorimotor pathways or language center involvement by acute ischemic insults has strong correspondence to clinical symptoms prognosis and long-term management. Diffusion tensor imaging improves tumor margin delineation, particularly in radiologically ambiguous lesions such as T2 hyperintense peritumoral voxels. Diffusion tensor imaging provides
anatomical guidance for preoperative planning and demonstrates displacement and disruption of the white matter tracts by tumor or hemorrhage.

**SUMMARY/CONCLUSION**

Although the full potential of DTI will probably not be realized until it is integrated with other modalities such as functional imaging, there are advantages of the DTI in every day practice such as determining prognosis, improving characterization of white matter lesions and preoperative planning.

**KEY WORDS**: Brain MRI, diffusion tensor imaging, white matter pathology

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**Scientific Exhibit 8**

**Mind Worms**

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**PURPOSE**

To present an educational review of parasitic infestations of the brain with their clinical and radiologic features.

**APPROACH/METHODS**

There are a considerable number of parasites that can infect the human brain and present as focal neurologic deficits, epileptic seizures, meningoencephalitis, blindness or confusion. These include cestodes like Echinococcus granulosus (Hydatidosis), Taenia solium (Cysticercosis), nematodes like Ascaris lumbricoides (Round worm), Strongyloides stercoralis, Toxocara spp., Angiostrongylus spp., Loa loa and protozoans like Toxoplasma gondii, Trypanosoma spp., Plasmodium falciparum, Acanthamoeba spp. and Naegleria fowleri. Many of these infections now have become worldwide problems and it is imperative to develop an understanding of their clinical presentations and radiologic manifestations. A multimodality approach using ultrasound, computed tomography and magnetic resonance imaging is employed to tackle the diagnostic dilemmas they present.

**FINDINGS/DISCUSSION**

We present a pictorial review of parasites that can invade the brain, either primarily or secondarily (as an uncommon/rare complication or as an ectopic site of infection). The typical and atypical radiologic features are described.

**SUMMARY/CONCLUSION**

Parasitic infestations of the brain are potentially treatable entities. An understanding of their clinical presentation and imaging manifestations will aid the radiologist in making an early diagnosis and prevent significant morbidity and mortality.

**KEY WORDS**: Parasites, brain, imaging

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**Scientific Exhibit 9**

**Brain Infections in the Solid Organ Transplant Population: Some Imaging Characteristics**

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**PURPOSE**

There are four patterns of CNS infection in the transplant population: acute meningitis, subacute and chronic meningitis, focal brain infection and progressive dementia. The transplant population is very susceptible to a wide array of infections, sometimes with unusual organisms because of their impaired immune system. These infections are very difficult to diagnose and treat because they usually are advanced by the time they are discovered and the organisms do not respond very well to available treatment regimens. The purpose of this exhibit is to present salient imaging features of selected focal brain infections in the solid organ transplant population.

**APPROACH/METHODS**

We illustrate cross-sectional imaging presentations of both transdural and hematogeneous brain infections in this population. The complementary nature of multimodal imaging is discussed. Distinguishing features between various entities related to the appearance of lesion walls, peculiar signal characteristics and enhancement using specific imaging sequences are presented. Complications such as subarachnoid hemorrhage, central mycotic aneurysm in the circle of Willis, acute ischemic events, parenchymal hemorrhage and brain herniations are illustrated. Illustrative cases of uncommon organism such as Nocardia spp. brain infections are shown. A comparative illustration of relatively common entities such as Mycobacterium spp, Aspergillus spp and Toxoplasma gondii abscesses is made.
SUMMARY/CONCLUSION
The educational benefits derivable from this exhibit include:
1. The understanding of the distinguishing features between
the various focal brain infections and other intracranial
masses in the transplant population.
2. The awareness of the potential for vascular injuries such as central mycotic
aneurysm, subarachnoid hemorrhage, and cerebrovascular
events in transdural infections.
3. Knowledge of the more unusual infections such as Nocardia spp. infections in this
population.
4. The awareness of the need for a low threshold
for brain imaging in transplant patients when the clinical sit-
uation suggests the possibility of a brain infection.

KEY WORDS: Brain infection in transplant population, imag-
ing of brain infection, CT, MRI of brain infection

Scientific Exhibit 10
Intraosseous Tumor of the Skull

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P. 2 · Nakajima, Y. 1
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PURPOSE
Neuroradiologists now and then do encounter intraosseous
 tumors of the calvarium in their daily clinical practice. However, when compared to parenchymal lesions they gen-
erally are speaking far and between, and subsequently our
knowledge about these lesions in most instances is limited.
Also when compared with other bone neoplasms, they are
rather rare and in the literature most reports represent only
case reports with limited access to the overall features and
their differentials. The purpose of this exhibit is to list dif-
ferent calvarial tumors that we have encountered over the
years and demonstrate their radiologic appearances and cor-
relate this to the pathologic findings.

APPROACH/METHODS
From medical records, we collected cases of intraosseous
tumors of the calvarium between 2003 and 2008. Among the
cases that we will present are primary intraosseous tumors
such as meningiomas, hemangiomas and epidermoid cysts.
We also will show cases of calvarial involvement from sys-
temic diseases, such as plasmacytomas, eosinophilic granu-
mas and lymphomas. Metastatic lesions of distant malignant
tumors will not be included. The radiologic findings
cover conventional x-ray, computed tomography and mag-
netic resonance imaging.

FINDINGS/DISCUSSION
The scope of this exhibit is to increase the knowledge of cal-
varial bone lesions and their differentials by a detailed
description of imaging and histologic findings that can dis-
clude between these lesions. Figure 1 (T2-weighted
images) shows a stripped appearance within the tumor.
Figure 2 (contrast image) shows it has intense enhancement.
These findings are characteristic of hemangioma.

SUMMARY/CONCLUSION
When we come upon an intraosseous tumor of unknown ori-
gin, we should request the referring physician to explore the
possibility of a systematic disease. In cases of primary bone
tumors, it is important to verify any soft tissue component
since this is an important differential diagnostic feature, also
with regard to the potentials of malignant transformation.

KEY WORDS: Intraosseous tumor
Suprasellar Meningiomas: How Important Is Neuroradiologic Planning?

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Purpose
Suprasellar meningiomas are a distinct group of meningiomas with diverse presentations, distribution and primary site of origin. We propose a neuroradiologic approach for better understanding of suprasellar meningiomas based on their primary site of origin, their distribution and the mass effect they have on the surrounding structures.

Approach/Methods
We reviewed 50 cases of suprasellar meningiomas from December 2005 to December 2008 who were managed at our tertiary care skull base referral center. All patients underwent computed tomography (CT) and magnetic resonance imaging (MRI) studies. High-resolution submillimeter CT scans were performed on multidetector CT scanners with sagittal and coronal reformatted images. MR imaging studies were performed on a 3 T scanner. High-resolution volumetric data were acquired with multiple MR sequences. MR angiography with MIP reconstructions also was performed. The studies were interpreted by three board-certified neuroradiologists. The medical records were reviewed for management and clinical outcome.

Findings/Discussion
A broad spectrum of suprasellar meningiomas was reviewed which included diaphragma sella, clinoid, tuberculum sella and planum sphenoidale meningiomas. The size, extent and mass effect on the surrounding structures were studied. Bony changes were characterized. The tumors were evaluated for mass effect on the surrounding structures with special emphasis on the sella, skull base, optic chiasm and circle of Willis. Observations that were made include: high-resolution CT images showed the bony changes and correlated with MRI. High-resolution MRI sequences demonstrated the optic nerves and the chiasm consistently. MR angiography with MIP reconstructions demonstrated the arterial displacement, compression and encasement. Suprasellar meningiomas cause variable effects on the optic chiasm and intracranial optic nerves. The planum sphenoidale meningiomas displaced the optic chiasm and anterior cerebral arteries posteriorly. The clinoidal meningiomas showed mass effect with encasement of the ipsilateral supraclinoid internal carotid arteries.

Summary/Conclusion
Precise surgical planning of suprasellar meningiomas requires careful attention to exact localization and the mass effect on the optic nerves and chiasm and the surrounding arterial structures. Our study consistently demonstrated these important radiologic findings that were critical for proper management. With high-resolution CT and MR imaging techniques it is now possible to precisely map the suprasellar meningiomas.

Key Words: Meningioma, suprasellar, MRI

Scientific Exhibit 12
Characteristic MR Finding of Metastasis to the Internal Auditory Canal

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Purpose
Internal auditory canal (IAC) is unusual site for metastasis, and MR finding of IAC metastasis mimics acoustic schwannoma. The purpose of this exhibit is to present the characteristic MR finding of IAC metastasis and point for differential diagnosis.

Approach/Methods
We retrospectively reviewed the imaging studies of three patients with bilateral IAC metastases (65- and 64-year-old females with pulmonary adenocarcinoma both of whom presented rapidly developing deafness and 86-year-old female with gastric carcinoma presenting dementia). They were assessed by the axial, sagittal, and coronal T1-weighted images with contrast enhancement.
Figure. 64-year-old female with lung adenocarcinoma. Axial (A) and sagittal (B) T1-weighted images with contrast enhancement. (A) Shows enhancing masses in the bilateral IACs. (B) Shows ring-like enhancement in left IAC.

FINDINGS/DISCUSSION
All lesions showed enhancing masses in the IACs. Axial and coronal T1-weighted images showed homogeneous contrast enhancement in the IACs. However, this finding was not specific to metastasis and it is difficult to distinguish metastasis from schwannoma. All lesions exhibited ring-like enhancement in the sagittal view (Figure) on the sagittal T1-weighted image with contrast enhancement. This finding may be characteristic of the IAC metastasis. Metastasis to the IAC is considered to result from leptomeningeal metastasis of malignant cells that spread along to the pia mater surrounding the 7th and/or 8th cranial nerves without distorting their positions. We speculate that this metastatic pattern exhibits ring-like enhancement of nerves keeping their circular shape in the IAC, while acoustic schwannoma is homogeneous enhancing mass dislocating cranial nerves.

SUMMARY/CONCLUSION
Most lesions of the IAC are benign tumors, including acoustic schwannoma and meningioma. Malignant tumors account for less than 1% of IAC tumors. Therefore, metastatic tumors of IACs are unlikely included in the differential diagnoses. However, metastasis should be considered in the case of older patient with ring-like enhancing IAC masses on sagittal T1-weighted image with contrast enhancement.

KEY WORDS: Metastasis, internal auditory canal, schwannoma

Scientific Exhibit 13
Radio-Pathologic Correlation of Low-Grade Temporal Neoplasms
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Detroit, MI

PURPOSE
Drug-resistant complex partial seizures are found to have temporal lobe neuroepithelial tumors in 20-30% of cases. Neuroepithelial tumors include low-grade neuroglial tumors, such as dysembryoplastic neuroepithelial tumors (DNET), ganglioglioma, mixed tumors and glial neoplasms like pleomorphic xanthoastrocytoma, pilocytic astrocytoma, low-grade astrocytomas and oligodendroglioma. The purpose of our exhibit is to review the common CT and MR imaging appearances of this subset of tumors with relevant radiopathologic correlation.

APPROACH/METHODS
Our retrospective review of temporal lobe tumors from our brain tumor registry revealed 30 patients of which 15 had neuroglial tumors (7 DNETs and 8 gangliogliomas). MR imaging was available in all patients, and CT was available in six patients. Conventional imaging features and advanced imaging wherever applicable to highlight radiopathologic correlations will be illustrated in this exhibit. The pathology slides were reviewed and re-evaluated with the pathologist and pertinent pathologic sections also will be presented.

FINDINGS/DISCUSSION
MR imaging characteristics, including morphologic appearances such as presence of cystic and/or solid component, pattern of enhancement, cortical involvement, T1- and T2-weighted signal characteristics, size, presence of edema and location will be analyzed along with advanced imaging such as MR spectroscopy, MR perfusion, MR diffusion and functional MR imaging (fMRI) will be illustrated. Relevant imaging appearances will be correlated with pathologic findings.

SUMMARY/CONCLUSION
After reviewing this exhibit, the viewer should be familiarized with the common tumors associated with complex partial seizures and be able to better differentiate between these tumors on imaging studies.

KEY WORDS: DNET, ganglioglioma, PXA

Scientific Exhibit 14
Intraventricular Brain Tumors and Nontumoral Lesions: A Pictorial Review
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PURPOSE
To review epidemiologic, clinical and radiologic defining characteristics of brain tumors and nontumoral lesions which arise in the ventricular system.

APPROACH/METHODS
We have conducted a retrospective review of all patients admitted with the diagnosis of intraventricular mass to the department of neurosurgery of our institution between January 1995 and September 2008. Data reviewed included patient demographics, clinical manifestations, computed tomography (CT) and magnetic resonance (MR) scan results, surgical technique and patient outcomes.

FINDINGS/DISCUSSION
Intraventricular mass lesions represent 10% of all central nervous system neoplasms, with common dissemination via the cerebrospinal fluid (CSF) and CSF flow obstruction. The main differential diagnosis of a tumor located in the trigone of the lateral ventricle should include choroids plexus papi-
ular lesion

KEY WORDS: Intraventricular tumor, neoplasm, intraventricular lesion

SUMMARY/CONCLUSION
The differential diagnosis of intraventricular brain masses is complicated due to nonspecific imaging findings. The consideration of patient’s age and the exact localization of the mass within the brain ventricular system are important factors for the correct differential diagnosis. CT and MR image of several entities is quite similar, making differentiation even impossible; thus biopsy and histopathologic examination may be the only way to obtain an accurate diagnosis.

APPROACH/METHODS
Selected patients with various disease processes, such as brain trauma, neoplasm, ischemia, vascular malformation, or neurodegenerative disease, undergoing conventional MR imaging obtained further evaluation with SWI. MR scanning was performed on a Sonata 1.5 T (Siemens) magnet at the MR Research Facility at Wayne State University. It has a gradient coil capable of 40 mT/m. An 8-channel head coil was used for parallel imaging for a number of the sequences. Each patient had a conventional MR scan including T1, T2, FLAIR and T1 postcontrast. Contrast-enhanced MR was performed using a single dose of Gd-DTPA. Susceptibility-weighted imaging was performed with the following imaging parameters: TR 60ms, TE 40ms, FOV 256/512, FOVy (mm)/Ny 192/192, transverse orientation, Nz/TH (mm) 32/2, time 370s.

FINDINGS/DISCUSSION
Many imaging examples will be shown in the exhibit relating to the following topics: 1) Trauma: SWI gives a better estimate of the amount of injury in diffuse axonal injury, as compared to standard gradient-echo sequences. 2) Malignancy: SWI provides valuable information about brain tumors including complicating processes, such as microhemorrhage, internal architecture, and tumor boundaries. Susceptibility-weighted imaging can provide excellent detail of the venous vasculature of the tumor which may correlate with angiogenesis and tumor grade. (3) Ischemia: SWI may be a useful adjunct to diffusion-weighted imaging, for evaluating the area at risk for infarct and for evaluation for hemorrhage within areas of infarct. (4) Angiographically occult vascular malformations: SWI improves detection of many slow flow angiographically occult vascular lesions, including developmental venous anomalies, cavernous malformations, and capillary telangiectasias. (5) Neurodegenerative
disorders: SWI may help to better track disease progression in neurodegenerative disorders, such as Parkinson disease, Huntington disease, Alzheimer disease, multiple sclerosis, amyotrophic lateral sclerosis and pantothenate kinase associated neurodegeneration, as these are related to increased iron deposition especially in the basal ganglia.

SUMMARY/CONCLUSION
Susceptibility-weighted imaging is a powerful MR imaging sequence which can provide clinically useful information in neuroimaging. The goal of this exhibit is to show many imaging examples where SWI is clinically applicable and useful as SWI may not be part of the standard neuroimaging protocol and many radiologists may be unaware of its utility.

KEY WORDS: MRI, susceptibility

Scientific Exhibit 16
Nonperinatal Hypoxic-Ischemic Encephalopathy: Spectrum of Imaging Findings with Clinical Features

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PURPOSE
Hypoxic-ischemic encephalopathy (HIE) is the consequence of global perfusion or oxygenation disturbance. Various clinical features of HIE result in variability in the radiologic characteristics. This presentation retrospectively reviews radiologic studies of nonperinatal patients with HIE. Clinical manifestations also are reviewed.

APPROACH/METHODS
The medical records of patients with HIE were reviewed for etiologic factors, symptoms, severity, outcome, and findings related to the timing of imaging. CT and MR imaging were correlated with the clinical features.

FINDINGS/DISCUSSION
Illustrative images of mild, severe, and brain death cases are discussed. Serial images showing changes over time are presented. Common findings including cortical gray matter swelling and basal ganglia involvement are demonstrated. This exhibit also includes some uncommon radiologic findings such as brain herniation, restricted diffusion throughout brain, and abnormalities in limbic system, pons, and tegmentum.

SUMMARY/CONCLUSION
Familiarity with various clinical features and correlated imaging findings of HIE is essential in making an accurate diagnosis. Subtle imaging findings pointed out in this presentation aid the radiologist in making HIE diagnosis when otherwise the diagnosis might be missed.

KEY WORDS: Hypoxic-ischemic encephalopathy

Scientific Exhibit 17
Pictorial Review of Corpus Callosal Abnormalities

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PURPOSE
To review the normal anatomy, vascular supply, and range of pathologies that may occur within the corpus callosum.

APPROACH/METHODS
The corpus callosum is the largest interhemispheric white matter tract and is responsible for the communication between the two cerebral hemispheres. Vascular supply is from branches of both the anterior cerebral and posterior cerebral arteries. This pictorial essay will review several illustrative cases of lesions in this structure after a review of the anatomy and vascular supply.

FINDINGS/DISCUSSION
The discussion will include several abnormalities that specifically affect the corpus callosum including congenital anomalies, multiple sclerosis, lymphoma, glioblastoma multiforme, post-ictal signal abnormality, acute meningitis-related callosal signal abnormality, Marchiafava-Bignami, pericallosal/splenial infarcts, diffuse axonal injury. In addition, diffuse brain processes also can manifest in the corpus callosum such as progressive multifocal leukoencephalopathy, lupus, mucopolysaccharidoses. Differentiating imaging characteristics will be highlighted.

SUMMARY/CONCLUSION
The corpus callosum is an interesting anatomical structure of the brain. A variety of lesions may affect the corpus callosum. We have reviewed anatomy, vascular supply, and lesions of the callosum with a discussion of the differentiating imaging characteristics.

KEY WORDS: Corpus callosum
Scientific Exhibit 18

Spontaneous Intracranial Hypotension: Cranial MR Findings

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PURPOSE
Once considered an exceedingly rare disorder, recent evidence suggests that spontaneous intracranial hypotension (SIH) is not that rare and has to be considered an important cause of new daily persistent headaches, particularly among young and middle-aged individuals. In a more recent emergency department-based study (1), SIH was half as common as spontaneous subarachnoid hemorrhage. Magnetic resonance (MR) imaging has revolutionized the understanding of SIH and has greatly facilitated the ability to arrive at the diagnosis with confidence without having to resort to invasive procedures. This exhibit reviews both classic and newly described cranial MR findings of SIH syndrome.

APPROACH/METHODS
Our database was searched, and 63 cases of SIH were identified between 2003 and 2007. A comprehensive evaluation of cranial MR imaging of 63 patients with SIH was performed.

FINDINGS/DISCUSSION
The five characteristic imaging features of spontaneous intracranial hypotension visible on MR imaging are subdural fluid collections, enhancement of the pachymeninges, and engorgement of venous structures, pituitary hyperemia, and sagging of the brain. These findings will be described with details. We also will describe uncommon or new MR findings of SIH such as internal acoustic channel venous engorgement, engorgement of cranio-vertebral venous structures, prominent pterygoid plexus and others. We also will discuss SIH cases with normal cranial MR findings.

SUMMARY/CONCLUSION
Recognition of cranial MR imaging features of SIH is the most important factor responsible for the ever-increasing number of patients diagnosed with SIH since the early 1990s. On the other hand, an incomplete understanding of the variability of MR findings has resulted in the diagnosis of spontaneous intracranial hypotension being erroneously excluded in patients with normal findings.

REFERENCES
2. Schievink WI. Spontaneous spinal cerebrospinal fluid leaks and intracranial hypotension. JAMA 2006;295:2286-2296

KEY WORDS: Spontaneous intracranial hypotension, cranial, MR imaging

Scientific Exhibit 19

Posterior Reversible Encephalopathy Syndrome: The Usual, the Unusual and the Way We Differentiate Between Them

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PURPOSE
Posterior reversible encephalopathy syndrome (PRES) is a well described clinical and neuroradiologic entity with several identified triggers and several proposed pathophysiological mechanisms such as cerebral edema, endothelial damage, failure of autoregulation and cerebral ischemia. Cross-sectional imaging (CT and MR imaging) makes early identification and diagnosis possible and therapeutic interventions can be initiated quickly. In real practice, some cases still are not diagnosed in a timely manner. The effect of early diagnosis on outcome is unmistakable. This is an educational exhibit detailing the usual findings of PRES as well as the complications seen on CT and MR imaging.

APPROACH/METHODS
This exhibit reviews the current thinking on the pathophysiology of posterior reversible encephalopathy syndrome with a discussion on the known triggers of this entity. CT and MR imaging changes of classic cases of PRES will be presented emphasizing the variability of location of lesions such as in the posterior fossa and frontal lobes as well as in the deep gray matter. Subtle changes on CT and the variability of findings on various MR sequences that should alert the radiologist to the presence of complication will be discussed. We also illustrate and highlight several unusual presentations and complications of PRES such as ischemic transformation, hemorrhage, hydrocephalus (Figure 1) and the presence of permanent lesions such as encephalomalacia (Figure 2) and cerebral volume loss. Early diagnosis is the key to avoiding these unusual and permanent lesions.
SUMMARY/CONCLUSION
We want to convey a message of how to comfortably make a diagnosis of PRES using CT and MR imaging with pertinent teaching points to include (1) how to identify classic PRES, (2) how to utilize various MR sequences, particularly DWI, ADC maps, GRE to your advantage, and (3) how to recognize complications.

KEY WORDS: PRES, encephalopathy, imaging of PRES

Scientific Exhibit 20
Hyperintensity in the Subarachnoid Space on T2-FLAIR MR Imaging

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PURPOSE
T2-FLAIR (fluid attenuated inversion recovery) pulse sequence has been part of the routine MR imaging of the brain in many institutions. The purpose of this exhibit is to illustrate the different causes of hyperintensity in the subarachnoid space on T2-FLAIR MR imaging.

APPROACH/METHODS
The understanding of the mechanisms of subarachnoid space hyperintensity in T2-FLAIR MR imaging entails knowledge of physics of T2-FLAIR pulse sequence and anatomy of the subarachnoid space and these will be discussed briefly. We reviewed cases from our teaching files for causes of T2-FLAIR subarachnoid space hyperintensity.

FINDINGS/DISCUSSION
This analysis involved 13 cases which included pathologic causes [subarachnoid hemorrhage, meningitis, meningeal carcinomatosis, acute stroke, elevated blood pool:cerebrospinal fluid (CSF), venous thrombosis, hydrocephalus, leptomeningeal melanosis and fat-containing tumors] and nonpathologic causes (artifact-related causes including supplemental oxygen, CSF pulsation, vascular pulsation, magnetic susceptibility artifact and motion artifact). We present a comprehensive illustrated review of these lesions and the mechanism(s) of each cause is discussed. Analysis of the distribution of subarachnoid space hyperintensity and ancillary findings (e.g., presence of adjacent mass) helps elucidate the cause. Imaging characteristics in GRE T2* and postgadolinium T1 images also are helpful to identify the cause. Occasionally, the findings remain nonspecific, thus, clinical correlation and CSF findings may be needed.

SUMMARY/CONCLUSION
T2-FLAIR pulse sequence is a commonly used sequence and radiologists should be aware of the mechanism(s) and causes of T2-FLAIR subarachnoid space hyperintensity.

KEY WORDS: FLAIR, subarachnoid space, hyperintensity

Scientific Exhibit 21
Post-Neurointervention CT Head Scan: Nuances and Pitfalls

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PURPOSE
To illustrate the range of appearances on the post-neurointervention CT-head, including unusual patterns of enhancement, intracranial devices and complications.

APPROACH/METHODS
With IRB approval, we reviewed the clinical data, angiographic and postprocedure CT imaging of patients over an 18-month period in a single institution. Abnormal findings were correlated with patient outcome and subsequent imaging.

FINDINGS/DISCUSSION
Neuroendovascular procedures often require injection of large volumes of iodinated contrast into a single cerebrovascular territory. Such concentrations can overwhelm an “intact” blood-brain barrier resulting in parenchymal enhancement. Patients are typically asymptomatic and the enhancement resolves within 24 hours without an underlying lesion on subsequent imaging. Infarcts show avid enhancement - earlier than expected with IV contrast - including hyperacute strokes undergoing IA therapy or occurring as a complication of a cerebrovascular intervention. A lack of corresponding mass effect helps differentiate from hemorrhage. Increased vascular permeability in cases of acute subarachnoid hemorrhage (SAH), recent intracranial surgery or large infarcts also can result in subarachnoid enhancement, mimicking a new SAH. Differentiation is usually simple on
clinical assessment but may rely more on the imaging appearance if the patient already is intubated with a poor exam. Procedural lesion ruptures usually are detected angiographically during the case or cause an abrupt decline with intracranial hypertension. Micro-guidewire perforations may be self-limiting and cause a characteristic hyper-attenuating subarachnoid “white out” appearance on CT similar to a dense CT-cisternogram. The contrast usually is reabsorbed rapidly, though it can linger in cases of communicating hydrocephalus. Severe streak artifact is caused by platinum coils and the tungsten contrast in the liquid embolic agent, Onyx. Although this limits their visualization on the axial images, the scout image should be referenced to the last procedural angiogram to rule out any immediate migration, though extremely rare. n-Butyl-cyano-acrylate (polymerizing glue) is less radiodense but, along with Onyx, is sufficiently radiopaque to be detected if there is an inadvertent microembolism distant to the site of intended embolization (usually an AVM or dural fistula). Tiny particles (PVA or Embospheres) for intracranial tumor embolizations, are not directly visualized but are associated with residual hyper-enhancement of the embolized tumor. Acute tumor necrosis rarely can occur within hours and cause mass effect requiring emergency surgical decompression or IV steroid. Stainless steel coronary stents, previously used for most intracranial stenting, cause streak artifact but have been largely superseded by self-expanding nitinol stents which are only mildly hyperattenuating apart from the radiopaque markers at the stent ends. The stent’s location should be scrutinized given the several reports of “watermelon seed” stent migration including the example illustrated in this presentation. Finally, fractured microcatheters and wires can be left behind, most often associated with the use of liquid embolic agents. In rare cases of “catheter gluing” the operator may choose to cut the microcatheter at the groin, bury the proximal end subcutaneously and leave the remaining construct in vivo.

SUMMARY/CONCLUSION
The post-neurointervention CT-head can have dramatic, occasionally misleading appearances. A detailed account of the procedure is often necessary for correct interpretation.

KEY WORDS: CT, endovascular, interpretation

Scientific Exhibit 22
Many Faces of Diffuse Axonal Injury

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PURPOSE
Diffuse axonal injury (DAI) is one of the primary trauma-related causes of morbidity and mortality worldwide. Diagnosing DAI can be a challenge because the majority of lesions are initially nonhemorrhagic, and when hemorrhagic, can have a wide range of radiologic presentations. In this pictorial exhibit, we will discuss the mechanisms that ultimately result in DAI and its many CT and MR imaging appearances.

APPROACH/METHODS
The mechanisms of injury and pathophysiology that results in DAI will be discussed. Emphasis will be placed on the wide-ranging radiologic manifestations of DAI, which will be presented using MDCT and MR images obtained from our Level I trauma center.

FINDINGS/DISCUSSION
Shearing forces, which are a combination of acceleration, deceleration, and rotational stresses, may lead to twisting and stretching of axons with an associated inflammatory cascade, which ultimately results in neuronal injury and/or death. Patients that suffer this type of injury, known as DAI, usually arrive at the ER with a depressed Glasgow coma scale. Ironically, considering the severity of this type of injury, it sometimes presents with negative or subtle radiologic findings. When injuries are identified they commonly are found at the gray-white matter junction of the cerebral hemispheres, splenium of the corpus callosum, dorsal midbrain, and basal ganglia, among others. CT is the study of choice to evaluate hemorrhagic lesions; nevertheless, MR imaging with the help of T2 and gradient-echo T2* sequences, has important diagnostic value for subtle hemorrhagic and nonhemorrhagic lesions. As you can see, the radiologic appearance of DAI can range from a normal radiographic study to multiple evident hemorrhagic lesions.

SUMMARY/CONCLUSION
Diffuse axonal injury is a serious sequela of severe trauma with sometimes fatal outcomes. The ability to accurately diagnose DAI in a timely fashion is key to treatment success and patient survival. Therefore, there must be a clear understanding of the varied CT and MR manifestations of this entity. Knowledge of the many faces of DAI is critical ammunition for every radiologist’s arsenal.

KEY WORDS: Diffuse axonal injury, DAI, trauma

Scientific Exhibit 23
CT and MR Imaging of Nonatheromatous Thrombosis in Internal Carotid Arteries: Imaging and Clinical Evolution with Treatment

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PURPOSE
Nonatheromatous thrombosis of internal carotid arteries (NATICA) is one of the potential causes of ischemic events and stroke. It may develop de novo or in a thrombophilic environment. Free-floating thrombus (FFT) is a subtype of NATICA infrequently seen in the evaluation of patients with acute cerebral ischemia. It usually has been described as case reports in the ultrasound literature. CT and MR angiography have become accurate methods to evaluate cervical and intracranial arteries. We review imaging features, clinical course and follow-up imaging with medical therapy in NATICA. These cases will be compared to atherosclerotic plaques and dissections.
PURPOSE
Toulouse, FRANCE
Bonneville, F.

source of cSAH. In the specific clinical context of elderly
dysregulation of the cerebral microvascularization, may be a
aware that posterior reversible encephalopathy syndrome, a
ventional angiography. Neuroradiologists also should be
sought by noninvasive or/and con-
moyamoya disease (or even severe atherosclerotic carotid
vascular disease) also should be
help of T2* sequence. Distal and proximal arteriopathies
usually is diagnosed on CT or MR venograms, and with the
thrombosis represents a classical origin of such a SAH and
SAH along the convexity. Cortical veins and/or dural sinus
ischemic symptoms. Three patients demonstrated resolution
or marked reduction in thrombus at short-term follow-up CT
or MR imaging. One patient had pathologic confirmation of
finger-like clot.

SUMMARY/CONCLUSION
We emphasize the imaging features and identification of
NATICA and FFT and differentiation from typical athero-
matous plaques and dissections at CTA or MRA. This dif-
ferentiation may affect acute management options. They may
resolve at short-term follow up.

KEY WORDS: Nonatheromatous, thrombosis, carotid

Scientific Exhibit 24
Acute Nontraumatic Cortical Subarachnoid Hemorrhage: A Pictorial Essay of Underlying Causes

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PURPOSE
To illustrate the unusual etiological background of isolated
acute nontraumatic cortical subarachnoid hemorrhage
cSAH).

APPROACH/METHODS
Isolated acute cSAH is sometimes observed at the cerebral
convexity on unenhanced CT scans. Once sacciform
aneurysm, arteriovenous malformation or dural arteriove-
nous fistula ruled out by CT angiogram, other numerous eti-
ologies remain possible. MR imaging, and less extensively
digital subtracted angiogram, then may be of precious help
in order to approach the final diagnosis.

FINDINGS/DISCUSSION
While basal SAH originates from a ruptured aneurysm in
about 85% of all cases, a broad spectrum of vascular and
even nonvascular pathologies can cause acute nontraumatic
SAH along the convexity. Cortical veins and/or dural sinus
thrombosis represents a classical origin of such a SAH and
usually is diagnosed on CT or MR venograms, and with the
help of T2* sequence. Distal and proximal arteriopathies
(vasculitis, systemic diseases, toxic, infectious…), reversible
cerebral vasoconstriction syndrome, mycotic aneurysms,
mooyamoya disease (or even severe atherosclerotic carotid
disease) also should be sought by noninvasive or/and con-
ventional angiography. Neuroradiologists also should be
aware that posterior reversible encephalopathy syndrome, a
dysregulation of the cerebral microvascularization, may be a
source of cSAH. In the specific clinical context of elderly
patients presenting with partial seizure, CT scan may depict
an isolated cSAH, that is attributed to cerebral amyloid angiopathy according to the numerous microbleeds demon-
strated by T2* images. Finally, cSAH also may be observed
in case of nonvascular disorders such as leptomeningeal car-
cinomatosis and abscess.

SUMMARY/CONCLUSION
A wide variety of pathologies may be responsible for isolat-
ed acute nontraumatic SAH along the convexity. Depending
on clinical features, nonvascular (tumoral, infectious) and
vascular (venous, arterial and arteriolar) causes should be
sought. Cerebral amyloid angiopathy certainly plays an
underestimated role in isolated cSAH in elderly patients.

KEY WORDS: Subarachnoid hemorrhage

Scientific Exhibit 25
Radiologic/Pathologic Correlation of Perivascular and Leptomeningeal Processes

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PURPOSE
To provide radiologic and pathologic correlation for abnor-
malities of the subarachnoid and perivascular spaces. To dis-
cuss differences in imaging and histopathology between
lesions in these two spaces and provide differential diag-
noses. After reviewing this exhibit, the viewer should: 1.
understand the anatomy of the subarachnoid and perivascu-
lar spaces, 2. be familiar with common abnormalities that
may occur in these spaces, 3. know differences in radiologic
findings between entities occurring in these spaces.

APPROACH/METHODS
A review of the anatomy highlighting the differences
between the subarachnoid and perivascular spaces will be
presented followed by illustrative cases with corresponding
radiology and pathology and a review of the literature.
Common and uncommon imaging characteristics will be
reviewed. Differentiating pathology findings will be dis-
cussed.

FINDINGS/DISCUSSION
Arteries course from the subarachnoid space into the
perivascular space. It was long believed that these two
spaces were contiguous; however, electron microscopy has
demonstrated them to be distinct from one another.
Arterioles and venules in the perivascular space differ in that
arterioles are invested with a second layer of pia. While cere-
brospinal fluid fills the subarachnoid space, fluid in perivas-
cular spaces is believed to be exudative from the brain
parenchyma akin to lymphatic drainage. There are distinct
anatomical, histologic, and imaging differences between
lesions of the perivascular space and lesions of the sub-
arachnoid space. Common entities affecting the subarach-
roid space include secondary lymphoma, metastatic disease,
neurosarcoidosis, and meningitis. Entities affecting the
perivascular spaces include cryptococcus, primary lymphoma, demyelinating disease, lymphomatoid granulomatosis. We also present a rare case of diffuse perivascular involvement in X-linked lymphoproliferative disorder.

**SUMMARY/CONCLUSION**
The subarachnoid and perivascular spaces are related spaces but are now known to be anatomically distinct from one another and should not be confused. We present cases demonstrating pathology in both these spaces and discuss the anatomical and imaging differences.

**KEY WORDS:** Subarachnoid, perivascular, brain

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**Scientific Exhibit 26**

*Intracranial Dural Arteriovenous Fistulas: An Anatomical and Angiographic Review*

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**PURPOSE**
To illustrate the anatomical and pathophysiologic differences between the different types of intracranial dural arteriovenous fistulas (DAVF) using clinical case studies and anatomical illustrations.

**APPROACH/METHODS**
Cases of intracranial DAVFs are presented from previously maintained IRB approved databases at the Johns Hopkins Hospital and University of Michigan, Ann Arbor. Illustrations were drawn by a medical illustrator with neurovascular expertise.

**FINDINGS/DISCUSSION**
Anatomical illustrations matched with clinical case examples of DAVFs highlight the salient features of the Cognard classification. Longitudinal follow-up depicts the dynamic nature of these lesions with both angiographic progression and regression from one grade to another. A discussion of treatment planning and endovascular approaches will be presented.

**SUMMARY/CONCLUSION**
The audience will gain a better understanding of the different types of intracranial DAVFs with special attention to their dynamic nature and endovascular treatment options.

**KEY WORDS:** Dural arteriovenous fistula, anatomy, classification

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**Scientific Exhibit 27**

*Imaging and Functional Anatomy of the Basal Ganglia and Diencephalon for Understanding of Deep Brain Stimulation*

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**PURPOSE**
Deep brain stimulation (DBS) is a surgical procedure used to treat a variety of disabling neurologic symptoms such as tremor, rigidity, stiffness, slowed movement, walking problems and pain. Before the DBS procedure, imaging studies such as magnetic resonance (MR) imaging and computed tomography (CT) scan are performed to identify and locate the exact target within the brain where electrical nerve signals generate the neurologic symptoms. The aim of this study is to demonstrate 1) the anatomical structures for DBS targeting using high resolution MR imaging, 2) the functional anatomy of those structures for understanding DBS procedures.

**APPROACH/METHODS**
High resolution MR images of healthy volunteers were obtained using 3 T MR scanners. We compared them to anatomical atlases to identify the target regions of DBS. In patients who underwent DBS for treatment of neurologic symptoms, post-DBS CT images and pre-DBS MR images were fused to validate the location of the electrodes. We also will demonstrate functional anatomy of the basal ganglia and diencephalon relating to DBS procedure using images of clinical cases with basal ganglia and diencephalon lesions.

**FINDINGS/DISCUSSION**
Frequently used structures as the target region of DBS are the thalamus, subthalamus nucleus, and globus pallidus. Sometimes, the pedunculopontine nucleus and internal capsule also are used. The thalamus is the major route by which subcortical neuronal activity influences the cerebral cortex, and the greatest input to most thalamic nuclei comes from...
the cerebral cortex. The basal ganglia including the putamen, globus pallidus and subthalamic nucleus is a functional complex involved in the control of movement and motivational aspects of behavior. On MR imaging, the putamen, globus pallidus (external and internal segment of the globus pallidus) and subthalamic nucleus can be identified; however, some of the thalamic nuclei cannot. We will discuss several problems for localization of the target region on imaging.

**SUMMARY/CONCLUSION**

After viewing this exhibit, radiologists should have a better understanding of the MR anatomy and functional anatomy of the basal ganglia and diencephalon for DBS targeting.

**KEY WORDS:** Basal ganglia, diencephalon, deep brain stimulation

**Scientific Exhibit 28**

**Highways and Byways: A Review of the Collateral Circulation of the Head and Neck**

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**PURPOSE**

The purpose of this exhibit is to demonstrate and review the most frequently encountered collateral pathways of the head and neck seen in patients with vaso-occlusive disease. A thorough understanding of these common collateral vessels and their expected locations will enable their recognition and provide for a more complete evaluation of a patient’s cerebrovascular disease on computed tomography angiography (CTA) examinations.

**APPROACH/METHODS**

We illustrate the most commonly occurring collateral pathways of the head and neck arterial vasculature. These include the circle of Willis, leptomeningeal circulation between pial branches of the ACA, MCA and PCA as well as between branches of the external and internal carotid arteries, external carotid and vertebral arteries and between the subclavian and the internal carotid, external carotid, and vertebral arteries.

**FINDINGS/DISCUSSION**

Because it is noninvasive, increasingly available, and rapidly acquired, CTA is largely supplanting digital subtraction angiography (DSA) as the mainstay in the evaluation of the head and neck vasculature. However, DSA continues to be superior in the detection and demonstration of collateral vessels as CTA currently lacks directional and temporal resolution in showing collateral blood flow. Consequently, it is important to know the most frequently occurring collateral pathways of the head and neck so that they may be recognized on CTA examinations allowing for a more complete evaluation of cerebrovascular disease.

**SUMMARY/CONCLUSION**

We review and illustrate the collateral pathways that occur most commonly in the head and neck arterial vasculature. A better knowledge of these collateral pathways will allow for their improved detection and inference on CTA examinations in the absence of DSA correlation.

**KEY WORDS:** CTA, collateral circulation

**Scientific Exhibit 29**

**Artery of Adamkiewicz: Know the Anatomy, or Know a Good Lawyer**

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2Asan Medical Center, Seoul, REPUBLIC OF KOREA, 3Los Robles Hospital, Thousand Oaks, CA

**PURPOSE**

1. To provide a comprehensive review of the anatomy and anatomical variants of the artery of Adamkiewicz (AKA) in MRA/CTA/Conventional angiogram and 2. To provide an updated evidence-based review of the clinical importance of the AKA, present various interventional procedures in which identification of the AKA is important, and the potential complications of inadvertent occlusion.

**APPROACH/METHODS**

Selected cases demonstrating the anatomical characteristics of the AKA, including a “hairpin turn” and the “continuity” criterion, will be presented in CTA, MRA, and angiographic images. Current literature will be reviewed to demonstrate the clinical significance of the AKA. A variety of thoracoabdominal interventional procedures in which the AKA was of utmost clinical importance will be shown. The dreaded complication of spinal cord infarct leading to paraplegia from failure to identify this artery also will be discussed.

**FINDINGS/DISCUSSION**

The origin of the AKA ranges from the level of T4 to L2. The AKA supplies the anterior spinal artery, which in turn supplies the anterior two thirds of the spinal cord. Occlusion of this artery may lead to spinal cord ischemia and possibly infarction. Causes for occlusion include hypotension, aortic clamping, embolization, and internal iliac artery disruption. The distal segment of the AKA forms a hairpin turn at its junction with the anterior spinal artery. In order to correctly distinguish the artery from the anterior radiculomedullary vein/anterior spinal vein, the continuity criterion must be fulfilled. This involves recognition of a continuous vascular path extending from the aorta, posterior branch of the intercostal artery, radiculomedullary artery, AKA, and the anterior spinal artery. The correct identification of this artery is critical in multiple interventional procedures, including abdominal aortic aneurysm repair, chemoembolization of hepatic and renal tumors, and embolization for spinal metastases. The course of therapy and management of the patient may change depending on the location of the AKA in relation to the area of interest, as well as collateral circulation.
SUMMARY/CONCLUSION
After reviewing our presentation, radiologists should be able to: 1. Recognize the different imaging presentations of the AKA in its usual anatomy and anatomical variants. 2. Appreciate that the AKA may be compromised in a wide range of interventional procedures and 3. Understand that the inability to identify the AKA prior to intervention may lead to unintentional occlusion and subsequent paraplegia.

KEY WORDS: Artery of Adamkiewicz

Scientific Exhibit 30
MR Imaging, Anatomical and Clinical Correlation of Incomplete Spinal Cord Syndromes

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PURPOSE
Improved spacial resolution in neuroimaging and improved patient care has led to an increase in the imaging of patients with incomplete spinal cord syndromes. It is essential for the neuroradiologist to be fluent in the clinical lexicon describing patients with these syndromes. This exhibit is designed to review the named syndromes that the neuroradiologist may encounter in clinical practice.

APPROACH/METHODS
Anatomical drawings of spinal cord pathways, both sensory and motor, are coupled with MR imaging of selected patients to illustrate the correlation between anatomical and imaging findings and the clinical syndrome.

FINDINGS/DISCUSSION
Brown Sequard, central cord syndrome, anterior cord syndrome, posterior cord syndrome, tabes dorsalis, conus medullaris syndrome, and cauda equina syndrome are commonly encountered spinal cord syndromes in neuroradiology. The exhibit reviews the relationship between, motor and sensory tract location, vascular supply, mechanisms of injury and imaging findings with clinically distinct clinical spinal cord syndromes.

SUMMARY/CONCLUSION
Upon review of this exhibit, the neuroradiologist will have a more complete understanding of the pathophysiologic basis of spinal cord injury and associated syndromes.

KEY WORDS: Spine, syndromes, anatomy

Scientific Exhibit 31
I Am NOT Just an “In-Between Space!”: (The Prestyloid Parapharyngeal Space)

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PURPOSE
This exhibit explores the prestyloid parapharyngeal space (PPS) of the neck, reviewing its normal anatomy and presenting a variety of primary PPS pathologies, which are often overlooked. In addition, the much more familiar “localizing” role of the PPS is depicted, as pathologic lesions arising from adjacent spaces are shown to impart their characteristic mass effects on the PPS.

APPROACH/METHODS
Through the use of artist renderings, CT, and MR examinations, the normal anatomy of the prestyloid parapharyngeal space and surrounding spaces (submandibular, masticator, parotid, carotid, retropharyngeal, and pharyngeal mucosal spaces) is demonstrated. Using a normal template as a guide, pathology, either arising within or secondarily affecting the PPS, is presented from recent CT, MR, and angiographic cases collected from teaching files of multiple institutions.

FINDINGS/DISCUSSION
Due to its central location and ease of recognition on CT and MR imaging, identification of mass effects on the prestyloid parapharyngeal space (PPS) is sometimes useful for localizing pathology to the major surrounding spaces of the neck. The role of the PPS in this regard is well established. However, primary pathology arising within the PPS is rarely emphasized. A variety of normal structures are located in the PPS including fat, ectopic salivary gland tissue, ascending pharyngeal artery, pterygoid venous plexus, tensor veli palatini muscle, and branches of V3. Accordingly, this diversity of normal structures yields a corresponding wide range of primary PPS pathology. The primary PPS pathology illustrated in this exhibit includes lipomas, liposarcomas, synovial cell sarcomas, benign and malignant salivary gland tumors, inflammatory pseudotumor, vascular lesions, nerve sheath tumors, as well as a variety of congenital lesions (hemangiomas, lymphatic malformations, venous malformations, branchial cleft cysts, and teratomas). In addition, we also present representative pathologic processes that produce classic compressions of the PPS from the various bordering spaces and emphasize the importance of differentiating deep lobe parotid lesions from primary PPS pathology.
SUMMARY/CONCLUSION
Based upon its diversity of normal structures, there exists the potential for development of a wide array of primary pathology within the prestyloid parapharyngeal space, indicating that the PPS is more than just an “in-between space” for localizing pathology to surrounding spaces of the neck. In practice, primary PPS pathology always must be considered so as not to falsely assign pathology to a surrounding space.

KEY WORDS: Parapharyngeal, prestyloid

Scientific Exhibit 32
Aneurysmal Bone Cysts of the Head and Face: Review of Imaging Appearance with CT and MR Imaging

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PURPOSE
Review the imaging appearance of aneurysmal bone cysts (ABCs) of the skull and face.

APPROACH/METHODS
We will review the CT and MR imaging appearance of ABCs of the skull and face, with three illustrative examples of ABCs involving the anterior cranial fossa, orbital roof and maxillary sinuses.

FINDINGS/DISCUSSION
Aneurysmal bone cysts of the skull and face present as expansile mass lesions arising from the bone, often with the appearance of a multiseptated mass with fluid-fluid levels. The internal architecture of the lesions, with their septations and fluid-fluid levels are more readily apparent with MR imaging.

SUMMARY/CONCLUSION
Aneurysmal bone cysts of the skull and face, have similar imaging characteristics to their peripherally located counterparts. While uncommon lesions, it is important for radiologists to recognize these lesions to aid in diagnosis and treatment planning.

KEY WORDS: Aneurysmal, bone, cyst

Scientific Exhibit 33
MR Imaging Findings in Brachial Plexopathy

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Antalya, TURKEY

PURPOSE
We evaluated MR imaging findings of subjects with brachial plexus (BPL) lesions.

APPROACH/METHODS
Within a 2-year period, MR imaging of a total 46 patients admitted for brachial plexopathy were reviewed. Ages of subjects (24 female, 22 male) ranged from 8 days to 74 years old. MR imaging (1.5 T) were performed from C4 to T2 with sagittal T2-weighted images for cervical spine, pre and post-contrast fat saturated axial and coronal T1-weighted for BPLs, axial T2-weighted through cervical spine for radiculopathy, spinal cord lesion and pseudomeningocele and 3D heavy T2-weighted for root avulsions and small sized pseudomeningocele. If there was a clinical suspicion of thoracic outlet syndrome, additional MR angiography and venography of subclavian vessels were obtained in abduction and if necessary in neutral positions.

FINDINGS/DISCUSSION
In traumatic BPL injury, commonly occurring as a result of birth trauma in neonates and traffic accident in adolescent, usual MR imaging findings were asymmetric thickening, irregularities and contrast enhancement of BPL fibers on symptomatic sides. This is called traction or stretching injury. It is difficult in these cases to decide which trunk or cord of BPL is affected. In these scenarios, electrophysiologic tests can help determine the level of injury. Rarely in the severe trauma cases, root avulsion, pseudomeningocele and contrast enhancement at the root entry zone can occur. Pseudomeningecele mostly alerts the radiologist and clinicians that there is a root avulsion associated. However, pseudomeningocele can be present alone without root avulsion. Root avulsion and small sized pseudomeningocele are better seen via 3D heavily T2-weighted images. This sequence is very important in trauma cases. Contrast enhancement can be seen along stretched nerve fibers as well as the entry zone of avulsed root into spinal cord. Other MR imaging findings noted especially in middle and older ages were diskopathy, radiculopathy (chronic disk degeneration with osteophyte, foraminal disk extrusion and malign foraminal extraosseous infiltration), Chiari malformation with syringohydromyelia, thoracic outlet syndrome, Pancost tumor and small cell lung cancer invasion, breast cancer metastasis, neurofibroma, posttraumatic neuroma and radiation fibrosis. MR imaging findings are presented and discussed for all these pathologies.

SUMMARY/CONCLUSION
MR imaging is valuable in characterization of BPL lesions. Brachial plexus lesions can change according to age of subjects. In newborn, birth trauma is the most common. In young and middle ages, diskopathy, radiculopathy, traumatic injury, cord lesion, neurogenic tumors and in older age, metastases, tumor invasion, or radiation fibrosis are the more commonly encountered ones.

KEY WORDS: Brachial plexus lesions, MRI
Iodine 131 SPECT/CT in Differentiated Thyroid Carcinoma: Interpretative Pearls and Pitfalls

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PURPOSE
To review the role of iodine scintigraphy in the management of patients with differentiated thyroid carcinoma (DTC). To illustrate the incremental value of SPECT/CT in patients with residual, recurrent or metastatic disease. To discuss the key interpretative pearls and pitfalls.

APPROACH/METHODS
The spectrum of scintigraphic appearances of primary, recurrent and metastatic DTC are presented from a large archive of cases at a high volume tertiary referral center. The increased sensitivity and specificity of SPECT/CT over traditional whole-body planar imaging is illustrated. The direct impact this has on patient management is discussed. Critical interpretative pearls and potential pitfalls also are demonstrated. The published data on the utility of Iodine 131 SPECT/CT in DTC, the incremental value of the technique and potential future applications also are reviewed.

FINDINGS/DISCUSSION
Hybrid SPECT/CT allows accurate anatomical and physiologic localization of tracer activity and improves the accuracy of iodine scintigraphy. SPECT/CT increases sensitivity by detecting additional sites of disease and increases specificity by excluding physiologic sites of activity. This has a direct impact on and guides patient management by influencing treatment decisions regarding surgery, radionuclide therapy or external-beam radiotherapy.

SUMMARY/CONCLUSION
This pictorial review illustrates the incremental value of SPECT/CT in the management of patients with differentiated thyroid carcinoma by improving diagnostic accuracy and helping to guide therapeutic options. It also highlights the interpretative pitfalls that clinicians should be aware of.

KEY WORDS: 131 I-SPECT/CT, thyroid carcinoma, imaging

Effect of Varying Vessel Input Functions on Quantitative Parameters in CT Perfusion Maps for Head and Neck Lesions

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PURPOSE
The primary purpose of this study was to determine the influence of various arteries and veins of the neck as the arterial input and venous outflow function on quantitative CT perfusion parameters for the head and neck region using the deconvolution method. It was also our goal to compare the perfusion parameters obtained from benign and malignant lesions to demonstrate the feasibility of the perfusion parameters in obtaining a differential diagnosis.

APPROACH/METHODS
Perfusion CT was performed in 30 patients using MDCT followed by routine contrast-enhanced CT scans from November 2007 to October 2008. The perfusion data were postprocessed using a commercially available software package based on a deconvolution-based technique (Perfusion 2 software package, Advantage Windows workstation; GE Medical Systems). One radiologist, who was aware of the primary tumor site, viewed and analyzed the images and subsequently obtained regions of interest (ROI) through the primary tumor and normal salivary gland, thyroid gland, and normal muscular structures of the neck for comparison. Six different available sets of arterial and venous input vessels were selected for calculation of perfusion parameters. The data were processed into maps for each arterial input and venous out flow that represented blood volume (BV), blood flow (BF), mean transit time (MTT), and capillary permeability surface product (CP). The average values of the BV, BF, MTT, and CP were obtained for the primary lesions, salivary glands, thyroid glands, paraspinal muscles, muscles of mastication, and SCM muscles and compared. All statistical analyses were done using the SPSS for Windows Korean 14.0. Receiver operating characteristic curve (ROC) analyses also were performed by calculating the area under the appropriated ROC curves.

FINDINGS/DISCUSSION
CT perfusion was not available in four patients, and two patients were excluded as one had a lipoma and the other a pure cyst. Of the remaining 24, nine patients had malignant lesions and 15 had benign findings (13 men and 11 women; age range, 24 - 79 years; mean age, 50 years). There was no significant difference of perfusion parameters among various arterial and venous input vessels. Contrast reflux did not affect the perfusion parameters. In the parotid region, the perfusion parameters were higher when using the external carotid artery and the external jugular vein as the arterial and venous input rather than the internal carotid artery and the internal jugular vein, but those were not statistically significant. Malignant lesions tended to have higher BV, BF, CP's and shorter MTT than benign lesions.

SUMMARY/CONCLUSION
CT perfusion for head and neck lesions is feasible without any difference on perfusion parameters among all paired arterial and venous input vessels. This suggests that we can use other arteries or veins for arterial input or venous outflow function when the feeding artery or draining vein do not exist due to anatomical variations or are not available as in the case of vessels compressed or encased by tumors. The CT perfusion might be useful for characterization of head and neck lesions and have value in distinguishing between benign and malignant lesions.

KEY WORDS: CT perfusion, head and neck tumor, deconvolution
PURPOSE
The head and neck (HN) is more likely to be involved by infectious and inflammatory disease compared with other regions. When the infection involves fascial spaces and forms a phlegmon or an abscess, the disease extends rapidly and widely, which may lead to a fatal condition. Inflammation of the middle ear or the paranasal sinuses may extend throughout the skull base. Prompt diagnosis and treatment such as tracheostomy, incision and drainage are necessary. This Scientific Exhibit describes the image findings of HN abscesses and phlegmons in emergency cases.

APPROACH/METHODS
Head and neck abscesses and phlegmons during the last 5 years were evaluated, including peritonsillar abscess, masticator space abscess or phlegmon, parotid space abscess, acute epiglottitis, Ludwig’s angina, retropharyngeal abscess, purulent or necrotizing lymphadenitis, Bezold’s abscess, Lemierre’s syndrome, and intracranial involvement by inflammation of the middle ear or the paranasal sinuses. In these cases, contrast-enhanced CT was performed for diagnosis. MR imaging also was evaluated when it was performed as a second step.

FINDINGS/DISCUSSION
Peritonsillar abscess: It was most common among emergency HN lesions. Diagnostic imaging is indicated when inspection is impossible because of difficulties in mouth opening. In many cases with the opening difficulties, the inflammation extends into the masticator space. Bilateral peritonsillar abscesses via the Waldeyer’s ring also are observed. Inflammation of the masticator space: There are two types, abscess and phlegmon. Possible causes include odontogenic problems, such as dental caries, apical periodontitis and mandibular osteomyelitis. The inflammation readily extends from the masticator space into the anterior cervical space. Parotid space abscess: The abscesses enlarge and extend into the parapharyngeal space and the peritonsillar area. The disease is not only odontogenic but also caused by various conditions including intraoral infection due to ductectasis, parenchymal inflammation, and extension of inflammation from extraglandular to intraglandular parotid lymph nodes, resulting in a wide variety of image findings. Acute epiglottitis: Significant swelling of the epiglottis and the aryepiglottic fold is observed. A ring-enhancing hyperdense mass is indicative of an abscess. Airway control is a top priority. Tracheostomy is the first treatment of choice in severe cases. Ludwig angina: CT shows thickening of the subcutaneous tissue and increased density of the fatty tissue in the area from the submental region to the supraclavicular fossa. Intracranial involvement by HN inflammation: Meningitis, epidural and intraparenchymal abscesses are observed. However, brain CT (or MR imaging) was performed because of neurologic symptoms including impairment of consciousness prior to HN imaging. In such cases, it is important to check the presence of HN infections. It must be noticed that fish bones can cause abscesses in Japan, where fish is commonly eaten. Small high density on CT might be pieces of a fish bone.

SUMMARY/CONCLUSION
It is important to evaluate changes in every fascial space because treatment strategy may vary according to the degree of involvement of the spaces. It is also necessary to determine the need for airway control and application of drainage without delay in diagnosing emergency inflammatory disease of the head and neck.

KEY WORDS: Head and neck, emergency
common. Direct invasion of the intrinsic muscles of the larynx is uncommon. Medial pyriform sinus lesions invade the paraglottic space early, and may extend to the pre-epiglottic space. Perineural spread along the superior laryngeal neurovascular bundle occurs because it lies in the paraglottic fat just deep to the mucosa of the medial wall. The intrinsic muscles of the larynx can be invaded early, especially with lesions of the pyriform sinus apex. Medial wall tumors unusually invade the thyroid cartilage or spread into the deep neck. Lesions arising from the post-cricoid region invade the larynx early because of the common wall they share. Tumors in this region often are large at presentation, and may involve the esophagus, trachea, or the pyriform sinuses. Hypopharyngeal cancers arising from the posterior pharyngeal wall tend to spread in a cranio-caudal direction, as there is no direct barrier to spread upward into the oropharynx or nasopharynx, or downward to the cervical esophagus. They may spread through the constrictor muscles to involve the prevertebral tissues. Submucosal spread is common. Large tumors may spread onto the lateral wall of the pharynx and into the deep neck.

**SUMMARY/CONCLUSION**

Hypopharyngeal tumors have distinct patterns of spread, a knowledge of which can assist in the pretreatment planning and staging process.

**KEY WORDS:** Hypopharynx, cancer

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**Scientific Exhibit 38**

**Pictorial Essay: Atypical Sites of Myeloma Involvement in the Head and Neck**

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**PURPOSE**

The most common location of myeloma involvement is in the bone marrow. However, with advancements in treatment, affected patients are able to survive much longer with this disease. As a result, we are seeing more of these long-term survivors presenting with diverse and unusual presentations of disease. The goal of this exhibit is to illustrate some of the imaging features and rare manifestations of myeloma in the head and neck.

**APPROACH/METHODS**

A systematic review of the radiology information system database at a university-affiliated, tertiary oncology hospital was performed. All head and neck CT and MR imaging reports of all patients with a diagnosis of myeloma were reviewed for a period from January 2005 to August 2008. Cases with atypical presentations of myeloma in the head and neck were noted along with patient age and sex.

**FINDINGS/DISCUSSION**

The age range at presentation of these patients ranged from 35 to 87 years. Several rare and interesting manifestations of myeloma were noted, including disease involving the masti- cator space, sinonasal cavity, orbit, central skull base, cavernous sinus, larynx, thyroid and neck nodes.

**SUMMARY/CONCLUSION**

The more typical imaging features and location of myeloma have been well documented. This exhibit presents examples of rare locations of disease involvement in the extracranial head and neck. It would be important for the radiologist and clinician to be aware of these variations in order to consider a diagnosis of myeloma.

**KEY WORDS:** Myeloma, head and neck

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**Scientific Exhibit 39**

**Hypopharynx: Detailed Imaging Anatomy with Clinical and Pathologic Correlation**

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**PURPOSE**

The hypopharynx can be a challenging region to image because of its complex shape and close proximity to the larynx, esophagus, and deep neck structures. In this exhibit, the anatomy of the hypopharynx is reviewed with specific attention to the anatomical features that are critical for the evaluation of patients with hypopharyngeal cancer.

**APPROACH/METHODS**

A combination of CT and MR images, clinical photos and pathologic section will be used to demonstrate the important anatomical features of the hypopharynx.

**FINDINGS/DISCUSSION**

The hypopharynx is a tapering mucosa-lined, incomplete muscular tube that extends from the level of the hyoid bone (pharyngoepiglottic fold) to the cervical esophagus, and is classically divided into three regions: the posterior pharyngeal wall, the pyriform sinuses, and the post-cricoid regions. The posterior pharyngeal wall is contiguous with the posterior pharyngeal wall of the oropharynx and nasopharynx above, and cervical esophagus below. The bulk of the wall is formed by the inferior constrictor muscles, with a contribution from the middle constrictor superiorly. The inferior constrictor attaches to the oblique line of the thyroid lamina, leaving the posterior margin of the thyroid cartilage vulnerable to neoplasms involving the lateral pyriform sinus. The pyriform sinuses are lateral recesses created by the intrusion of the larynx into the pharynx. The medial wall of the pyriform sinus is the aryepiglottic fold. The lateral wall of the pyriform sinus is the lateral pharyngeal wall, which overlies the thyroid lamina inferiorly and thyrohyoid membrane superiority. The fat deep to the mucosal surface of the pyriform sinus anteriorly and medially is the paraglottic fat and ultimately contiguous with the pre-epiglottic space, and the thin fatty layer that covers the posterior inter-arytenoid region. The anterior wall of the pyriform sinus is a continuation of the medial wall, and is variable by imaging. The internal branch of the superior laryngeal nerve, and its accompanying vessels, run in the fat just anterior to the mucosa of the pyriform sinus. The apex of the pyriform sinus is at the level of the glottis, with the cricoarytenoid joint and lateral cricoarytenoid muscles medial to it. The post-cricoid
region is the anterior wall of the hypopharynx, and extends from the level of the cricoarytenoid joint inferiorly to the cervical esophagus. It is predominantly mucosa overlying the posterior cricoid lamina. On imaging studies, this region of the hypopharynx is collapsed and can be difficult to evaluate. There are intumeral fat planes in the post-cricoid region that can be helpful in assessing this area on imaging studies.

SUMMARY/CONCLUSION
Having a working knowledge of the complex relationship of the hypopharynx to the larynx, laryngeal cartilages, esophagus, and deep neck structures is key to understanding the imaging appearance and patterns of spread of hypopharyngeal cancer.

KEY WORDS: Hypopharynx, anatomy

Scientific Exhibit 40
Denervation Atrophy of Skeletal Muscles: A Harbinger of Cranial or Peripheral Nerve Lesions
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Detroit, MI

PURPOSE
The purpose of this exhibit is to describe imaging features of skeletal muscle denervation atrophy which can lead to the diagnosis of a cranial or peripheral neuropathy.

APPROACH/METHODS
Imaging features of acute, subacute and chronic muscle denervation atrophy will be reviewed on both CT and MR imaging along with a brief discussion of the expected temporal evolution of MR imaging features. Following the brief review, various patterns of skeletal muscle denervation atrophy in head and neck due to various motor cranial nerve palsies as well as other peripheral nerve territory distributions will be described with clinical case presentation as well as use of line drawing format. We will demonstrate various patterns of muscle atrophy due to lesions along cranial nerves III, IV, V, VI, VII, IX, X, XI and XII, as well as teaching cases of muscle group denervation atrophy due to brachial and lumbosacral plexus lesions will be discussed, along with relevant clinical anatomy and appearance on CT and MR imaging. Various etiologies of denervation atrophy will be discussed and presented, including both traumatic denervation and denervation secondary to perineural tumor spread.

FINDINGS/DISCUSSION
Complex cases of muscle atrophy are often seen in the head and neck due to various neuropathies. In the acute phase of denervation muscle atrophy, imaging features often are first recognizable on fat saturated T2-weighted images. Fat saturated post-contrast T1-weighted images also help assess for the acuity of denervation injury. Chronic denervation atrophy is best visualized on precontrast T1-weighted images without fat suppression. Once muscle denervation atrophy is recognized, it becomes slightly easier to localize some of the subtle lesions based on the knowledge of gross anatomy and muscle innervation patterns.

SUMMARY/CONCLUSION
After reviewing the scientific exhibit, the audience will be able to recognize complex patterns of muscle atrophy in the head and neck, and use these findings to direct their search pattern to find pathology along specific cranial or peripheral nerves. Evaluating the patterns of denervation atrophy of various skeletal muscles first, rather than looking directly for a lesion along the nerve roots, as some of the cranial or peripheral nerve lesions often are extremely subtle when compared to the relatively large structures of the atrophied muscles, could be more helpful.

KEY WORDS: Cranial nerves, head and neck, atrophy

Scientific Exhibit 41
Do Not Touch Me! Arrested Pneumatization: A Pitfall of Skull Base Imaging
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PURPOSE
Arrested pneumatization is a common pitfall of skull base imaging that occasionally can be disconcerting for even the most experienced neuroradiologist. This exhibit illustrates the imaging characteristics of arrested pneumatization and a variety of mimics. The recognition of these lesions is integral to patient care for limiting unnecessary additional evaluation and/or biopsy.

APPROACH/METHODS
Characterization of common features and diagnostic criteria for arrested pneumatization was achieved through review of current literature. Twenty-six illustrative cases and a variety of mimics were obtained from teaching files of two major teaching institutions.

FINDINGS/DISCUSSION
Symmetry of the skull base is useful for determining the presence of pathology although it is often unreliable due to the presence of benign variants, particularly asymmetric pneumatization. Our interest lies primarily with arrested pneumatization due to brachial and lumbosacral plexus lesions will be discussed, along with relevant clinical anatomy and appearance on CT and MR imaging. Various etiologies of denervation atrophy will be discussed and presented, including both traumatic denervation and denervation secondary to perineural tumor spread.

Complex cases of muscle atrophy are often seen in the head and neck due to various neuropathies. In the acute phase of denervation muscle atrophy, imaging features often are first recognizable on fat saturated T2-weighted images. Fat saturated post-contrast T1-weighted images also help assess for the acuity of denervation injury. Chronic denervation atrophy is best visualized on precontrast T1-weighted images without fat suppression. Once muscle denervation atrophy is recognized, it becomes slightly easier to localize some of the subtle lesions based on the knowledge of gross anatomy and muscle innervation patterns.
ing fibroosseous lesions and the persistent craniopharyngeal canal of the sphenoid bone (Figure 2).

SUMMARY/CONCLUSION
Arrested pneumatization is a pertinent diagnosis in everyday practice. It can be diagnosed easily with appropriate knowledge of sinus pneumatization, its variants, and common mimics. Its recognition is crucial for patient management in order to avoid additional imaging and/or biopsy.

KEY WORDS: Arrested pneumatization, skull base, pseudolesion

Scientific Exhibit 42
Pneumatization of the Temporal Bone: A Review
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PURPOSE
To describe and illustrate the normal and variant anatomy of the air cell system of the temporal bone on computed tomography (CT).

APPROACH/METHODS
There is a wide variability in the degree of pneumatization of the human temporal bone. The observed spectrum ranges from extensive pneumatization to diploic or sclerotic patterns. Traditionally the temporal bone pneumatization is divided into five main regions: middle ear, squamomastoid, perilabyrinthine, petrous apex and accessory. Pathologies such as acute infection, cholesteatoma, cholesterol granuloma and mucocele are inextricably linked to the presence of pneumatization. An appreciation of the pattern of air cells throughout the temporal bone can offer insights into the spread of disease such as acute infection or cholesteatoma. Moreover the choice of tympanomastoid and petrous apex surgery is markedly influenced by variations in pneumatization.

FINDINGS/DISCUSSION
We shall illustrate and describe the terminology applied to the spectrum of temporal bone pneumatization. In addition cases demonstrating the relationship between air cell patterns and disease presence or spread will be reviewed.

SUMMARY/CONCLUSION
After reviewing this exhibit the reader should be familiar with the main patterns of temporal bone pneumatization and its impact on the spread of disease and surgical options within the petrous temporal bone.

REFERENCES

KEY WORDS: Temporal bone, anatomy, pneumatization

Scientific Exhibit 43
Masses of the Middle Ear: Toward Greater Relevance for the Clinician
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West Virginia University
Morgantown, WV

PURPOSE
The educational exhibit will seek to provide a review of the imaging anatomy, important anatomical relationships, and pathologic entities occurring within and adjacent to the middle ear. Through the use of example illustrations, these entities are presented and reviewed with highlights of particular clinical importance. Histopathologic, otoscopic, and surgical correlation is provided for select cases toward the goal of producing more clinically relevant reporting.

APPROACH/METHODS
Retrospective case review of a broad range of pathologically and clinically proved masses involving the middle ear accumulated from 1996-2008 at a tertiary referral center. The anatomical relationships and major disease processes for this location are reviewed with an emphasis on cholesteatomas. Important cholesteatoma mimics, additional differential diagnostic considerations, complications, and recommended imaging approaches for common clinical presentations also are discussed. High quality images illustrate the findings and complement the succinct review of disease in this location. Examples of cases discussed include but are not limited to the following: acquired cholesteatomas, congenital cholesteatomas, glomus tympanicum, glomus jugulotympanicum, aberrant internal carotid artery, cholesterol granulomas, osseous lesions, and metastases. There is a particular emphasis on clinical context, with many of the cases accompanied by histopathologic, otoscopic, and surgical correlation.

FINDINGS/DISCUSSION
The viewer of this exhibit will gain or refresh information about the anatomical relationships and disease entities involving the middle ear for clinical practice and for preparation for certifying examinations. The images provided aid recognition with an emphasis on clinical context and differential diagnosis.

SUMMARY/CONCLUSION
The anatomy of the middle ear can be intimidating and formulating a concise and clinically relevant report can be challenging. Extensive illustrations of the intricate anatomical structures and the different disease entities, as well as a solid...
understanding of the clinical presentations, can aid the radiologist in arriving at the appropriate diagnosis.

**KEY WORDS:** Cholesteatoma, mimics, ear

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**Scientific Exhibit 44**

**Rare Congenital Intracranial Vascular Variants with Associated Aneurysm**

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Syracuse, NY

**PURPOSE**

In this exhibit, we present a pictorial review of rare intracranial vascular variants with associated aneurysm. The cases presented are relevant to general and neuroradiology, demonstrating findings which will be encountered by the radiologist while covering both the emergency room and routine patient imaging. Typically the normal variant is subtle, and the aneurysm small, making detection difficult. However, failure to diagnose these aneurysms may be devastating for the patient.

**APPROACH/METHODS**

CT angiography, MR angiography, and conventional angiogram cases were compiled over many years. Cases of rare normal intracranial vasculature variants with aneurysm were selected for display and discussion in this exhibit. IRB approval was not obtained, as these studies were performed for clinical indications, and did not require further experimental or investigational imaging. Images were selected for display, and all have been rendered HIPAA compliant. Where relevant, imaging technique labeling has remained on the image. All patient identifying information has been removed. Clinically relevant information has been included where appropriate, including history of present illness and therapeutic interventional measures.

**FINDINGS/DISCUSSION**

Within our daily radiology practice at a university hospital, including emergency radiology and daily routine in- and outpatient imaging, we have found a high incidence of aneurysm occurring with rare normal variants of intracranial vasculature. Most of these cases presented as subarachnoid hemorrhage in the emergency department. Our cases include fenestrations with aneurysm of the anterior and posterior circulation, and aneurysms of persistent fetal trigeminal and hypoglossal arterial anatomy. While these normal variants are very rare, there is a high incidence of aneurysm within the variant. The aneurysms are typically very small and can be difficult to visualize. Recognition of the variant is important in presurgical and preangiographic therapy planning. Detection of aneurysm in patients with subarachnoid hemorrhage is critical to further patient management.

**SUMMARY/CONCLUSION**

We have prepared a scientific exhibit illustrating the imaging appearance of rare intracranial vascular variants with a high incidence of aneurysm. We have provided an opportunity for radiology residents, practicing general radiologists, neuroradiologists, and neurointerventional radiologists to become familiar with the CT and MR angiogram, and conventional angiogram appearance of many rare but very clinically important intracranial vascular variants. Detection of these aneurysms becomes critical to management and therapy of patients with association subarachnoid hemorrhage, and possibly to the prevention of future aneurysm rupture when detected during routine patient imaging.

**KEY WORDS:** Aneurysm, congenital vascular anatomy

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**Scientific Exhibit 45**

**Childhood Stroke: What the Resident Ought to Know**

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Leeds, UNITED KINGDOM

**PURPOSE**

To describe the various clinical presentations of stroke and stroke-like episodes in children with correlative imaging findings using computed tomography (CT) and magnetic resonance imaging (MRI). To review the current imaging protocols used internationally. To make residents aware of the differential diagnoses of stroke in children and their representative imaging manifestations.

**APPROACH/METHODS**

Classification of childhood stroke; Clinical presentations; Cross-sectional imaging findings and role of CT and MRI; Optimizing imaging protocols.

**FINDINGS/DISCUSSION**

Pitfalls and differential diagnoses: arteriopathies, vasculitis, vascular malformations, arterial dissection, epilepsy, hypoperfusion injury, mitochondrial encephalopathies, sepsis, coagulopathies and other nonischemic causes of cortical swelling (encephalitis, acute disseminated encephalomyelitis).

**CONCLUSION/SUMMARY**

Strokes in childhood are often under-recognized entities leading to severe morbidity and mortality. It is important to be aware of their subtle and often vague presentations to guide appropriate and timely imaging and subsequent management to prevent this. The incidence of stroke in the pediatric population is 2-3/100,000 per year. The underlying cause may not be discovered in over 30% of cases. It is important therefore for on-call residents to be aware of the typical and atypical imaging manifestations of this condition and the differentiating features from its various differentials.

**KEY WORDS:** Stroke, childhood, differentials
Spectrum of Diffusion Restriction Abnormalities in Pediatrics: A Pictorial Review

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PurposE
The purpose of this exhibit is to describe the spectrum of restricted diffusion abnormalities in a pediatric population.

APPROACH/METHODS
We present a series of illustrative cases recruited at a tertiary referral pediatric hospital over the past 5 years and discuss a range of pathologies on diffusion-weighted images (DWI) and ADC maps.

FINDINGS/DISCUSSION
In adults, ischemia is a well recognized etiology of diffusion restriction on DWI and ADC maps. However, stroke is a less common cause of restricted diffusion abnormalities in children and several other entities can cause diffusion restriction, which need to be considered. We will review and provide illustrative examples of diffusion restricted lesions including vascular (stroke/ischemia), demyelinating (acute disseminated encephalomyelitis, multiple sclerosis), metabolic (such as ferrugination and hepatic encephalopathy), infections (abscesses, empyema, etc.), dermoid, a spectrum of cellular tumors (anaplastic ependymoma, posterior fossa primitive neuroectodermal tumor and atypical teratoid/rhabdoid tumor, supratentorial glioblastoma multiforme) and transient splenial restriction abnormality.

SUMMARY/CONCLUSION
There is a wide spectrum of pathologies in the pediatric population that can cause diffusion restriction on magnetic resonance imaging. Unlike adults, ischemia/stroke is not the most common cause for abnormalities on DWI and ADC map in pediatrics and the differential diagnosis will be discussed.

KEY WORDS: Diffusion restriction, ischemia, pediatrics

Merosin-Deficient Congenital Muscular Dystrophy: A Review of the Intracranial Magnetic Resonance Imaging Findings and Illustration of Associated Brainstem Abnormalities

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PurposE
Our purpose is to review the characteristic brain magnetic resonance (MR) imaging findings in patients with merosin-deficient congenital muscular dystrophy (CMD), including the typical supratentorial white matter abnormalities in addition to the associated brainstem abnormalities present in a significant proportion of merosin-deficient CMD patients. For comparison, the typical intracranial MR imaging findings in merosin-positive CMD patients also are discussed.

APPROACH/METHODS
The brain MR examinations from five patients with known merosin-deficient CMD were reviewed retrospectively. The extent and distribution of white matter abnormalities were noted. In addition, the brainstem was subjectively evaluated for hypoplasia as well as any intrinsic T2 signal abnormality. Two patients had partial merosin deficiency, and the other three patients had complete merosin deficiency per immunocytochemical testing. The intracranial MR imaging findings in two additional patients with Fukuyama and Walker-Warburg CMD also are included to demonstrate the marked differences in the MR imaging abnormalities between the different forms of CMD.
FINDINGS/DISCUSSION
All five patients had markedly abnormal T1 and T2 prolongation in the deep cerebral white matter, without an associated cerebral or cerebellar cortical abnormality. Three patients had varying degrees of ventral pontine hypoplasia. In four patients, there was linear and symmetric T2 signal hyperintensity within the ventral medullary pyramids along the course of the corticospinal and corticobulbar tracts, an MR finding which has not been described previously. Although this finding is of uncertain clinical significance, it may potentially aid in the diagnosis of merosin-deficient CMD or possibly correlate with disease severity.

SUMMARY/CONCLUSION
The congenital muscular dystrophies comprise a diverse group of disorders with varying clinical manifestations including contractures, hypotonia, and muscle weakness. The diagnosis of congenital muscular dystrophy is based on a combination of clinical findings, genetic testing, and muscle biopsy results. Over the years, various classification schemes has been proposed, and recent studies have shown that a large proportion of patients with “pure” congenital muscular dystrophy have a deficiency of the extracellular matrix protein laminin-α2 (merosin), a component of the basement membrane in brain and muscle fibers. Although some overlap may exist between the merosin-positive and merosin-deficient subtypes, in general merosin-deficient CMD patients have characteristic MR imaging findings predominantly involving the supratentorial white matter and, to a lesser degree, the posterior fossa structures. We illustrate the typical MR imaging abnormalities in patients with merosin-deficient CMD, provide a comparison with the MR findings in other subtypes of CMD, and describe a previously unreported finding involving the ventral medullary pyramids in four patients out of our series of five.

KEY WORDS: Merosin, muscular dystrophy

Scientific Exhibit 50
Pediatric Superficial Supratentorial Brain Tumors: A Pictorial Essay

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PURPOSE
To review the neuroimaging features of a wide variety of both common and unusual primary tumors arising in the cortical and subcortical regions of the brain in our pediatric populations.

APPROACH/METHODS
A three-year retrospective review of the imaging features of pathologically proved supratentorial tumors in children was undertaken at two medical centers. Both have active pediatric neuroradiologic services. This review included clinical features as well as all available MR scans, CT scans and MR spectrography and functional MR imaging. Neuropathologic correlation will be included as available.

FINDINGS/DISCUSSION
The following types of pediatric superficial supratentorial tumors are included in this review: Ependymoma, Astrocytoma, Desmoplastic Infantile Ganglioglioma, Dysembryoplastic Neuroepithelial Tumor, Primitive Neuroectodermal Tumor, Atypical Teratoid/Rhabdoid Tumor, Gliofibroma, Primary Glioneural Tumor and Extrasosseous Ewings Sarcoma.

SUMMARY/CONCLUSION
This poster will illustrate neuroimaging features of a large spectrum of peripherally located supratentorial tumors in children. Typical and distinguishing imaging features of each tumor type will be emphasized.

KEY WORDS: Brain tumor, children, MRI
Scientific Exhibit 51

Cystic Pediatric Brain Tumors with a Mural Nodule: A Pictorial Review

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PURPOSE
To illustrate and review the differential diagnosis of cystic pediatric brain tumors containing a mural nodule on MR imaging and to discuss their distinguishing imaging features and clinical presentation.

APPROACH/METHODS
This exhibit is based on a retrospective review of all cystic pediatric tumors with a mural nodule imaged at our institution between 2001 and 2008. Images of each entity will be presented and any distinguishing imaging features, diagnostic imaging pearls, patient demographics, and prognosis will be discussed.

FINDINGS/DISCUSSION
A wide variety of intracranial tumors were found to have cysts and enhancing mural nodules in our pediatric population including but not limited to: juvenile pilocytic astrocytoma, pleomorphic xanthoastrocytoma, ganglioglioma, desmoplastic infantile ganglioglioma, hamangioblastoma, and craniopharyngioma.

SUMMARY/CONCLUSION
There is a broad differential diagnosis for cystic intracranial pediatric neoplasms with enhancing mural components. Location, presentation and patient age were found to be important factors that differentiated tumor types.

KEY WORDS: Pediatric brain tumor, cysts with mural nodules

Scientific Exhibit 52

Imaging Features of Intracranial Meningiomas in Children with Pathologic Correlation

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PURPOSE
Intracranial meningiomas are rare in children and adolescents. In most large series, the incidence of meningiomas before the age of 18 years ranges between 0.4% and 4.6% of all primary brain tumors. They can occur spontaneously or can be associated with neurofibromatosis (especially NF2) or prior brain irradiation. The latency between irradiation and the diagnosis of meningiomas tends to be shorter in pediatric population than in adults. We review clinical findings and imaging features of pediatric meningiomas on CT and MR images and correlate these findings with histopathology and clinical outcome.

APPROACH/METHODS
Twelve pediatric patients (2-16 years, mean age 11.7) diagnosed with intracranial meningiomas over a 16-year span from 1993 to 2008 were included. We assess clinical findings, CT and MR imaging characteristics (size, density/signal intensity, enhancement pattern, cystic changes, calcifications, dural base and associated bony abnormalities) in correlation with histopathology and clinical outcome. In addition association with NF2 and irradiation were noted.

FINDINGS/DISCUSSION
There were 8 males (66.7%) and 4 females (33.3%). Three patients (25%) had a confirmed diagnosis of neurofibromatosis type 2 (NF2), four patients (33.3%) met the criteria for postradiation meningioma (one of these patients had multiple associated malignancies and a familial history of malignancy and another also had diagnosis of NF2). Four patients (33.3%) had no known underlying etiology. Nine patients had both preoperative CT and MR imaging, two had only preoperative CT and one patient had only preoperative MR imaging. Nine patients had surgical pathologic diagnosis (excluding two patients with NF2 and one that met the criteria for postradiation meningioma). The most common pathologic subtype was atypical meningioma in four of nine (44.5%), followed by meningothelial in three of nine (33.3%), anaplastic in one of nine (11%) and fibroblastic in one of nine (11%). One patient with initial diagnosis of atypical meningioma underwent second surgery for tumoral recurrence and the diagnosis was anaplastic meningioma. In three of five (60%) patients with malignant meningiomas the tumoral size was over 5 cm at the moment of the diagnosis. The follow-up period ranged from one to fifteen years with a mean of 7.2 years. There were two patients with pathologic confirmation of tumoral recurrence. All patients were alive until either the last follow up in 2008 or until they were discharged at 18 years of age.

SUMMARY/CONCLUSION
Intracranial meningiomas in children are frequently associated with either NF2 or prior radiation (60% of the cases in our series). Contrary to the previously reported benign histological predominance of pediatric meningiomas, in our series we found malignant meningiomas in 56%. The tumor size was over 5 cm in 60% of the patients with either atypical or anaplastic meningiomas. There was no correlation between cystic changes and malignant histopathology. We found 28.6% recurrence rate in patients diagnosed with malignant meningiomas.

KEY WORDS: Pediatric meningioma

Scientific Exhibit 53

Pediatric Orbital Lesions: An Approach to Differential Diagnosis on CT and MR Imaging

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PURPOSE
1. Review orbital anatomy. 2. Gain familiarity with the expected MR and CT imaging appearances of common non-
traumatic pediatric orbital lesions. 3. Provide an approach for obtaining a concise and specific differential diagnosis by utilizing key lesion characteristics and lesion localization.

**APPROACH/METHODS**

1. Orbital anatomy will be reviewed with emphasis placed on structures that delineate orbital compartments and regions. This will include defining the orbital septum, globe, optic nerve and nerve sheath complex, muscular cone, peri-orbital, and select vessels. 2. CT and MR imaging findings of common orbital neoplasms, inflammatory conditions, congenital abnormalities, and vascular diseases will be outlined. 3. Key characteristics that allow differentiation of orbital pathology will be evaluated after lesion localization. These will include, but will not be limited to: calcification, globe size, pattern of enhancement, mass effect, bilaterality, and concomitant lesions. Specific identifying features, such as the presence of fat or identification of fluid-fluid levels, also will be incorporated in deriving a differential diagnosis.

**FINDINGS/DISCUSSION**

The presence of calcification can differentiate nodular retinoblastoma from other globe pathology. Among noncalcified globe lesions, small globe size may distinguish persistent hyperplastic primary vitreous and retinopathy of prematurity from Toxocaris infection or Coats disease. Nerve sheath meningiomas can be differentiated from optic nerve gliomas by the presence of calcification and prominent enhancement. Of the retrobulbar vascular lesions, capillary hemangiomas may demonstrate prominent flow-voids, venous-lymphatic malformations are characterized by heterogeneous cystic components (sometimes with fluid-fluid levels), and varices can be elicited with Valsalva maneuvers. Rhabdomyosarcoma, subperiosteal hemorrhage, and orbital cellulitis with abscess may be discriminated by clinical history and patterns of enhancement. Additional peripheral orbital lesions can be characterized by the presence of fat (dermoid) or fluid attenuation with restricted diffusion (epidermoid). Bilaterality or multicentricity of disease can aid in the identification of multisystem pathology or metastatic neoplasms.

**SUMMARY/CONCLUSION**

Orbital diseases in the pediatric population vary substantially from those commonly seen in the adult population. Pediatric patients with orbital disease will often present with nonspecific signs and symptoms including leukocoria, proptosis, altered vision, and orbital pain; for further characterization, radiographic imaging frequently is requested. Radiographic evaluation is a critical noninvasive step that often can lead to a specific diagnosis or a short differential. This is best accomplished by first accurately localizing the lesion of interest to a specific anatomical compartment or region, and second, by using key imaging characteristics to distinguish between potential pathologies. The natural tissue contrast of orbital fat, bone, soft tissue, and fluid allow CT and MR to detect subtle pathology, delineate extent, and determine invasion into adjacent structures. CT and MR imaging are complementary in the evaluation of orbital pathology. CT optimally detects calcification and has the advantage of rapid scan times. MR imaging has improved soft tissue differentiation, enhanced by the use of fat suppression and gadolinium contrast. In conjunction with pertinent clinical information, CT and MR imaging allow for advanced discrimination of lesion characteristics, often providing a specific diagnosis.

**KEY WORDS:** Orbit, imaging, pediatric

**Imaging of Neonatal Brachial Plexus Palsy**

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**PURPOSE**

To review imaging characteristics of neonatal brachial plexus injury and correlate with clinical findings and nonimaging diagnostics.

**APPROACH/METHODS**

Present a pictorial review of classic findings involved in neonatal brachial plexus injury using conventional imaging including MR imaging and CT myelography and correlate these findings with nonimaging diagnostics including physical examination, electrophysiology and surgical exploration.

**FINDINGS/DISCUSSION**

Neonatal brachial plexus palsy affects up to three out of every 1000 neonates secondary to stretching injury during vaginal birth. Seen commonly in macrosomic infants, this injury can range from mild stretching causing neuropraxia to severe injury including frank avulsion of the nerve root. There is need to identify severity of these lesions to determine prognosis and surgical candidates for nerve repair. Imaging has some drawbacks as it may underestimate injury in the case of isolated ventral root avulsions or overestimate injury in the instance of meningoceles. Correlation with nonimaging diagnostics including electromyography and surgical exploration may improve the accuracy of diagnosis of brachial plexus palsy.

**SUMMARY/CONCLUSION**

We present a pictorial review of conventional imaging of neonatal brachial plexus palsy with correlation to nonimaging diagnostics.

**KEY WORDS:** Brachial plexus, avulsion
Scientific Exhibit 55

Transitional Lumbosacral Vertebral Body: Classification, Imaging Findings and Symptomatology

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PURPOSE
The purpose of this exhibit is 1) to describe the imaging appearance of transitional lumbosacral vertebral segments, 2) to define the clinical relevance based on imaging findings and patient symptomatology and 3) to explore controversies regarding transitional segments with attention to the use of standardized nomenclature between radiologists and surgeons.

APPROACH/METHODS
Through numerous imaging examples, this exhibit will review the appearance of transitional lumbosacral segments. The focus will be on the relevance of anatomical variance as it relates to the development of symptoms. Cases will be shown exemplifying changes that can develop based on vertebral morphology, sacralization or lumbarization as well as postsurgical alterations. The importance of correct nomenclature and numbering of segments will be addressed as it relates to surgical intervention and agreement between the radiologist and surgeon.

FINDINGS/DISCUSSION
Transitional lumbosacral vertebral segments can be associated with the development of low back pain secondary to altered biomechanics and stress forces within the lower spine. The morphology and number of mobile segments in the lumbosacral spine changes secondary to varying degrees of lumbarization and sacralization. It is important for the radiologist to understand the potential clinical relevance of this anatomical variation and how it relates to the development of pain and instability. As important is the nomenclature used to describe the spine when such variance is present. Accurate, formalized and consistent description allows for reliable agreement between surgeon and radiologist and avoids dire complications such as wrong level spine surgery.

SUMMARY/CONCLUSION
Transitional lumbosacral segments are common and therefore are frequently identified in patients undergoing spinal imaging. A complete understanding of nomenclature, morphology and clinical relevance will allow the radiologist to correctly diagnose these patients and accurately relay the findings to the referring spinal surgeon.

KEY WORDS: Transitional, spine, pain

Scientific Exhibit 56

Imaging of Spinal Instrumentation: CT and MR Techniques, Normal Appearance and Complications

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PURPOSE
Spinal fusion and instrumentation is exceedingly common in clinical practice necessitating advanced knowledge of imaging techniques and findings. The purpose of this exhibit is to 1) familiarize the radiologist with current surgical techniques and instrumentation, 2) explain the indications for postoperative imaging, 3) review modern advances in CT and MR imaging in the setting of spinal instrumentation and 4) discuss the normal and abnormal imaging appearances of the postoperative spine.

APPROACH/METHODS
Surgical techniques and instrumentation will be reviewed with attention to the clinical basis for each procedure. Appropriate imaging protocols will be discussed with an emphasis on recent advances in metal reduction techniques both on CT and MR imaging. Normal and abnormal imaging findings will be displayed highlighting the most common complications.

FINDINGS/DISCUSSION
A thorough knowledge of the surgical techniques and instrumentation used in spinal surgery will aid the radiologist in understanding the often complex appearance of the postoperative spine. Commonly encountered complications include incomplete fusion, hardware failure and inappropriate positioning, infection and secondary complications of altered biomechanics. Each of these complications are best evaluated by CT and MR imaging with application of advanced imaging techniques and protocols.

SUMMARY/CONCLUSION
Spinal fusion surgery is increasingly performed and therefore the complications are commonly encountered by radiologists. With advancements in imaging technology alongside a solid knowledge of orthopedic hardware, surgical technique and postoperative imaging, the radiologist plays a vital role in diagnosing and managing these often difficult and complex patients.

KEY WORDS: Spine, fusion, hardware
Scientific Exhibit 57

Spinal Facet Joints: Anatomy, Pathophysiology and Treatment of Facet-Related Back Pain

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PURPOSE
Back pain is an extremely common problem which often results in significant physical disability as well as socioeconomic strain. Facet-related pain is a common but often neglected source of back pain. The purpose of this exhibit is to 1) review normal and variant anatomy of the facet joints, 2) discuss the pathophysiology of facet-related pain as it relates to imaging findings on MR imaging, CT, nuclear imaging, and radiographs, and 3) explain treatment options with specific attention to image-guided techniques and therapies.

APPROACH/METHODS
Facet joint anatomy will be reviewed, including anatomical variants and normal imaging findings. Illustrations and case images will be shown demonstrating the biomechanics of the facet articulation, with attention to anatomical risk factors and their relation to the development of degenerative and traumatic pathology. The pathophysiology of facet-related pain as it relates to associated spinal pathology and disease will be reviewed. Therapeutic options will be discussed with attention to image-guided procedures and the radiologist’s role in the treatment of back pain.

FINDINGS/DISCUSSION
An appreciation of the anatomy and biomechanics of the facet joints is helpful in understanding the specific forces to which these joints are subjected and the pathology which may result. Facet-related pain may result from a variety of pathologic states, including osteoarthritis, segmental instability, synovial cysts, infection and trauma. The mechanisms by which differing pathologic processes produce pain are related to the rich innervation of the region. Diagnosis of back pain as facet-related purely on the basis of clinical or imaging findings is difficult, and diagnostic facet blocks play a major role in establishing a diagnosis. Available therapies span multiple disciplines and range from conservative to invasive, including physiotherapy, imaging-guided joint injections and neurolysis, and surgical intervention.

SUMMARY/CONCLUSION
Facet joint pathology is a common source of back pain; therefore attention needs to be focused beyond the disks and disk spaces in patients with back pain and radiculopathy. Treatment of facet-related back pain must be multidisciplinary, including a role for rehabilitation medicine, image-guided therapy, and surgery. Image-guided techniques often are best performed by radiologists who can translate imaging findings into focused, effective therapy.

KEY WORDS: Facet, spine, degenerative

Scientific Exhibit 58

Imaging Characteristics of Primary Extramedullary Intradural Spinal Tumors

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PURPOSE
The most frequent intradural extramedullary tumors are meningiomas and nerve sheath tumors. Primary intradural extramedullary ependymomas are rare lesions. The aim of this presentation is to give a comprehensive imaging review of primary extramedullary intradural tumors with inclusion of a pictorial demonstration of an intradural extramedullary ependymoma.

APPROACH/METHODS
We provide a retrospective review of common and uncommon intradural extramedullary tumors with emphasis on the CT and MR imaging characteristics.

FINDINGS/DISCUSSION
Primary extramedullary intradural spinal tumors are relatively uncommon lesions that if misdiagnosed may result in serious morbidity. A careful radiographic assessment is required to make the correct diagnosis, define an appropriate treatment plan and improve patient outcome. Our presentation familiarizes the audience with the common anatomical locations and imaging characteristics of a spectrum of tumors ranging from rare to common lesions. These include schwannomas, neurofibromas, meningiomas, and less common entities like paragangliomas, lipomas, neurothekeomas, vascular tumors, ependymomas, and sarcomas. Additionally we present a rare case of ependymoma of which only 12 cases have been reported in literature.
SUMMARY/CONCLUSION
This presentation revisits the important anatomical and imaging characteristics of primary extramedullary intradural spinal lesions and gives a closer analysis of an unusual extramedullary anaplastic ependymoma. Each type of tumor is reviewed in detail with emphasis on age, sex, imaging characteristics, and anatomical location that support the diagnosis. This exhibit will provide a comprehensive review of differential possibilities when encountering extramedullary intradural tumors.

KEY WORDS: Extramedullary, spine, ependymoma

Scientific Exhibit 59
CT-Guided Radiofrequency Ablation of a Recurrent Osteoid Osteoma
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PURPOSE
To present our experience with a case of recurrent osteoid osteoma, which was treated successfully with radiofrequency (RF) ablation.

APPROACH/METHODS
A 15-year-old boy was admitted to our institution diagnosed with osteoid osteoma of the vertebral body L2. Considering the age of the patient and the need for excessive resection of vertebral body in open surgical technique, CT-guided percutaneous removal of the nidus was recommended. After 3 months, the patient’s complaints recurred and CT examination of the lumbar spine showed recurrence of the nidus. After consultation with neurosurgeons and an orthopedic surgeon, it was decided to perform RF ablation due to the reasons mentioned above.

FINDINGS/DISCUSSION
Since the origin of the artery of Adamkiewicz is usually between T9 and L2, we performed digital subtraction angiography (DSA) of the spine between T12 and L3 before RF ablation. Digital subtraction angiography showed that the origin of the artery of Adamkiewicz was at the level left D8 and no close relation to the lesion at L2. On the following day, we performed percutaneous RF ablation of the lesion under mild sedation using CT guidance. The procedure was performed with an array-type electrode (The LeVeen Electrode, Boston Scientific) with a diameter of 5 mm. Power from the radiofrequency generator (RF3000 Radiofrequency Generator, Boston Scientific) was delivered in a stepwise algorithm that provided a starting power of 1 W and increased to 5 W in the first 8 minutes. In the following 15 minutes, a starting power of 1 W was increased to 10 W in a stepwise fashion. In both attempts, ablation was terminated when the impedance reached 600Ω. There was no complication related to the procedure and the patient was discharged after only 1 day of hospitalization. At the 20th month follow-up, the patient had no symptoms and CT examination of the lumbar spine showed no evidence of recurrence.

SUMMARY/CONCLUSION
Radiofrequency ablation seems to be an effective and safe option in treating a recurrence of osteoid osteoma, especially in the pediatric population where the growth of the spine can be adversely affected by surgical interventions. The potential hazard of this procedure is one of thermal injury to the artery of Adamkiewicz, which may result in serious neurologic deficits. Therefore, we think it is necessary to locate the origin of the artery of Adamkiewicz and its relations with the affected vertebra before performing RF ablation.

KEY WORDS: RF ablation, osteoid osteoma, recurrent

Scientific Exhibit 60
Extra-Arachnoid Thoracic Meningoceles: Role of Dynamic CT Myelography in Diagnosis and Treatment Planning
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PURPOSE
One of the limitations of CT myelography to identify a cerebrospinal fluid (CSF) leak is temporal resolution. Dynamic CT myelography has been used to overcome this problem but still has temporal limitations inherent to the volume of tissue that must be imaged. We aim to analyze the optimal imaging work up of patients with extra-arachnoid thoracic pseudomeningoceles with emphasis on dynamic CT myelography and MR imaging. We also aim to describe the association between thoracic pseudomeningoceles and superficial siderosis of the central nervous system.

APPROACH/METHODS
In this exhibit we will review four cases of thoracic pseudomeningoceles who underwent myelography, dynamic CT myelography and MR imaging. We will point out the diagnostic contributions made by dynamic CT myelogram and also discuss the association of thoracic pseudomeningoceles with superficial siderosis of the central nervous system (CNS). We will describe the protocol at our institution for dynamic CT myelograms. The clinical presentation and treatment options also are reviewed.

FINDINGS/DISCUSSION
Dural defects with extra-arachnoid fluid collections are frequent, though unrecognized finding in superficial siderosis of the CNS. In the presence of long segment extra-arachnoid intraspinal collection, a dynamic CT myelogram may be required to identify the exact defect site. Dynamic CT myelogram in each of our cases showed filling of the extra-arachnoid fluid collection with contrast, confirming communication with the subarachnoid space. The dynamic nature of the study helped in identifying progressive differential opacification of the ventral cyst leading to localization of the site of communication between the fluid collection and the cal sac.
CONCLUSION
Pseudomeningoceles are well described and well known entities, but the association with superficial siderosis is not well recognized. Our exhibit illustrates the importance of looking for a communication of the extra-arachnoid fluid collection with the subarachnoid space with dynamic CT myelogram for identification of the precise site of the fistulous communication for surgical correction. However, we do not advocate using this technique for all patients with a leak, as it is more invasive, has a higher radiation dose and is more time and resource intensive.

KEY WORDS: Thoracic pseudomeningoceles, dynamic CT myelogram, superficial siderosis

Scientific Exhibit 61
Approaches, Techniques, and Strategies for Difficult and Challenging Image-Guided Lumbar Punctures
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PURPOSE
To describe techniques and strategies for image-guided lumbar puncture in difficult cases including the postoperative spine, exaggerated scoliosis, and ankylosing spondylitis patients.

APPROACH/METHODS
A review of our institutional experience with diagnostic and myelographic lumbar punctures was performed, and cases of difficult image-guided lumbar punctures were selected. The techniques and strategies employed in these cases to successfully perform the lumbar puncture are explained. If the lumbar puncture was contraindicated, the techniques used for cervical puncture are explained.

FINDINGS/DISCUSSION
Image-guided, usually fluoroscopic, lumbar puncture is a well established technique to access the thecal sac when bedside lumbar puncture is difficult or unsuccessful. However, many diagnoses which lead to the request of image-guided lumbar puncture can make even the image-guided procedure challenging or complex. This includes lumbar puncture in the postoperative spine, in cases with significant degenerative stenosis or presence of spine mass, exaggerated scoliosis or malalignment, and ankylosing spondylitis. These conditions can obstruct the usual translaminar approach for lumbar puncture. We describe alternate lumbar approaches including the transosseous approach, transfemoral approach, and low thoracic approach, as well as technical strategies to increase the success rate of image-guided lumbar puncture in these cases. The C1/2 high cervical puncture is another well established approach when lumbar puncture is not technically feasible. However, lower cervical punctures can be performed if there are contraindications to the C1/2 high cervical puncture.

SUMMARY/CONCLUSION
The presence of postoperative changes and spinal hardware, exaggerated scoliosis or malalignment, or spinal ankylosis can obstruct the usual translaminar approach to image-guided lumbar puncture. Alternate approaches, including the transosseus and transfemoral lumbar approaches and the low thoracic approach, can be employed to perform image-guided lumbar puncture. Nonlumbar approaches include the high C1/2 cervical and lower cervical punctures. These approaches and technical strategies to increase the success rate of image-guided lumbar and cervical punctures are described. Understanding these techniques and strategies would be helpful to any radiologist performing lumbar punctures.

KEY WORDS: Difficult, lumbar puncture, image-guided

Scientific Exhibit 62
Lipomeningomyelocele - Cele or No Cele: A Simplified Approach to Dorsal Spinal Dysraphism
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PURPOSE
To present a new simplified classification of dorsal spinal dysraphism based on imaging features and terminology.

APPROACH/METHODS
The classification of spinal dysraphism as presented by Rossi et al is widely accepted. Rationale for a new classification is four fold: a) Dysraphism is either open or closed but this determination is made clinically before imaging. This is certainly of clinical utility but is not primary imaging finding. Also, open dysraphisms are almost always myelomeningoceles (98.8%), further mitigating its significance on imaging; b) Presence or absence of a cele or cystic dilatation at the dorsal dysraphism, easily appreciated on imaging, can be used for dichotomous classification; c) Assigning the correct diagnosis using current classification is dependent on the clinical information. However, just focusing on some of these terms can make this process fairly easy (e.g., adding lipo and myelo as prefixes while cele, meningocele and myelocystocele as suffixes) and finally; d) Presence of a cele actually determines a palpable mass, which was used by Rossi et al as criteria in closed spinal dysraphisms. So, the major task on MR imaging of the spine (which is mostly lumbosacral spine) is to identify a meningocele which represent cele in majority of cases and can rarely have associated myelocystocele. The next step is to identify associated lipomas. If no cele is present, look for configuration, position and duplication of distal spinal cord with or without associated intradural lipomas.

FINDINGS/DISCUSSION
We divide dorsal spinal dysraphism into two categories based on the presence of a cele; A) Cele: Remember 4Ms. 1) Meningocele, 2) Myelocele, 3) Myelomeningocele and, 4) Myelocystocele. Add lipo if a lipoma is present: Lipomeningocele, Lipomyelocele and Lipomyelocystocele...
minal myelocystocele). Lipoma is also a marker of closed spinal dysraphism. B) No Cele: Remember 7Ts. 1) Tight filum terminale, 2) Two cords/diastematomyelia and, 3) Terminal/caudal agenesis (segmental dysgenesis is rare), 4) Terminale lipoma (intradural, transitional and filar) which may be associated with other abnormalities presenting with 5) Tethered cord syndrome, 6) Terminal ventricile, due to secondary neurulation (rarely result in terminal myelocystocele); 7) Tract anomalies (neuroenteric cyst, dermal sinus, dorsal enteric fistula).

**SUMMARY/CONCLUSION**

The proposed classification for dorsal spinal dysraphism is imaging based, dependent on identification of a cele, easy to memorize and does correlate with clinical findings.

**KEY WORDS:** Dysraphism, myelomeningocele, lipomyelomeningocele

**Scientific Exhibit 63**

**Spontaneous Intracranial Hypotension: Spinal MR Findings**

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**PURPOSE**

Once considered an exceedingly rare disorder, recent evidence suggests that spontaneous intracranial hypotension (SIH) is not that rare and has to be considered an important cause of new daily persistent headaches, particularly among young and middle-aged individuals (1). Magnetic resonance (MR) imaging has revolutionized the understanding of SIH and has greatly facilitated the ability to arrive at the diagnosis with confidence without having to resort to invasive procedures. In the past, relatively scant attention was given to spinal MR imaging in the diagnosis of spontaneous intracranial hypotension, mainly because it is not particularly effective in localizing the cerebospinal fluid (CSF) leak. However, numerous spinal manifestations of spontaneous intracranial hypotension now have been described (1, 2). This Scientific Exhibit reviews classic and uncommon spinal MR findings of SIH syndrome.

**APPROACH/METHODS**

Our database was searched, and 63 cases of SIH were identified between 2003 and 2007. A comprehensive evaluation of spinal MR imaging of 63 patients with SIH was performed.

**FINDINGS/DISCUSSION**

The characteristic imaging features of spontaneous intracranial hypotension visible on spinal MR imaging are dilated epidural veins, dural enhancement, meningeal diverticula, extraathelial CSF collections, and collapsed dural sac. We also will describe uncommon spinal MR imaging findings of SIH such as syringomyelia, false localizing sign retrospinal C1-C2 fluid collections, spinal intradural vein engangement and others. We also will present CT myelography and intrathecal gadolinium-enhanced MR cisternography findings of SIH.

**SUMMARY/CONCLUSION**

Spinal MR imaging can lead to an accurate diagnosis of SIH. Spinal MR imaging should be known to confirm the diagnosis in patients with SIH without abnormalities on brain MR imaging.

**REFERENCES**

1. Schievink WI. **Spontaneous spinal cerebrospinal fluid leaks and intracranial hypotension. JAMA** 2006;295:2286-2296

**KEY WORDS:** Spontaneous intracranial hypotension, spine, MR imaging

**Scientific Exhibit 64**

**High-Resolution Cervical Cord Tractography at 3 T: A Pictorial Essay**

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**PURPOSE**

To noninvasively map all the tract trajectories in the cervico dorsal cord using high-resolution diffusion tensor imaging at 3 T and to elucidate the clinical usefulness of tractography in the setting of spinal trauma, demyelination, cord compression, canal stenosis and neoplasia.

**APPROACH/METHODS**

Twenty-five normal controls were used to depict the normal anatomy of tracts as the reference standard. Twenty-five patients (M:F ratio of 2:1, age range 28-52 years) and 15 normal controls in the same age range and M:F ratio were included in the study. Cord injury with contusion, three; cord compression with edema and myelomalacia, six; cord edema, two; epidural abscess, two; multiple sclerosis, 2; astrocytoma, 2; ependymoma, 2; syringomyelia, 2; acute transverse myelitis, 1; cavernous angioma, 1. All patients were examined on a 1.5 T/3T MR system using diffusion tensor imaging, EPI sequence using a multichannel phased array coil with the sequence parameters as follows: TR 9772 TE 88 msec, B value of 0 and 600,1000, number of directions: 25, NEX :4 matrix 128x128. Data obtained in axial, sagittal planes and were analyzed on Functool software. Processing steps: a) Loading the raw data in the functool; b) Processing for correction of EPI distortions. Final setting selection: a) SEED region of interest (ROI) track: for single ROI method; b) SEED ROI and target ROI and track for double ROI method. Final Settings: a) T2 images: 1; b) anisotropy weighting: 1.3; c) threshold: noise 309, upper 3086; d) fiber track max steps:160; e) fiber track minimum FA value: 0.18; f) fiber track maximum ADC value: 0.01; g) reformat spacing: 6.1457. Regions of interest are deposited on FA maps in anterior, lateral and posterior funiculi to generate anterior and lateral spinal thalamic, vestibulo spinal tracts, rubro spinal tracts and posterior columns.
FINDINGS/DISCUSSION
Normal control data: anterior, lateral spinothalamic, rubrospinal, vestibulo spinal tracts and posterior columns are displayed in all the patients (n=25). Patient data: The tractographic appearances of cord compression, canal stenosis, cervical disk, neoplasms (astrocytoma, ependymoma), cord contusion are shown. Fractional anisotropy data and the value of FA maps for quantitative assessment in normally appearing cord in demyelination are discussed with examples. Pitfalls and limitations of DTI tractography in spine are highlighted.

SUMMARY/CONCLUSION
3 T MR tractography of cervicothoracic cord is an adjunct tool in comprehensive spine imaging protocol and offers surgeon friendly lesional and eloquent tract relationship information with diagnostic characterization.

KEY WORDS: Fractional anisotropy, tractography, diffusion tensor imaging

Scientific Exhibit 65
Imaging Myelopathy: Basic Findings and Lesion Patterns
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PURPOSE
In the last years against an impressive improvement in MR imaging spatial/contrast resolution that resulted in a dramatic increased sensitivity of detecting spinal cord (SC) diseases, the specificity remains relatively low, thus resulting in delayed/equivocal/wrong diagnoses and possibly in inappropriate patient treatments. We developed a rational “step-by-step” assessment in order to shorten the list of differential diagnosis and to support the clinical decisions in the daily practice.

APPROACH/METHODS
Starting from anatomy of SC, moving through technical requisites and imaging sequences “attitudes” of MR imaging, we manage to define the key MR findings and the basic imaging patterns in intramedullary SC lesions (“intrinsinc”) to narrow the differential diagnosis.

FINDINGS/DISCUSSION
We summarize the key MR findings to be systematically taken into account: SC size, the number of lesions, the level/cranio-caudal extent (number of segments) of the lesions, the extent on axial slices, the respect of gray/white matter boundary, the location on axial slices, the borders, the signal behavior and the assessment of contrast enhancement and its morphology. We underline how to integrate different imaging sequences to recognize several tissue/material (hemorrhage, paramagnetic material, flow-void, fat tissue, cyst) which facilitate in certain diagnoses. We propose five main imaging patterns on the basis of two basic parameters: cord size and location on axial slices: 1) central expansile, 2) central nonexpansile, 3) peripheral expansile, 4) peripheral nonexpansile, 5) meningeal/roots involvement. We conclude by classification of spinal cord changes due to extramedullary abnormalities (“extrinsic”) basing on displacement, compression, infiltration, tethering/adhesion and herniation.

SUMMARY/CONCLUSION
A meticulous technique is the prerequisite for imaging myelopathy. Basic imaging patterns can be defined on the basis of key MR findings (i.e., cord size and location on axial images), thus addressing the different diagnosis. Within the single basic pattern, a definite diagnosis of the “intrinsinc” myelopathy is feasible in most patients, taking into account clinical data and other MR findings. Strict analysis and terminology are needed in evaluating “extrinsic” changes of the SC to avoid over/underestimation of myelopathy.

KEY WORDS: Spinal cord, imaging patterns, differential diagnosis
Primary Central Nervous System Vasculitis: Spectrum of Imaging Findings and a Systematic Approach to Diagnosis

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PURPOSE
The purpose of this exhibit is to review the classification of central nervous system (CNS) vasculitis, define the role of noninvasive and invasive imaging in the work up and diagnosis of primary CNS vasculitis, illustrate the spectrum of imaging findings in primary CNS vasculitis, and to provide a systematic approach to assist with the diagnosis of this rare condition.

APPROACH/METHODS
We identified patients having been diagnosed with CNS vasculitis over the last 8 years from our institution and retrospectively reviewed their imaging studies, clinical presentation, diagnostic work up, and any follow-up studies available. Patients were divided into histologically and clinically diagnosed primary CNS vasculitis, or secondary CNS vasculitis. Indeterminate cases of CNS vasculitis (whether due to sudden patient death or incomplete work up) also were considered and evaluated.

FINDINGS/DISCUSSION
Presenting symptoms and clinical course varied widely in patients with either primary or secondary CNS vasculitis. Commonalities in laboratory investigations included an elevated serum ESR and elevated CSF total protein on lumbar puncture. The most common imaging feature on MR was the presence of multiple infarcts in different vascular territories. Beading or stenosis of small and intermediate vessels was commonly but not always appreciated on different modalities, including CTA, MRA and conventional angiography. Imaging abnormalities improved significantly after treatment.

SUMMARY/CONCLUSION
Primary CNS vasculitis is a diagnostic challenge, often one of exclusion. If biopsy is not performed, the diagnosis of primary CNS vasculitis often can be inferred on the basis of clinical presentation, CSF investigations, exclusion of underlying secondary causes, and imaging features. 3T MR imaging enables visualization of direct signs of CNS vasculitis, such as circumferential thickening and enhancement of the vessel walls, while routine imaging relies on detecting secondary features of vessel wall inflammation, namely ischemic changes, stenoses, hemorrhage and perfusion deficits. Early recognition and diagnosis is imperative in reducing morbidity and mortality from primary CNS vasculitis.

KEY WORDS: Vasculitis

Posterior Fossa Stroke: Vascular Anatomy, Vascular Syndromes and MR Imaging Correlation

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PURPOSE
1) To illustrate the normal vascular anatomy, anatomical variations, and territorial distribution of the posterior fossa structures. 2) To illustrate with examples various brain stem vascular syndromes with clinical and MR correlation.

APPROACH/METHODS
The clinical picture of brainstem and cerebellar infarctions is variable and mainly depends on the area involved. The anatomy of the brainstem is complex due to presence of numerous tracts, vital structures and cranial nerve nuclei. Unlike supratentorial infarcts, a small stroke in posterior fossa potentially can be disastrous clinically. Infarction of cerebellum and brainstem can produce characteristic clinical pattern or syndromes. CT has a major limitation in posterior fossa due to poor soft tissue differentiation and beam hardening artifact. MR imaging especially DWI and thin high-resolution T2-weighted imaging has revolutionized the diag-
nosis of posterior fossa stroke. For best clinico-corelation understanding the anatomy of the posterior fossa structures and vascular pattern is important.

**Findings/Discussion**
We retrospectively reviewed MR images of 154 patients from our archive system with clinical and MR diagnosis of posterior fossa stroke. Axial T2, DWI/ADC, FLAIR, GRE, MRA and perfusion images from these patients formed the basis of this exhibit. We first illustrate in detail the normal vascular anatomy and territorial distribution of the various major and minor branches. We also review the vascular anatomical variation of the posterior fossa. We present the various brain stem vascular syndromes with clinical and imaging correlation, knowledge of which is very essential for the practicing radiologist.

**Summary/Conclusion**
This exhibit will be core learning module to understand the normal vascular anatomy of the posterior fossa and various clinical syndromes associated with stroke.

**Key Words:** Posterior fossa stroke

**Electronic Scientific Exhibit 3**
**Completing the Circle: Evaluation of the Circle of Willis. Common and Uncommon Variants: What Your Neurosurgeon and Interventionalist Want to Know**

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**Purpose**
1) Demonstrate the basic anatomy of the circle of Willis. 2) Display important anomalies and variants of the circle of Willis. 3) Describe how these variants affect the diagnosis and management of cerebrovascular disease.

**Approach/Methods**
We searched our radiology information system of all noninvasive (CTA and MRA) and invasive imaging to search for circle of Willis variants.

**Findings/Discussion**
1) Describe the normal anatomy of the anterior cerebral artery and the important variants of the anterior communicating artery. 2) Demonstrate the normal and variant anatomy of the middle cerebral artery. 3) Describe the importance of the fetal origin of the posterior cerebral artery. 4) Demonstrate normal and variations of the posterior circulation, particularly a fenestrated basilar artery, persistent hypoglossal artery, and variants of the vertebral artery.

**Summary/Conclusion**
With the ever expanding use of noninvasive vascular imaging, it is important to understand the normal and variant anatomy of the circle of Willis and its importance in the diagnosis and management of cerebrovascular disease, particularly aneurysm management and stroke. This exhibit highlights the basic anatomy and describes the most common and important vascular variants that will affect endovascular and surgical management of cerebrovascular disease as well as certain stroke syndromes.

**Key Words:** Circle of Willis, variants

**Electronic Scientific Exhibit 4**
**Measurement of Cerebral Circulation Times Using 320-Slice CT**

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**Purpose**
To present a method of measuring cerebral circulation times by dynamic whole-brain 320-slice CT angiography (4D CTA). To present initial results in normal subjects in order to establish physiologic values with this method. To show cases of abnormal cerebral circulation times in patients with hemodynamically relevant pathologies.

**Approach/Methods**
In 12 patients without cerebrovascular pathologies a 4D CTA was performed with a 320-slice CT scanner. The image reconstruction window length amounted to 0.5 seconds. The cerebral circulation time was defined by measuring the time interval between arrival of the contrast agent bolus (40ml @5 ml/s) in the arteries at the skull base and the arrival of the bolus at the bulb of the jugular veins. The compactness of the bolus was also assessed. Five patients with hemodynamically relevant pathologies (3 arteriovenous malformations, 1 cortical vein thrombosis, 1 transverse and sigmoid sinus thrombosis) were evaluated with this method and cerebral circulation times were compared to physiologic values.

**Findings/Discussion**
Cerebral circulation time could be assessed in all patients by using 4D CTA. In normal patients cerebral circulation time amounted to 7 ± 2 seconds. In the three patients with arteriovenous malformations cerebral circulation time amounted to 2.5 ± 1.5 seconds. In the case of the sinus thrombosis a lacking outflow via the thrombosed sinus was noted with otherwise not significantly altered overall cerebral circulation time. In the case of the cortical vein thrombosis a significantly delayed cortical venous washout of 15 seconds was registered in the compromised area with corresponding lengthening of the venous bolus.

**Summary/Conclusion**
Whole-brain 4D CTA by using 320-slice CT is capable of measuring cerebral circulation times. By establishing normal physiologic values it may become possible for CT to diagnose subtle cerebrovascular pathologies by their cerebral circulation time deviation, such as cortical vein thrombosis or the confident exclusion of an arteriovenous shunt. Furthermore, this method seems to be able to add information to the analytic-hemodynamic characterization of shunting vascular disorders.

**Key Words:** 320-slice CT, 4D CTA, cerebral circulation time
Carotid Thrombosis and the Circle of Willis. Topographic Correlation of Cerebral Infarction Considering the Various Variants of the Circle of Willis

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PURPOSE
To analyze how collateral pathways are established through the circle of Willis in patients with occlusive disease of the internal carotid arteries. To illustrate the main anatomical variants of the configuration of the circle of Willis and to correlate them with the distribution of ischemic events due to carotid thrombosis.

APPROACH/METHODS
The circle of Willis is the main collateral arterial path to maintain adequate cerebral arterial blood flow in patients with carotid obstruction. The anterior cerebral artery, middle cerebral artery, and posterior cerebral artery converge in the circle of Willis, providing a system with a great deal of self-regulating capacity if an eventual ischemic event develops. During embryonic development some connections are established between the anterior (carotid) and the posterior (vertebrobasilar) circulations. Most of these anastomoses normally regress; however, the anastomosis formed through the posterior communicating artery frequently persists in adulthood. There is considerable anatomical variation in the circle of Willis. Only about a third of patients present the classic configuration. While the configuration of some variants can lead to the hemodynamic isolation of a territory, making it vulnerable to ischemia, other configurations lead to the development of collateral supply without increased clinical risk. It is important to differentiate between complete arterial variants and incomplete arterial variants. Incomplete variants involve a greater risk of ischemic events if sufficient compensatory supply is lacking.

FINDINGS/DISCUSSION
The anatomical variants of the circle of Willis most commonly affect the A1 segment of the anterior cerebral artery, the posterior communicating artery, and the P1 segment of the posterior cerebral artery. We present a series of cases studied using CT, conventional MR imaging, CT angiography, and MR angiography that exemplifies the distinct topographic distributions of cerebral infarcts from carotid thrombosis according to the variant or supply of the circle of Willis.

SUMMARY/CONCLUSION
The circle of Willis is the main collateral system to maintain blood flow when carotid thrombosis occurs. The final cerebral hemodynamic compromise after a carotid occlusion is closely related to the collateral supplies. The anatomical variants and the functional patterns established through the circle of Willis determine the vascular territories that will be affected in an ischemic event.

KEY WORDS: Circle of Willis, carotid thrombosis, stroke

Tinnitus: Evaluation with CT Arteriography and Venography

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PURPOSE
Tinnitus, the perception of auditory sensations in the absence of external stimuli, has been estimated to affect 12% of the population in Western countries, although the severity of symptoms is widely variable. Pulsatile tinnitus (PT), which refers to a repetitive sound accompanying the patient’s pulse, is usually the result of a vascular abnormality or vascular tumor. To date, the imaging work up has included temporal bone CT, MR imaging, MR angiography, and catheter angiography. CT arteriography and venography (CTA/V), a technique capable of evaluating both temporal bone and skull base vascularity, can serve as a single imaging examination to assess all possible causes of nonpulsatile and pulsatile tinnitus, except for an occult dural arteriovenous fistula (DAVF).

APPROACH/METHODS
Vascular anomalies, which may be arterial or venous, presumably cause PT by producing turbulent flow that reaches the cochlea. Arterial causes of PT include: carotid artery stenosis or occlusion, aberrant internal carotid artery, carotid artery dissection, fibromuscular dysplasia, DAVF, aberrant anterior inferior cerebellar artery, and persistent stapedial artery. The major venous etiologies of PT include: turbulent flow through a dominant venous system, dehiscence or high-rising jugular bulb, venous stenosis, venous diverticulum, or abnormal condylar or mastoid emissary veins. Vascular tumors of the middle ear, such as paragangliomas, and osseous dysplasias associated with increased vascularity of the petrous bone also may cause PT. Finally, recent evidence suggests that dehiscence of the superior semicircular canal and benign intracranial hypertension can cause tinnitus.

FINDINGS/DISCUSSION
Our routine imaging approach to tinnitus or PT is CTA/V accomplished by power injection of nonionic contrast at a rate of 3-4 ml/sec after a fixed delay of 25 seconds, allowing for single-phase arterial and venous opacification. Axial images are reconstructed at 0.625 mm section intervals from the vertex to approximately the C5 level, and all images are reconstructed using a bone algorithm. Multplanar reformatting, maximum intensity projection, and volume rendered images are generated on an independent workstation. Arterial, venous, middle ear, and miscellaneous causes are carefully excluded using our algorithm.

SUMMARY/CONCLUSION
With the exception of some cases of DAVF, CTA/V can serve as a sensitive and reliable single imaging examination in the work up of tinnitus, allowing evaluation of middle and inner ear pathology as well as arterial and venous abnormalities in the head and neck. The spectrum of findings on CTA/V are presented in this educational exhibit.

KEY WORDS: Tinnitus, CT arteriography
Electronic Scientific Exhibit 7

Many Faces of Cerebral Amyloid Disease

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PURPOSE
Recognition of the imaging spectrum of cerebral amyloid disease is important as it is commonly associated with increasing age, dementias, and spongiform encephalopathies. We present this comprehensive review of cerebral amyloid disease in effort to raise awareness of the characteristic imaging features to improve accurate diagnosis.

APPROACH/METHODS
A retrospective analysis of the digital archive record and pathology database revealed 14 cases with histologically proved amyloid at our institution. MR imaging and CT examinations of these subjects and 75 additional cases with characteristic imaging findings were reviewed. The spectrum of imaging findings included macrohemorrhages, microhemorrhages, leukoencephalopathy, CNS angiopathy, and tumefactive lesions (amyloidoma).

FINDINGS/DISCUSSION
Amyloidosis is a disease complex that results in the extracellular deposition of an insoluble fibrillar protein with a beta-pleated sheet configuration, which accounts for its various biochemical and physical properties. Amyloid deposition within the brain can take many forms, including cerebral amyloid angiopathy, senile plaques of Alzheimer dementia, deposits seen in familial amyloid disease, and tumor-like deposition (amyloidoma). The pathophysiology of amyloid involves deposition of amyloid in small cortical and leptomeningeal vessels, provascular plaques in perivascular tissues, and alpha-beta deposition in vessels leading to dysregulation of the blood-brain barrier. The most common form of cerebral amyloid disease is intracranial hemorrhage, including macrohemorrhage and microhemorrhage, as well as CNS angiopathy. Amyloid also may present as leukoencephalopathy with T2 hyperintensity involving the gray and white matter due to hypoxic/ischemic changes in the brain. Rarely, amyloid may present as tumefactive lesions. Studies have shown that almost 25% of amyloid is missed on neuroimaging. The symptoms depend on location and type of manifestation, (i.e., hemorrhage, ischemia, and/or mass effect). Clinical manifestations include seizures, chronic cognitive impairment, and encephalopathy. Although the majority of amyloid is untreatable, knowledge of disease presence will impact clinical management. Control of hypertension and cautious anticoagulation is prudent in patients with amyloid.

SUMMARY/CONCLUSION
Awareness of the spectrum of imaging findings of amyloid is critical in the diagnosis and management of these patients in light of the protean clinical manifestations.

REFERENCES

KEY WORDS: Cerebral amyloid disease, amyloid, cerebral amyloid angiopathy

Electronic Scientific Exhibit 8

Contemporary Management of Carotid-Cavernous Fistulas: A Case-Based Review

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PURPOSE
Carotid-cavernous fistulas (CCFs) are abnormal arteriovenous communications in the cavernous sinus. These are broadly classified as direct and indirect fistulae. Symptomatic lesions are treated with endovascular methods but there is considerable heterogeneity in the methods chosen to obliterate the fistulae. We aim to illustrate the relative benefits and drawbacks of different endovascular approaches in this exhibit.

APPROACH/METHODS
This case material for this exhibit is selected from prospective interventional neuroradiology databases of authors’ two institutions. A dedicated medical illustrator with special expertise in vascular neuroradiology created anatomical artwork for this exhibit. The case material includes symptomatic direct and indirect fistulae treated over the last 5 years at the authors’ institutions. A variety of endovascular agents were used during this period, including detachable balloons, coils and liquid embolic agents (Onyx and nBCA glue).

FINDINGS/DISCUSSION
Direct CCFs almost always are treated given the high risk of visual compromise as well as cortical venous reflux (CVR). In a vast majority of patients, satisfactory occlusion of fistula is possible with covered stents or a combination of porous stents and detachable coils. Vessel sacrifice is rarely needed.
given the recent availability of excellent vascular reconstruction devices (VRDs). The majority of indirect CCFs are approached transvenously. Coils and liquid embolics, either alone or in combination are used to treat these lesions. In some cases with difficult or impossible access to the venous compartment, transarterial embolization can be performed.

**SUMMARY/CONCLUSION**

This exhibit will provide an overview of decision-making process in the treatment of direct and indirect CCFs with the help of representative case illustrations and anatomical drawings. The audience will gain appreciation of currently available endovascular methods and their relative merits and demerits.

**KEY WORDS:** Carotid, cavernous, fistula

### Electronic Scientific Exhibit 9

**A 3D Interactive Atlas of Cerebral Vasculature and Structure from 3 T and 7 T**

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**PURPOSE**

Redefining the radiology classroom and reading room is one of the biggest challenges in radiology. The knowledge of cerebral structure correlated with vasculature is critical in education, diagnosis and treatment. Numerous textbooks and articles present them in a print form as drawings or autopsy photographs, usually in a small exposure. A few electronic atlases present structure or vasculature, however, separately. The objective of this exhibit is to construct a three-dimensional (3D) interactive, detailed atlas of cerebral vasculature correlated spatially with structure derived from multiple 3 T and 7 T acquisitions. This atlas allows the user exploring any cerebral region of interest along with its surroundings just with a few clicks.

**APPROACH/METHODS**

Multiple high-resolution acquisitions of the same brain specimen were done on 3 T and 7 T including MPRAGE, TOF, SPGR and SWI. The scans were placed in the same stereotactic space by applying affine transformations. Dedicated tools were developed for extracting and editing 3D structure and vasculature. The initial version of the cerebrovascular atlas developed from 7 T (presented at RSNA 2008) was extended with 3 T/32 channel MRA and MRV scans. The structure was extracted from several 3 T MPRAGE acquisitions. A user-friendly and efficient application was developed.

**FINDINGS/DISCUSSION**

This atlas has a rich content and provides numerous tools for studying and understanding the brain anatomy. The cortical, subcortical, and ventricular neuroanatomy is created in 3D. The vascular system contains over 700 arteries and veins, the smallest of 100 microns. All structures are labeled with names, and the vessels additionally with diameters. A cutting plane technique along with texture mapping enables to combine surface and sectional anatomy in 3D. When applied interactively, this facilitates to electronically cut off any part of the brain in a realistic way exposing the vessels in the volume of interest. Any structure/vessel can be searched and highlighted in 3D. Measurement of 3D distances and stereotactic coordinates enable quantitative analysis. A real-time interactive manipulation with rotate, zoom, pan, and set view facilitates a user-friendly exploration of the cerebrovascularly correlated with neuroanatomy.

**SUMMARY/CONCLUSION**

This exhibit redefines the radiology classroom in terms of learning and exploring the cerebral vasculature related to the brain structure. In a few clicks the user easily can get familiarized with the cerebral arterial and venous systems correlated with the surrounding 3D neuroanatomy. The atlas is useful for both medical students and educators to prepare teaching materials. It may serve as a reference aid in the reading room. The atlas is easily extendable with new structures and vessels.

**KEY WORDS:** Cerebral vasculature

### Electronic Scientific Exhibit 10

**Susceptibility-Weighted MR Imaging in Central Nervous System Disorders: A Pictorial Review**

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**PURPOSE**

To review the utility of susceptibility-weighted imaging (SWI) in imaging central nervous system disorders, highlighting cases in which SWI offered improved diagnostic accuracy in addition to standard MR brain imaging protocols.

**APPROACH/METHODS**

Susceptibility-weighted MR imaging (SWI) is a high-resolution three-dimensional gradient-echo sequence that utilizes the magnetic susceptibility differences between tissues in order to create an image. It is particularly sensitive for detecting small volumes of substances such as blood products, deoxygenated blood, iron and calcium along with small vessel depiction. This relatively new sequence may offer improved specificity and grading accuracy in brain tumour diagnosis as well as being useful as an additional sequence in imaging trauma, cerebrovascular disease and developmental venous anomalies. The full utility of the technique has, however, yet to be validated in the literature. A retrospective review was performed of brain studies performed with a SWI sequence at our institution. This review involves over 150 cases of pathologically proved brain malignancies ranging from low- to high-grade tumors along with cases of cerebrovascular disease and vascular abnormalities. Two radiologists reviewed each case with agreement by consensus in order to try and establish imaging features or patterns, which highlight the potential of SWI in improving the diagnostic
specificity of neuroimaging. We present a pictorial review of our findings using SWI. In particular we will emphasize cases in which susceptibility-weighted sequence offered additional information over and above our usual brain protocol.

**FINDINGS/DISCUSSION**

Susceptibility-weighted imaging is yet to be validated in brain imaging although speculation exists that the improved contrast resolution for blood products and vasculature offered by this sequence may assist in characterization and specificity in brain imaging. This review shows that SWI can offer an important adjunct to routine brain magnetic resonance imaging improving diagnostic accuracy in certain cases.

**SUMMARY/CONCLUSION**

Susceptibility-weighted imaging offers potential to improve the accuracy of brain tumor characterization and increases sensitivity for hemorrhage and vascular malformations. 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:** Susceptibility-weighted imaging, tumor, vascular

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**Electronic Scientific Exhibit 11**

Application of Diffusion-Weighted Imaging in Nonstroke Pathologies of the Brain

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**PURPOSE**

1. To understand the relevant physical principles of the diffusion-weighted imaging (DWI) for the practicing neuroradiologist. 2. To highlight the applications and usefulness of DWI in nonstroke pathologies of the brain.

**APPROACH/METHODS**

Diffusion-weighted imaging has an established role in imaging of stroke. However, there are various intracranial pathologies where this sequence can be extremely helpful in reaching the specific diagnosis. We highlight this concept with illustrations. To understand application and usefulness of DWI sequence, knowledge of physics and principle behind this sequence is mandatory. We divide this exhibit into two parts. In the first half of this exhibit we simplify the physics and the principle of DWI sequence for the practicing radiologist. In the second half of the exhibit we show various pathologies which can show restricted diffusion and how DWI can some times help in reaching the specific diagnosis. We categorize these pathologies under following: hemorrhagic and nonhemorrhagic stroke, infection, trauma, hemorrhage, demyelination, and extra and intraaxial neoplasm.

**FINDINGS/DISCUSSION**

The importance of DWI and its usefulness in differentiating and yet at times giving specific diagnosis is highlighted.

**CONCLUSION**

This exhibit will be a core learning tool for DWI sequence.

**KEY WORDS:** DWI, Nonstroke pathologies

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**Electronic Scientific Exhibit 12**

Surgical Complications of the Skull Base: Encephalocele and Infarcts. Pictorial Essay

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**PURPOSE**

To show series of cases with postprocedure otolaryngology and neurosurgery complications.

**APPROACH/METHODS**

From 2002 to 2008 five patients who underwent otolaryngology and neurosurgery procedures, complicated with meningoencephalocele and encephalomalacia, are shown on this paper. Three-dimensional CT scan acquisition with multiplanar reformats and MR imaging were performed to demonstrate the anatomical site of the surgical complication. The complications included are frontal lobe meningoencephalocele, temporal lobe meningoencephalocele, anterior-middle cranial fossa cyst and frontal encephalomalacia.

**FINDINGS/DISCUSSION**

Otolaryngology and neurosurgical procedures including mastoidectomy, transsphenoidal pituitary adenomectomy and fundoscopic surgery are common daily procedures in many health centers. Most of the patients undergo uneventful recovery. However, a small population may be affected by different complications. Encephalocele, cerebrospinal fluid (CSF) leak and infection are the more important and common complications. The usual clinical presentation is related to spontaneous CSF leak or infection. Precise anatomical identification of the complication is extremely important for adequate surgical planning.

**SUMMARY/CONCLUSION**

Surgical complications of the anterior and middle cranial fossa may occur, although represent an infrequent event. Adequate imaging is of great help to the referring physician in treatment planning.

**KEY WORDS**

Skull base, surgery, complication

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**Electronic Scientific Exhibit 13**

Transsphenoidal Meningoencephaloceles in Adults: A Case Series

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**PURPOSE**

Transsphenoidal meningoencephalocele presenting in adults is a rare clinical entity and the least common variety of basal
encephaloceles. Only a few cases have been described in the literature.

**APPROACH/METHODS**
We describe high-resolution skull base CT and MR imaging findings in a series of five cases of transsphenoidal meningoencephaloceles. We review the embryology and anatomy to explain the possible mechanisms of pathogenesis of sphenoidal encephaloceles. Our case series consist of true transsphenoidal encephaloceles in adults without cerebrospinal fluid (CSF) rhinorrhea and with unusual clinical features, viz: seizures (2 cases), trigeminal neuralgia (1 case), meningitis (2 cases).

**FINDINGS/DISCUSSION**
Transsphenoidal meningoencephalocele consists of herniation of an ependymal-lined sac containing CSF and neural tissue, through a defect in the sphenoid bone. This is the least common variety, representing 5% of basal encephaloceles with an estimated incidence of 1 in 700,000 live births. Typically they present in childhood and are rare in adults. Transsphenoidal meningoencephaloceles are classified into intrasphenoidal and true transsphenoidal. Intrasphenoidal meningoencephaloceles extend into the sphenoid sinus whilst true transsphenoidal meningoencephaloceles traverse the floor of the sinus and protrude into the nasal cavity or nasopharynx. Meningoencephaloceles can result from various acquired processes, including infection, trauma, surgical damage and neoplasms. Those which develop in the absence of such acquired processes are congenital or early postnatal maldevelopments and are termed spontaneous meningoencephaloceles. Pathogenesis of congenital encephaloceles is unclear and various theories have been proposed. We discuss the complex anatomy and embryology of the sphenoid sinus and postulate the pathogenesis of herniation at these sites.

**SUMMARY/CONCLUSION**
Understanding the complex embryoanatomy of sphenoid bone is essential in understanding the unusual clinicoradiologic presentation of a rare variety of encephaloceles.

**KEY WORDS:** Meningoencephalocele, sphenoid, skull base

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**Electronic Scientific Exhibit 14**

**Neuroradiologic Menagerie: Case-Based Quiz and Review**

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Albert Einstein College of Medicine Montefiore Medical Center
Bronx, NY

**PURPOSE**
To provide an interesting interactive review and summary of descriptive neuroradiologic signs that are named after animals including the origin, specificity, and utility of these signs.

**APPROACH/METHODS**
Descriptive signs long have been used in radiology because they are helpful visual mneumonics and are useful in helping to make specific diagnoses. The selected cases will demonstrate the broad array of imaging signs named after animals used in neuroradiology, from the common to the uncommon. The radiographic images will be accompanied by illustrative photographs where appropriate. Our exhibit seeks to provide an entertaining and interactive case-based quiz and review of the differential diagnoses, historical basis and value of these zoological neuroradiology signs.

**FINDINGS/DISCUSSION**
The entities presented will include a “butterfly” glioma, the “owl-eye” appearance of central pontine myelinolysis, the “Scotty-dog” appearance of the pars interarticularis, the “eye-of-the-tiger” sign seen in Hallervorden-Spatz, the “batwing” configuration of the fourth ventricle in Joubert’s syndrome, “fish” vertebra, and others.

**SUMMARY/CONCLUSION**
Many neurologic diseases have pathognomonic appearances on imaging studies that have historically been described using animal references. This exhibit reviews the wide range of such signs, including both common and uncommon diseases, with illustrative examples and information on their source and utility.

**KEY WORDS:** Brain

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**Electronic Scientific Exhibit 15**

**Headache Imaging: Is It Hypo or Hyper?**

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University of Ottawa
Ottawa, ON, CANADA

**PURPOSE**
To demonstrate the spectrum of radiographic findings of both spontaneous intracranial hypotension (SIH) and idiopathic intracranial hypertension (IIH) and discuss the diagnostic accuracy of these findings.

**APPROACH/METHODS**
We have collected several cases that illustrate the multimodal imaging manifestations of SIH and IIH. After reviewing these cases and the available literature we describe the relevant imaging findings, anatomical details and pathophysiologic processes that underlie both pathologies.
**PURPOSE**

University Medical Center, East Meadow, NY

localizers and their etiology.

efficient search pattern. We also review the concept of false

of neurologic signs can help the radiologist develop a more

ed, highlighting the way in which a detailed understanding

our respective institutions during the past 5 years are provid-

logic eponyms also is reviewed. Examples of cases seen at

ic signs according to brain location. The spectrum of neuro-

We organized our compendium of focal localizing neurolog-

APPROACH/METHODS

signs we discuss. 3. To give examples of false localizing

encounter, providing a location-based approach to assist in

rologic signs and symptoms that the neuroradiologist may

consider by the referring clinician. Neuroimaging fre-

quently is required to exclude central nervous system neo-

plasm, infection, aneurysm, vascular malformation or hem-

orrhage as the cause of headache. A high degree of suspicion

is required on the part of the neuroradiologist to recognize

the subtle findings of SIH and IIH because often, the diag-

nosis is not suspected clinically. This exhibit will demon-

strate the features of both SIH and IIH on noncontrast CT,

pre and postcontrast MR imaging, MR venography, MR cis-

ternography and nuclear medicine cisternography. 

Furthermore, we will illustrate the role of endovascular

venous stenting in the treatment of intracranial hypertension.

As neuroradiologists we should be familiar with the range of

findings in SIH and IIH and their degree of sensitivity and

specificity.

**SUMMARY/CONCLUSION**

Familiarity with the findings of SIH and IIH will lead to the
diagnosis of these uncommon but important primary
headache disorders. Occasionally, these findings will sug-
gest the diagnosis even if it was not suspected clinically.

**KEY WORDS:** Intracranial Hypotension

**Electronic Scientific Exhibit 16**

**Signing On: A Survey of Neurologic Localizing Signs and Their Imaging Correlates**

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1South Nassau Radiology, P.C., Oceanside, NY, 2Nassau University Medical Center, East Meadow, NY

**PURPOSE**

1. To review the common and unusual focal localizing neurologic signs and symptoms that the neuroradiologist may encounter, providing a location-based approach to assist in formulating an accurate differential diagnosis. 2. To display a wide array of informative illustrative cases to reinforce the signs we discuss. 3. To give examples of false localizing signs, which seemingly do not follow the expected clinical anatomical correlation.

**APPROACH/METHODS**

We organized our compendium of focal localizing neurologic signs according to brain location. The spectrum of neurologic eponyms also is reviewed. Examples of cases seen at our respective institutions during the past 5 years are provided, highlighting the way in which a detailed understanding of neurologic signs can help the radiologist develop a more efficient search pattern. We also review the concept of false localizers and their etiology.

**FINDINGS/DISCUSSION**

Signs such as hypertonia, hemiparesis, and Broca’s aphasia can indicate lesions located within the frontal lobe, along with changes in personality and frontal release signs. Deficits related to tactile sensation, proprioception, sensory and visual neglect syndromes, dyslexia, and astereognosis could indicate presence of a lesion within the parietal region. Cortical deafness, auditory hallucinations, and Wernicke’s aphasia represent signs related to temporal lobe lesions, along with memory loss and complex partial seizures. Signs suggesting an occipital lesion might include cortical blindness, Anton’s syndrome, visual agnosia and visual hallucinations. Ataxia, intentional tremors, and nystagmus are examples of signs related to cerebellar pathology. There are a vast array of sensory and motor abnormalities pertaining to the brainstem, depending on sublocalizations of specific neural pathways. False-localizing signs include Kernohan’s notch, secondary to raised intracranial pressure, and cerebellar syndrome, which may be due to anterior cerebral artery infarction damaging the frontocerebellar pathways.

**SUMMARY/CONCLUSION**

The histories that the clinician or neurologist may provide can be terse or cryptic in nature. A thorough understanding and awareness of focal localizing as well as false-localizing signs can enable the neuroradiologist to better define the search for subtle causative lesions and help him/her focus the radiologic work up.

**KEY WORDS:** History, neurologic, signs

**Electronic Scientific Exhibit 17**

**New Web-Based Interactive Application for Neuroradiology Learning**

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**PURPOSE**

To debate the learning of neuroradiology in a classical way versus a possible new interactive learning. To show our new web-based interactive application including a teaching file case database with interactive games and exercises, developed at our center.

**APPROACH/METHODS**

An interactive application was implemented to show a quiz presentation associated with each case included in the database. It was developed with a MySQL server and a PHP running on a Apache server. This Java application permits management of different games and entertaining radiologic skills and problems including cases with images and videos in different formats.

**FINDINGS/DISCUSSION**

This program revolutionized the learning and management of teaching database by our residents and fellows by including high entertainment in the analysis of the cases registered. Inspired in recent videogames, the user must face several questions and games associated with the cases. Each user
may develop his own profile and learning curves, with interactive contact with his imaginary neuroradiology teacher. In addition, several skills try to improve their depiction capacity.

**SUMMARY/CONCLUSION**
This new web application may provide an easier and entertaining way to learn radiology by the residents.

**KEY WORDS:** Education, database

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**Electronic Scientific Exhibit 18**

**Feasibility of Prefronto-Caudate Pathway Tractography Using High-Resolution Diffusion Tensor Tractography Data at 3 T**

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Houston, TX

**PURPOSE**
Lack of adequate imaging sensitivity and spatial resolution, so far, impeded depiction of prefronto-caudate pathway in lower resolution studies. This work aimed to explore the accuracy and feasibility of visualization of white matter substructure within the human caudate nuclei in vivo such as frontotriatal pathway using a high-resolution diffusion tensor imaging technique and deterministic tractography approach.

**APPROACH/METHODS**
The caudate and putamen (Striatum) are the principal input of the basal ganglia circuit in the human brain. The caudate nucleus curves around the ventricular system and receives most of the projections from association areas of the cortex. The projections are particularly heavy from prefrontal cortex and frontal pole which project to the head of the caudate. The noninvasive mapping of the frontal lobe connections to the thalamus and basal ganglia would help advance our knowledge of brain-behavior relations as a result of natural aging, or pathologies such as Huntington's disease, bipolar disorders, Tourette's syndrome, and attention-deficit hyperactivity disorder. Diffusion tensor tractography of white matter connections between the cortex and deep gray matter structures is challenged by the signal-to-noise ratio (SNR) due to overestimation of anisotropy at low SNR and partial volume averaging upon using large voxel volumes. Subjects: Five healthy men (age range 24-37 years) were studied and written informed consent was obtained from all subjects. Conventional and DT-MRI Acquisition: Data were acquired using a Philips 3.0 T Intera system using a SENSE receive head coil. Diffusion-weighted image (DWI) data were acquired axially using a single-shot multi-slice 2D spin-echo diffusion with the balanced Icosa21 tensor encoding scheme. The b-factor = 500 sec mm-2, TR/TE = 14460/60 msec, FOV = 256 mm x 256 mm and slice thickness/gap/ #slices = 1 mm / 0 mm / 120. The EPI phase encoding used a SENSE k-space undersampling factor of two, with an effective k-space matrix of 112x112 and an image matrix after zero-filling of 256x256. Fiber Tracking: We used the FACT algorithm (DTISTudio) to reconstruct prefronto-caudate and the anterior thalamic radiation connections with a fractional anisotropy (FA) threshold of 0.22 and angle threshold of 60 degrees. Statistical comparisons were made using analysis of variance (student t-test) and the Mann-Whitney tests.

**FINDINGS/DISCUSSION**
Using higher resolution combined with higher magnetic field strength improved the detectable anisotropy in gray matter (caudate) along with reducing partial volume effects. This allowed us to reveal more anatomical details and to map the prefronto-caudate pathway. In our experience, anterior thalamic radiation is traceable using slice thickness ~ 3mm, while the prefronto-caudate pathway was not traceable using the FACT approach at ~ 3mm which is attributable to mixing of fibers in different orientations within the voxel leading to lack of needed anisotropy in gray matter in larger voxel volume which was solved by using thinner slices and smaller voxel volume.

**SUMMARY/CONCLUSION**
In this report we demonstrated that using higher resolution along with thinner slices reduce the partial volume effect and enabled the tracing of the prefronto-caudate pathway within the gray matter (caudate nuclei) in vivo.

**KEY WORDS:** Tractography, prefronto-caudate, diffusion tensor

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**Electronic Scientific Exhibit 19**

**Comparison of Corrected with Uncorrected Signal Intensity Curves Derived from T2* DSC MR Imaging Perfusion MR Imaging in Intracranial Neoplasms after Preloading with Gadolinium**

Lacerda, S. P.1 · Law, M.2 · Furtado, A. D.3 · Fatterpekai, G.2 · Delman, B.2 · Tanenbaum, L.3 · Fowkes, M.3 · Naidich, T.3

1Image Memorial - DASA, Salvador, Bahia, BRAZIL, 2Mount Sinai School of Medicine, New York, NY

**PURPOSE**
Intracranial lesions can demonstrate significant vascular permeability and leakage which can cause an overestimation or underestimation of rCBV resulting in erroneous perfusion maps depending on the extent of T1 versus the dipolar T2* effect. This can result in incorrect estimation both qualitatively and quantitatively of rCBV maps. The purpose is to characterize and describe the signal intensity curves from T2* DSC MR imaging perfusion MR imaging in intracranial neoplasms after preloading with gadolinium and identify the pattern of curve will result in erroneous measurements.

**APPROACH/METHODS**
We performed a retrospective review of 36 patients (20 male and 16 female; median age, 54 years; range), diagnosed by histopathology with grade II, III and IV astrocytomas, as defined by the World Health Organization (WHO) criteria, radiation necrosis and metastatic disease. Patients underwent a first pass gradient-echo T2*-weighted DSC MR imaging. We compared and correlated the shape of the signal intensity curves and its effect on the rCBV map with and without correction for leakage. The data were post-processed on Functools, Brainstat using a negative enhancement integration of the area under the curve after gamma variate fitting.
which also minimized bolus recirculation effect. This also has the advantage of not requiring a deconvolution to an arterial input function, is reproducible, fast and robust, eliminates recirculation effects.

**FINDINGS/DISCUSSION**

In lesions which demonstrate minimal leakiness on T2* DSC MR imaging, there is no difference in the uncorrected versus the corrected rCBV maps and curves. In lesions which demonstrate marked leakiness, there is a considerable difference in the signal intensity curves and rCBV maps depending on whether there is a preponderance of T1 effect or dipolar T2* effect. In lesions with a very marked dipolar T2* effect, the values obtained using uncorrected rCBV were substantially overestimated whereas the value acquired in lesions with significant T1 effect were usually underestimated.

**SUMMARY/CONCLUSION**

When there is substantial T1 or T2* dipolar effect in very leaky/permeable intracranial lesions, there are significant differences both qualitatively and quantitatively in the appearance of the rCBV color maps and ROI analysis respectively. This will significantly alter the final diagnosis in comparing high grade from low grade gliomas, recurrent tumor from radiation necrosis.

**KEY WORDS:** Perfusion MRI, T2* DSC MRI, brain

**Electronic Scientific Exhibit 20**

**Comparison and Characterization of Signal Intensity Curves Derived from T1 DCE MR Imaging Versus T2* DSC MR Imaging in Patients with Enhancing Intracranial Lesions**

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¹Mount Sinai School of Medicine, New York, NY, ²Image Memorial - DASA, Salvador, Bahia, BRAZIL

**PURPOSE**

Perfusion can be characterized by using T2* DSC MR imaging signal intensity curves and steady state T1 DCE MR imaging. The T1 DCE MR imaging is a longer steady state acquisition whereas the T2* DSC MR imaging is a first pass acquisition without reaching the steady state phase. It has been demonstrated that lesions with a very high permeability show less percentage of recovery of the signal intensity curve when compared to lesions with low permeability in T2* DSC MR imaging. The purpose of this study is to compare the T2* DSC MR imaging signal intensity curves with steady state T1 DCE MR imaging in patients with enhancing intracranial lesions.

**APPROACH/METHODS**

We performed a retrospective review of 32 patients (18 male and 14 female; median age, 54 years; range), diagnosed by histopathology with grade II, III and IV astrocytomas, as defined by the World Health Organization (WHO) criteria, meningiomas, radiation necrosis and metastatic disease. The 2D FSE steady state T1-weighted acquisition followed by the first pass gradient-echo T2*-weighted DSC MR imaging were performed as part of the routine protocol in our institution. We compared the signal intensity curves obtained by using T2* DSC MR imaging with the maximal upslope curve obtained by using steady state T1 DCE MR imaging.

**FINDINGS/DISCUSSION**

Our preliminary data suggests that T2* DSC MR perfusion imaging signal intensity curves correlate with maximal upslope T1 DCE MR imaging in enhancing intracranial lesions regarding the vascular phase. However, T2* DSC MR imaging percentage of recovery seems to not directly correlate with the steady state T1 DCE MR imaging signal intensity curves regarding the leakage phase (delayed acquisitions).

**SUMMARY/CONCLUSION**

The leakage (steady state) phase of the T1 DCE MR imaging signal intensity curves did not correlate with the T2* DSC MR imaging percentage of recovery. This finding suggests that the leakage phase of these two acquisitions represents different hemodynamic properties of enhancing brain lesions and that prolonged steady state T1 DCE MR imaging provides additional information not yet completely understood.

**KEY WORDS:** T1 DCE MRI, T2* DSC MRI, brain perfusion

**Electronic Scientific Exhibit 21**

**Whole Brain CT Perfusion on New 320 Slice CT Scanner: Pictorial Review**

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Ottawa, ON, CANADA

**PURPOSE**

CT perfusion has been criticized because of the limited brain coverage. This may result in inadequate coverage of the lesion, inadequate arterial input function or omission of the lesion within the target perfusion volume. The availability of new 320 slice CT scanners confers whole brain coverage. We present a variety of clinical scenarios in which whole brain CT perfusion is especially useful.

**APPROACH/METHODS**

We retrospectively reviewed 30 cases in which whole brain perfusion was performed on a 320 slice Toshiba CT scanner for various clinical indications. CT perfusion was performed using 50 ml of contrast at the rate of 4 ml/sec. Twenty volumes of the brain were acquired at the rate of one volume every 2 seconds for 24 seconds followed by one volume every 5 seconds for another 20 seconds with an acquisition delay of 7 seconds. The acquisition parameters were 80 KV and 100 mA with a rotation time of 1 second. The postprocessing of all perfusion studies was on a Vitrea fx version 1.0 workstation (Vital Images Inc., Minnesota) using singular value decomposition (SVD) plus deconvolution method.

**FINDINGS/DISCUSSION**

CT perfusion on a 320 slice CT scanner has a similar advantage of whole brain coverage compared to MR perfusion. This minimizes the chance of misregistration of lesions regardless of location. The arterial input function can be
selected easily. The relative delay in the blood flow between
the vertex and base also is compensated by the SVD plus
method. This limits measurement of absolute values as it
underestimates the cerebral blood flow in normal gray mat-
ter. Relative values may address this issue rather than obtain-

ing absolute values. Crossed cerebellar diaschisis which is
observed in SPECT and MR perfusion also is demonstrated
in cases of large unilateral cerebral hemispheric lesions.

SUMMARY/CONCLUSION
This presentation highlights the added advantage and impli-
cations of whole brain perfusion compared to standard limit-
ed CT perfusion volumes in older generation scanners.

KEY WORDS: CT perfusion, volume acquisition, crossed
cerebellar diaschisis

Electronic Scientific Exhibit 22
Diagnostic Applications of Cerebrospinal Fluid Flow
Imaging

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Birmingham, AL

PURPOSE
This electronic exhibit will illustrate the diagnostic utility of
MR cine phase contrast cerebrospinal fluid (CSF) flow
imaging in a variety of pathologic conditions.

APPROACH/METHODS
MR cine CSF flow imaging was performed to evaluate a
variety of pathologies associated with abnormal CSF flow. A
flow encoding of VENC = 5 cm/sec was employed. The
direction (AP, SI, or RL) of flow encoding was chosen
according to the anticipated direction of CSF flow.

FINDINGS/DISCUSSION
We have found cine CSF flow imaging to be very useful in
the evaluation of a variety of conditions that adversely affect
CSF flow. We will illustrate application of the technique for
evaluation of CSF flow obstruction (aqueductal stenosis,
Chiari malformations) as well as for assessment of third ven-
triculostomy patency, for evaluation of flow in cranial and
spinal pseudomeningoceles, and for the evaluation of
intracranial arachnoid as well as spinal meningeal cysts.

SUMMARY/CONCLUSION
MR cine flow imaging is a simple yet robust technique that
is useful in evaluating many common clinical problems that
adversely affect CSF flow.

KEY WORDS: CSF flow, CSF leak, hydrocephalus

Electronic Scientific Exhibit 23
PROPELLER FLAIR of the Brain Compared with
Standard FLAIR: Clinical Usefulness and Limitations
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Mie University School of Medicine
Tsu, JAPAN

PURPOSE
Periodically rotated overlapping parallel lines with enhanced
reconstruction (PROPELLER; BLADE) techniques have
been proposed to reduce the effects of head motion. Preliminary results have shown that PROPELLER also
reduces pulsation artifacts from venous sinuses. The aim of
our exhibition is to demonstrate clinical usefulness and lim-
itations of PROPELLER FLAIR in comparison with stan-
dard FLAIR.

APPROACH/METHODS
Consecutive 73 patients who gave consent were included in
a prospective comparison of PROPELLER and standard
FLAIR sequences. Central nervous system (CNS) diseases
included infarction, multiple sclerosis, tumors, and miscella-
nous lesions. All examinations were performed at 1.5 T
with comparison of standard T2-weighted FLAIR to PRO-
PELLER T2-weighted FLAIR in the axial image orienta-
tion. Imaging protocols were matched for spatial resolution, with
data evaluation by two experienced neuroradiologists. Image
data were compared qualitatively and quantitatively regard-
ing various image artifacts [motion, cerebrospinal fluid
(CSF) flow, pulsation, and metal artifacts] and overall image
quality (lesion conspicuity and lesion detectability).

FINDINGS/DISCUSSION
Qualitatively, PROPELLER FLAIR showed significantly
less motion, CSF flow, and pulsation (particularly from
transverse sinuses) artifacts than the standard FLAIR. In two
patients with artificial denture, PROPELLER FLAIR
showed less metal artifacts than the standard FLAIR.
Standard FLAIR was more superior in lesion conspicuity to
PROPELLER FLAIR, but the two methods were not signifi-
cantly different in lesion detectability. Quantitatively, pre-
pontine CSF/pons contrast (pons signal - preponsine CSF
signal/pons signal) was significantly higher in PROPELLER
FLAIR than standard FLAIR, indicating less CSF artifacts in
PROPELLER FLAIR. On the other hand, lesion contrast
(lesion signal - adjacent normal parenchymal signal/adjacent
normal parenchymal signal) was significantly lower in PRO-
PELLER FLAIR than the standard FLAIR.

SUMMARY/CONCLUSION
PROPELLER FLAIR had disadvantage in lesion conspicu-
ity compared with the standard FLAIR. However, PRO-
PELLER FLAIR significantly reduces various artifacts
including motion, pulsation, metal and CSF flow artifacts,
which appear advantageous particularly in unsedated chil-
dren or emergent patients. PROPELLER has the potential to
replace the standard FLAIR in the unsedated patients.

KEY WORDS: PROPELLER, BLADE, FLAIR
Evaluation of Dural Sinus Invasion in Patients with Meningiomas: Subtraction CT Angiography Using Color-Coded Volume Rendering Technique and Multplanar Reformatted Images

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PURPOSE
To show the usefulness of subtraction computed tomographic angiography (CTA) for evaluation of dural sinus invasion by meningiomas and to introduce the optimized scanning and postprocessing technique to display 3-dimensional volume rendering (VR) images of dural sinuses and meningiomas.

APPROACH/METHODS
Twenty-five patients (8 men and 17 women; mean age, 50 years) who had intracranial meningiomas were included in this study. CT angiography and digital subtraction angiography (DSA) were performed in all patients for preoperative evaluation. CT angiography was obtained 45 seconds after contrast infusion to visualize meningiomas and dural sinuses. The optimal scan delay was determined on the basis of the time-attenuation curves obtained by placing the region of interest at the intracranial artery, superior sagittal sinus and meningioma. Volume rendering and coronal multilplanar reformatted (MPR) images were reconstructed from bone-subtracted axial source images. To facilitate the differentiation of meningiomas and vascular structures, each structure was color-coded differently on volume rendering images. Degrees of dural sinus invasion by meningioma were evaluated on VR images and coronal MPR images and categorized into 4 groups: intact, compression, partial invasion, and complete occlusion. CT angiography findings were correlated with DSA findings as a reference standard.

FINDINGS/DISCUSSION
Among 25 patients with meningioma in various locations, six patients had intact dural sinus, three had compression, eight had partial invasion, and eight showed complete occlusion on VR images and MPR images. DSA showed seven intact dural sinuses, three compressions, eight partial invasions and seven complete occlusions. The degree of invasion on CTA correlated well with the results of DSA (r = 0.836, p < 0.0001).

SUMMARY/CONCLUSION
Our acquisition and display technique using subtraction CTA, color-coded VR technique, and MPR images proved to be useful in evaluating the dural sinus invasion by meningioma. This noninvasive technique may replace invasive DSA in many cases of meningiomas for the surgical planning.

KEY WORDS: Subtraction computed tomographic angiography, meningioma, intradural sinus invasion

Clinical Utility of Dynamic Subtracted Computed Tomographic Angiography with 320 Multislice Volume CT in Neuroradiology

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PURPOSE
Dynamic subtracted computed tomographic angiography (dsCTA) offers a noninvasive technique to acquire a time series of CT angiography images of the whole brain, thus removing timing uncertainties found in typical static CTA images and also provides temporal flow information. We demonstrate the clinical utility of dsCTA using a 320 multislice volume CT in depicting various neurovascular diseases.

APPROACH/METHODS
We prospectively recruited 31 patients from May 2008 until November 2008 with various neurovascular diseases including eight arteriovenous malformations (AVMs), one arteriovenous fistulae (AVFs), two moyamoya disease, one dural venous thrombosis, 14 internal carotid arteria (ICA) stenoses, two subelavian artery stenoses, two posturgical superficial temporal artery (STA)-middle cerebral artery (MCA) bypass and one brain death to undergo dsCTA on a 320 multislice volume CT. The dynamic nature of dsCTA is illustrated with cine images. All patients with vascular malformations had catheter digital subtraction angiography (cDSA) for correlation.

FINDINGS/DISCUSSION
A concise explanation of the physics of dsCTA and our acquisition techniques using a 320 multislice volume CT will be described. In cases of vascular malformations (AVMs and AVFs), dsCTA demonstrates arterial feeders and venous drainage patterns shown on cDSA and allows for lesion localization, enabling hemodynamic and morphologic appreciation of these lesions. The dynamic nature of dsCTA enables one to distinguish occluded versus near-occluded internal carotid artery and dural venous sinus stenoses. We illustrate a case of near-occluded ICA on dsCTA which appeared occluded on conventional static CTA which had important clinical implications. We demonstrate steal phenomenon in a case of subelavian arterial stenosis and patency of STA-MCA bypass in two cases with this new technique. Dynamic subtracted computed tomographic angiography appearance of a patient with suspected brain death is illustrated. The pitfalls and limitations of dsCTA technique are discussed.

SUMMARY/CONCLUSION
Dynamic subtracted computed tomographic angiography adds a second dimension to routine CTA enabling one to appreciate vascular flow characteristics over time. It is therefore a valuable tool in depicting various neurovascular diseases allowing for precise localization and temporal resolution of these lesions.

KEY WORDS: Dynamic subtracted computed tomographic angiography, 320 multislice volume CT
PURPOSE
Lack of adequate neuroimaging sensitivity and spatial resolution, so far, impeded depiction of visual pathways within the brain. The purpose of the current study is to demonstrate the feasibility of parcellation of optic tract and optic radiation in relation to the gray matter nuclei using fiber tractography by deterministic approach and high spatial resolution DTI data on 3 T.

APPROACH/METHODS
Visual neural pathways include optic nerves, optic chiasma, optic tract and optic radiations. This system consists of two neuron chains: optic nerve fibers which project from retina to the lateral geniculate nucleus (LGN) of the thalamus and second neurons which originate from LGN and project to the visual cortex. Diffusion tensor tractography of white matter connections between the cortex and deep gray matter structures is challenged by the signal-to-noise ratio (SNR) due to overestimation of anisotropy at low SNR and partial volume averaging upon using large voxel volumes. Recent DTI tractography studies have used 7T and 9T scanners for visualizing the neuronal fiber trajectories in primate and human visual system. This work aimed to demonstrate the feasibility of in vivo quantification and visualization of human visual pathways in relation to the gray matter nuclei (LGN) on 3T. We also show the ability to separate and quantify the tract volume and corresponding diffusion tensor metrics of optic tract and optic radiations. Subjects: Five healthy men (age range 24-37 years) were studied and written informed consent was obtained from all subjects. Conventional and DT-MRI Acquisition: Data were acquired using a Philips 3.0 T Intera system using a SENSE receive head coil. Diffusion-weighted image (DWI) data were acquired axially using single-shot multi-slice 2D spin-echo diffusion with the balanced Icosa21 tensor encoding scheme. The b-factor = 500 sec mm⁻², TR/TE = 14460/60 msec, FOV = 256 mm x 256 mm and slice thickness / gap / #slices = 1 mm / 0 mm / 120. The EPI phase encoding used a SENSE k-space undersampling factor of two, with an effective k-space matrix of 112x112 and an image matrix after zero-filling of 256x256. Fiber Tracking: We used the FACT algorithm (DTIStudio) to reconstruct optic chiasma and tracts with a fractional anisotropy (FA) threshold of 0.22 and angle threshold of 60 degrees.

FINDINGS/DISCUSSION
To our knowledge, the current study is the first to present the optic chiasma and optic tract using high spatial resolution DTI measurements on 3T. The optic chiasma and optic tract are clearly distinguishable and we also demonstrated the relationship of optic tract and radiations with gray matter nuclei (LGN of the thalamus). Using high spatial resolution specially reduced slice thickness (1mm) in this study, reduced the partial volume effect as well as incoherency due to the fiber intercrossings within each voxel and we were able to reconstruct and show the whole visual trajectories by deterministic approach.

SUMMARY/CONCLUSION
In this report we demonstrated that using higher resolution along with thinner slices reduce the partial volume effect and enabled us to show for the first time the whole visual pathways in vivo on 3T.

KEY WORDS: Diffusion tensor, tractography, high resolution

Electronic Scientific Exhibit 27

Combined Gadolinium-Enhanced MR Cisternography and Multidetector CT in the Evaluation of Patients with Rhinorrhea and Suspected Dural Leaks: At Last We Can See the Cerebrospinal Fluid Leak!

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PURPOSE
Radiologic localization of a cerebrospinal fluid (CSF) leak is often a significant diagnostic challenge but it is very helpful for guiding surgical planning and repair. CT cisternography has long been considered the best diagnostic modality for diagnosing this condition. However, this technique has the limitations of excessive radiation exposure due to repeated acquisitions and potential iodinated contrast allergy. Gadolinium-enhanced MR cisternography (GEMRC) is as time consuming as CT cisternography but mitigates its inherent limitations. The aim of our study is to demonstrate that GEMRC combined with multidetector CT images (MDCT) may be an accurate tool in the diagnosis of CSF leaks.

APPROACH/METHODS
Six consecutive patients clinically suspected of having CSF leaks were studied prospectively with GEMRC followed by MDCT. Half of them had a previous history of trauma. Lumbar puncture was performed and a solution (saline + 0.5 ml of gadolinium) was injected intrathecally. Each patient was immobilized in several positions on a special bed for 10 minutes. Thin T1-weighted fat-suppression images were performed 60° and 120° after injection in the three orthogonal planes. MDCT subsequently was performed with 1 mm slices to assess bone structures at the skull base. The findings on GEMRC and MDCT were compared. Surgical findings then were correlated with the radiographic findings.

FINDINGS/DISCUSSION
We observed objective CSF leak on GEMRC in all six patients. Contrast extravazation due to the defects were demonstrated only in the delayed acquisitions (120°). MDCT complemented the findings on GEMRC showing tiny bone defects in the suspected areas of CSF leak. Without the GEMRC, the tiny bone defects easily could have been mistaken to be anatomical variants or vascular channels. One patient developed headache for the first 24 hours. Surgical findings confirmed the correct diagnosis and localization in all patients.
SUMMARY/CONCLUSION
In patients clinically suspected of CSF leaks, combined GEMRC and MDCT is highly accurate in the localization of CSF leaks.

KEY WORDS: Gadolinium-enhanced MR cisternography, CSF leak, multidetector CT

Electronic Scientific Exhibit 28
Glioma Diagnosis and Grade: Quantitative MR Imaging Biomarkers
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PURPOSE
To improve the reader’s diagnostic accuracy of glioma. Cases of patients undergoing quantitative MR imaging are shown. On completion the reader will be able to: 1. Understand how quantitative imaging differs from conventional imaging; 2. Describe quantitative glioma MR imaging techniques; 3. Discuss characteristic glioma findings to aide diagnosis and grading [dynamic susceptibility contrast MR imaging (DSC-MRI), apparent diffusion coefficient (ADC) and MRS].

APPROACH/METHODS
Interesting cases will be presented in an illustrated quiz format. Key points will be highlighted in each case. Included is: 1. Discussion of quantitative MR imaging techniques; 2. Description of the key findings to aide diagnosis and grading.

FINDINGS/DISCUSSION
Imaging techniques discussed include dynamic susceptibility contrast MRI (DSC-MRI), ADC and spectroscopy (MRS). Dynamic susceptibility contrast MRI is described [cerebral blood volume (rCBV), relative cerebral blood flow (rCBF) and mean transit time (MTT) derived from the kinetics of signal intensity]. The differentiation of glioma from abscesses and metastasis is discussed - in particular the relationships between ADC value and glioma necrosis; rCBV values and high grade gliomas; choline, NAA, lactate and mobile lipid peak values and gliomas. The importance of peritumoral region analysis is highlighted. The differentiation of grades is discussed - in particular the relationships between rCBV, K\text{trans}, myoinositol, lactate, lipid, choline and NAA values and grade of glial tumor. The quantitative MR imaging findings in glioblastoma and oligodendrogliomas are described. In addition the biomarkers of presurgical survival and malignant transformation are discussed.

SUMMARY/CONCLUSION
Quantitative biomarkers reveal noninvasive insights into metabolic and physiologic processes associated with tumor growth, blood flow and ultrastructure. Quantitative biomarkers are used for tumor characterization and prognosis, and evaluating treatment response. Conventional imaging provides useful nonquantitative structural information, but limited physiologic detail. Angiogenesis is a key feature of high grade glioma. Relative cerebral blood flow correlates with angiographic and histological markers of tumor vascularity. Key metabolites are choline-containing compounds (Cho), N-acetyl aspartate (NAA) lactate, myoinositol and mobile lipid moieties which are associated with necrosis. Apparent diffusion coefficient, but not diffusion-weighted imaging (DWI), is a glioma biomarker. Definitive diagnosis lies with histological examination of tissue.

KEY WORDS: Glioma, oligodendroglioma, quantitative

Electronic Scientific Exhibit 29
MR Imaging of Primary Central Nervous System Lymphomas
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PURPOSE
To describe the usual and unusual imaging findings of primary central nervous system lymphomas on CT and MR imaging including diffusion-weighted imaging, perfusion imaging and MR spectroscopy.

APPROACH/METHODS
A retrospective review of 15 biopsy-proved cases of primary CNS lymphomas (PCNSL) were performed. Nine patients were immunocompetent and four patients were immunosuppressed. All patients underwent MR examinations including axial T1 pre and postcontrast, T2, FLAIR and diffusion-weighted imaging. Twelve patients had axial T2 GRE perfusion-weighted imaging and six patients had MR spectroscopy using TE=135.

FINDINGS/DISCUSSION
In our series, PCNSL most commonly present as multiple solid enhancing lesions in the subcortical region, periventricular region or corpus callosum. Lesions in the subcortical region often do not cause significant mass effect and follow the U fibers. This pattern of enhancement could help distinguish lymphoma from metastasis or glioblastoma multiforme. Primary CNS lymphoma lesions can involve exclusively the middle cerebellar peduncles or corpus callosum which can mimic the presentation of a demyelinating process. One patient who was immunocompromised had a ring-enhancing lesion involving the basal ganglia which can be indistinguishable from an abscess on conventional imaging. On diffusion-weighted imaging, the average apparent diffusion coefficient (ADC) ratio between the tumor and normal white matter was 1.1 in our series. Some early lymphomatous lesions do not show restricted diffusion. On perfusion-weighted imaging, we observed a PBP (percentage baseline at peak) ratio of 0.74 between lymphomatous lesions and normal white matter. There was a wide range of PBP values among patients and sometimes between different lesions in the same patient. We have found a mean choline/creatine ratio of 1.5. This could help differentiate
between lymphomas and high grade glioma as we have observed a higher choline/creatine ratio in gliomas (mean was 2.5).

**SUMMARY/CONCLUSION**

Lymphomas can have variable appearance and location in the central nervous system. Not all lesions (especially small early lesions or ring-enhancing lesions) show restricted diffusion or increased vascularity as described in prior studies in the literature.

**KEY WORDS:** Lymphoma, neoplasm, perfusion

Electronic Scientific Exhibit 30

**Variable Appearance of Primary Lymphoma of the Central Nervous System: Imaging Features**

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**PURPOSE**

Primary central nervous system lymphoma (PCNSL) is defined as lymphoma limited to the cranial-spinal axis without systemic disease. The incidence of PCNSL in immunocompromised patients has significantly increased and is highly associated with Epstein Bar virus (EBV) infection. However, its incidence also has increased in immunocompetent patients for unknown reasons. Neuroimaging is integral for the diagnosis of PCNSL and to monitor treatment. Radiologic features of PCNSL are varied and can mimic many other pathologic processes. The purpose of this exhibit is to illustrate and describe the various imaging features of PCNSL.

**APPROACH/METHODS**

We retrospectively identified patients with confirmed diagnosis of PCNSL from our radiology database in both immunocompetent and immunocompromised patients. Imaging was performed using CT and/or MR imaging in all patients. Advanced MR imaging techniques like MR spectroscopy were available in few patients. We reviewed the imaging features of PCNSL with respect to the number, size, contrast enhancement and distributions of these lesions along with signal characteristics on conventional T1- and T2-weighted images as well as diffusion-weighted images. The characteristic imaging features of common clinical mimickers of PCNSL like high-grade glioma, metastatic disease and opportunistic infections also were reviewed and compared.

**FINDINGS/DISCUSSION**

There is a wide spectrum of imaging findings of PCNSL. The most common findings in our patients include solitary or multiple lesions located in the cerebral hemispheres, the basal ganglia and the corpus callosum. The majority of the lesions demonstrated enhancement, which vary from ring-like or irregular enhancement in immunocompromised patients to irregular or avid enhancement in immunocompetent patients. Diffusion-weighted images can provide additional information by demonstrating restricted diffusion. Primary central nervous system lymphoma generally tend to cause less edema than glioma or metastases of the same size. Less commonly seen areas of involvement in PCNSL are lesions in the posterior fossa or the spinal canal, involvement of the cranial nerves and white matter spread.

**SUMMARY/CONCLUSION**

Despite the wide spectrum of the imaging features of PCNSL, imaging often suggest the diagnosis, especially if the lesions are multifocal located adjacent to cortical convexities or ventricular surfaces. There is, however, an overlap of some of the imaging features with other disease entities such as primary gliomas or opportunistic infection causing a diagnostic dilemma. Nonradiologic investigations should be performed to exclude other pathologic entities and when needed, histology may be the only way of confirming the diagnosis.

**KEY WORDS:** Lymphoma, CNS

Electronic Scientific Exhibit 31

**Diffusion-Weighted MR Imaging in the Study of Brain Tumors**

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**PURPOSE**

Diffusion-weighted (DW) magnetic resonance imaging (MRI) provides information on water diffusion within tissues. Diffusion-weighted MR imaging has been used to study brain tumors and its diagnostic potential and usefulness for obtaining the apparent diffusion coefficient (ADC) have been reported. The aim of this study was to determine if ADC values could be used to differentiate brain tumors.

**APPROACH/METHODS**

A total of 64 patients with untreated brain tumors underwent MR examination including conventional MRI and DW MRI. Imaging was performed with a 1.5 T scanner (GE Healthcare, IL, WI, USA). MR imaging exam included axial T2-weighted, arterial FLAIR and axial T1-weighted images before and after contrast injection. Unenhanced transverse DW MRI was performed using single-shot T2-weighted echo-planar spin-echo sequence. After brain surgery histological analysis was performed. Imaging data were transferred to a workstation and processed with the program Functool (GE Healthcare, IL, WI, USA) for calculation of ADC maps. The ADC was measured manually placing regions of interest in solid components of the tumor, excluding cystic, necrotic and hemorrhagic areas using the other MR anatomical images for guidance. We performed statistical analyses (ANOVA) and a p value of less than 0.05 was considered as statistically significant.

**FINDINGS/DISCUSSION**

After brain surgery the tumor type was confirmed to be: 24 glioblastomas (GBM), 13 meningiomas, 8 astrocytomas, 6 metastases, 4 ependymomas, 3 oligodendrogiomas, 2 astrocytomas pilocytic, 2 lymphomas, 1 medulloblastoma, and 1 PNET. Mean ADC values calculated for each tumor type were analyzed using ANOVA. A p value of less than 0.05 was considered statistically significant. After brain surgery the tumor type was confirmed to be: 24 glioblastomas (GBM), 13 meningiomas, 8 astrocytomas, 6 metastases, 4 ependymomas, 3 oligodendrogiomas, 2 astrocytomas pilocytic, 2 lymphomas, 1 medulloblastoma, and 1 PNET. Mean ADC values calculated for each tumor type
were as follows: astrocytoma pilocytic=1298x10^-6 mm^2/s; PNET=1030x10^-6 mm^2/s; astrocytoma= 966x10^-6 mm^2/s; metastasis=928x10^-6 mm^2/s; meningioma=926x10^-6 mm^2/s; oligodendroglioma=895x10^-6 mm^2/s; GBM=877x10^-6 mm^2/s; ependimoma=725x10^-6 mm^2/s; lymphoma=646x10^-6 mm^2/s and medulloblastoma=619x10^-6 mm^2/s. We found that ADC values may be useful for differentiating between lymphomas and GBM as observed in others reports (1, 2), as it appears to be a correlation of higher ADC with higher cellularity in lymphomas. Although ADC values were higher in metastases and low-grade astrocytomas than in GBM, this difference did not reach statistical significance in order to discriminate among them. This finding was consistent with a previous report (3) and probably results from the substantial overlap in ADC values among different grades of glioma, and even within the single given tumor, due to its inherent heterogeneity.

**SUMMARY/CONCLUSION**

Our results show that the ADC value may be useful for differentiating between lymphoma and GBM, ependymoma and PNET, and ependymoma and astrocytoma pilocytic.

**REFERENCES**


**Electronic Scientific Exhibit 32**

**Extraventricular Neurocytoma and Ganglioneurocytoma: Advanced MR Imaging, Histopathologic, and Genetic Findings**

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**PURPOSE**

Extraventricular neurocytoma and extraventricular ganglioneurocytoma are very rare tumors. Little is known about the advanced MR imaging and genetic abnormalities of these tumors. We describe the conventional and advanced MR imaging, histopathologic, immunohistochemical, and chromosomal findings in two patients with extraventricular neurocytoma and extraventricular ganglioneurocytoma, some features which have not been described previously.

**APPROACH/METHODS**

Two patients with confirmed diagnosis of extraventricular neurocytoma and ganglioneurocytoma were evaluated. Conventional MR imaging, short TE proton MR spectroscopic imaging (MRSI), and dynamic T2* susceptibility MR perfusion with relative tumor blood volume (rTBV) determination was performed. Histologic examination of the resected tumors, various immunohistochemical stains, Ki-67 proliferation index, and cytogenetic tumor analysis by fluorescent in-situ hybridization (FISH) also were determined in these tumors.

**FINDINGS/DISCUSSION**

The lesions demonstrated heterogenous enhancing supratentorial mass lesions. Both tumors demonstrated a markedly elevated rTBV greater than 7.5 compared to normal contralateral white matter. In extraventricular neurocytoma, proton MRSI showed significantly increased Cho/Cr ratio (3.6 vs 0.66) and decreased NAA/Cr ratio (1.66 vs 2.33) compared to the normal contralateral white matter. Proton MRSI demonstrated increased choline/creatinine (Cho/Cr) ratio (1.26 vs 0.65) and preserved NAA/Cr (1.68 vs 1.70) ratio. Histologic examination revealed neoplastic neuronal cells with strong immunoreactivity for synaptophysin, but no GFAP (glial fibrillary acidic protein) expression. Oligodendroglial-like cells with perinuclear halos, characteristic of a central neurocytoma were observed in both patients. In addition, cells with abundant eosinophilic cytoplasm were observed in the patient with ganglioneurocytoma. Multinucleated neoplastic neurons, demonstrated by neurofilament stains, were present in ganglioneurocytoma, indicating a mature neuronal component. Ki-67 staining showed proliferation indices of 3-5%. Cytogenetic tumor analysis by fluorescent in situ hybridization (FISH) revealed 1p19q chromosomal codeletion in both tumors.

**SUMMARY/CONCLUSION**

Extraventricular neurocytoma and ganglioneurocytoma are rare tumors which should be considered in differential diagnoses of more common parenchymal brain neoplasms. Finding of elevated Cho/Cr in combination with preserved NAA/Cr ratios may be a clue to differentiate ganglioneurocytoma from other tumors. Presence of very high rCBV in these neoplasms and its association with 1p19q deletion should be further confirmed in future studies.

**KEY WORDS:** Neurocytoma, ganglioneurocytoma, extraventricular

**Electronic Scientific Exhibit 33**

**Schistosomiasis Mansoni as a Cause of Hyperintense Basal Ganglia**

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**PURPOSE**

The purpose of this study is to describe basal ganglia (BG) bilateral symmetric hyperintensity on T1-weighted images (T1WI) at magnetic resonance imaging (MRI) in young
patients with hepatosplenic schistosomiasis mansoni (HSM), without neurologic symptoms.

**APPROACH/METHODS**

This study included eight young individuals, ranging in age from 9 to 19 years. All patients came from endemic regions for schistosomiasis mansoni (SM) and previously had been treated with oxamniquine as well as undergone splenectomy, ligature of the left gastric vein and auto-implantation of spleen tissue. All of them underwent neurologic evaluation and were scanned on a 1.5 T system. Multiplanar T2WI, T1WI and FLAIR images were obtained and the reports were done by two radiologists after a consensus review. Liver function tests also were performed at the time of the brain MRI exams.

**FINDINGS/DISCUSSION**

The MRI exams showed symmetric hyperintense globus pallidus in seven patients associated with symmetric hyperintense cerebral peduncles in six. In one patient only the cerebral peduncles were affected. Associated periaqueductal T1 hyperintensity was observed in two patients. The pituitary gland appeared hyperintense on T1WI in one patient. All liver function tests were normal and their neurologic evaluations were within normal limits.

**SUMMARY/CONCLUSION**

To the best of the authors’ knowledge, this abnormality has been reported only once in a patient with HSM who developed porto-systemic encephalopathy. These findings suggest that SM should be included in the differential diagnosis of hyperintense BG and that this abnormality can be found even in patients without overt neurologic symptoms and with normal liver function tests.

**KEY WORDS:** Schistosomiasis mansoni, brain, MRI

**Electronic Scientific Exhibit 34**

**Marker Metabolite Peaks on Proton MR Spectroscopy of Brain Lesions**

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**PURPOSE**

To demonstrate some of the specific metabolite peak patterns in diverse lesions of the brain on proton MR spectroscopy.

**APPROACH/METHODS**

Many different cases of genetic/metabolic, infective, inflammatory and neoplastic lesions and their mimics were studied with multivoxel MR spectroscopy at TE 30, 135 ms and wherever possible at 270 ms using a PRESS sequence. In metabolic cases a single voxel spectroscopy with TE 144ms and when needed with 31 ms were used. Only the cases with specific/relatively specific MR imaging and spectroscopic patterns are included. The metabolic conditions included congenital lactic acidosis, nonketotic hyperglycinemia, maple syrup urine disease, mitochondrial disorders. Infections included tuberculomas, tuberculous abscesses, parenchymal cysticercosis, racemose cysticercosis, pyogenic abscesses, chronic sterile abscess and cryptococcosis. Tumefactive demyelinating lesions also were included. Tumors studied were meningiomas, central neurocytomas, medulloblastomas including desmoplastic medulloblastoma, gliomas, colloid cysts and metastatic lesions. Histopathologic correlation was obtained whenever possible.

**FINDINGS/DISCUSSION**

Congenital lactic acidosis and various mitochondrial disorders showed lactate as a prominent peak at 1.33 ppm. 1-2 Propane diol used in phenobarbital preparation showed a separate peak at 1.1 ppm. Nonketotic hyperglycinemia showed a glycine peak at 3.56 ppm and MSUD demonstrated the cytosolic amino acids at 0.9 ppm. Tuberculomas and tuberculous abscesses showed a prominent lipid peak. Cysticerci, especially racemose cysts showed the presence of lactate, alanine, acetate and succinate. The pyogenic abscesses were characterized by cytosolic amino acids, lactate, alanine, acetate, succinate and glycine. Chronic sterile abscesses showed only prominent lactate peak. Tumefactive demyelinations showed graded increase in choline and lactate in the different portions of the lesion and also demonstrated a high GLX. Some meningiomas demonstrated a small alanine peak in addition to lactate. Central neurocytomas showed presence of alanine and glycine. Classical and desmoplastic variant of medulloblastomas demonstrated a peak at 3.56 on TE 30 ms attributed to myoinositol, and the classical taurine peak was seen in only in one case. In addition all these showed very high Cho/Cr ratio. Gliomas showed high Cho/Cr ratio, but was not proportional to the grade of malignancy. Some also showed lactate/lipid peaks. Metastatic lesions showed moderately high Cho/Cr ratio and a lipid peak. The colloid-like cysts showed a consistent peak at 2.02 ppm attributable to the presence of N-acetyl sugars.

**SUMMARY/CONCLUSION**

It is possible to detect somewhat characteristic metabolite patterns in many metabolic, infective, inflammatory and neoplastic lesions of the brain using H1 MRS. This differentiation may be very important for reaching a specific diagnosis.

**KEY WORDS:** MR spectroscopy, metabolites, brain

**Electronic Scientific Exhibit 35**

**Role of Blood Oxygen Level Dependent Functional MR Imaging and Diffusion Tensor Imaging in Presurgical Planning of Brain Tumors**

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**PURPOSE**

The authors emphasize the power of the combined use of the techniques blood oxygen level dependent (BOLD) functional MR imaging (fMRI) and diffusion tensor imaging (DTI) in the preoperative evaluation of brain tumors.
**APPRAOCH/METHODS**
From a pictorial review of BOLD fMRI and DTI examinations of 25 patients presenting with intracranial tumors, the best cases were selected to show clearly the benefits of those methods. All cases underwent surgery and clinical/radiologic follow up were performed as well.

**FINDINGS/DISCUSSION**
This pictorial review provides a brief discussion about the clinical applications of the BOLD and DTI techniques in the presurgical evaluation of brain tumors. The following will be discussed: 1) a technical overview; 2) role of BOLD fMRI and DTI to demonstrate the important functional areas and major tracts that should be preserved in surgical approaches of brain tumors. Key anatomical brain structures were demonstrated by BOLD fMRI and DTI in all our cases. Clinical and radiologic follow ups were performed in order to demonstrate preservation of the specific brain functions evaluated. From the 25 studied patients, seven cases were selected to show clearly the benefits of those methods. The surgical approach was changed in 40% (3) of these cases taking into account BOLD fMRI findings. Clinical preservation of brain functions were demonstrated in 95% (6) of those cases.

**SUMMARY/CONCLUSION**
This review illustrates that presurgical fMRI and DTI are promising noninvasive clinical tools in the evaluation of patients with brain tumors, providing crucial information about eloquent areas and white matter tracts for surgical planning.

**KEY WORDS:** Bold, DTI, tumor

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**Electronic Scientific Exhibit 36**

**Diffusion Tensor Tractography for Different Types of Ataxia**

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**PURPOSE**
Diffusion tensor imaging (DTI) is a powerful technique that allows one to image white matter tracts in the brain. Although a great deal of work has evaluated the supratentorial brain, DTI tractography of the brainstem is a relatively new endeavor. Furthermore, little published research has utilized tractography to examine the anatomical changes seen in various ataxias that affect the brainstem and cerebellum. The assessment of these anatomical alterations may provide insight into new methods of both diagnosis and treatment.

**APPROACH/METHOD**
Using 1.5 T MR imaging (Siemens Sonata), we scanned eight normal volunteers and eight patients with clinically similar subtypes of ataxia. Diffusion tensor imaging was performed which consists of an axial 2D EPI diffusion-weighted sequence acquired with diffusion gradients along six non-collinear directions at a b value of 600 and 1200 sec/mm². The data were obtained using DTI studio, an imaging process program developed by Laboratory of Brain

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**Electronic Scientific Exhibit 37**

**Double Inversion Recovery in Patients with Refractory Epilepsy**

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**PURPOSE**
The purpose of this study was to identify the role of double inversion recovery (DIR) sequence, that has been suggested to improve the sensitivity in finding lesions with low T2 contrast in the identification of lesions in patients with refractory epilepsy.

**APPROACH/METHOD**
Fourteen patients with refractory epilepsy have been studied in a 3 T scan, using a specific protocol that includes 2D coronal T2-weighted imaging TSE (3mm slice, matrix 384 x 384 and FOV 213 x 189); 2D FLAIR (3 mm slice, matrix 228x 256 and FOV 213 x 190); and 3D coronal DIR (1 mm slice , matrix 192 x 192 and FOV 225 x 199). Detection of lesions, suspected etiologic and evaluation of which sequence was better to characterize the lesion were done using visual...
inspection by an experienced neuroradiologist. The radiologic findings were correlated with clinical, EEG, PET or SISCOM studies.

**FINDINGS/DISCUSSION**

Only 25 patients have shown lesions in almost one of the three sequences [14 patients with mesial sclerosis (6 of them with dual pathology), 7 patients with malformation of cortical development (3 of them with multiple displasias), 3 tumors (2 of them were cavernomas) and one patient has posttraumatic malacic changes]. Eighteen lesions were located in temporal lobes. Overall sensitivity to the number of lesions was similar between FLAIR and DIR, although DIR was slightly higher. Double inversion recovery sequence was better than FLAIR in 52%, equal in 16%, and worst in 8% of the cases; FLAIR was better that T2-weighted imaging in 40%, equal in 16% and worst in 6%; DIR was better than T2 in 48%, equal in 32% and worst in 16%. In two patients DIR was the only sequence that showed abnormalities (hippocampus and amygdala lesions), and one cortical displasia was detected only in the FLAIR sequence. However patients with calcification or hemosiderin were better characterized with T2 sequences.

**SUMMARY/CONCLUSION**

Double inversion recovery is a sequence providing high sensitivity to detect lesions in patients with refractory epilepsy. Although its sensitivity is similar to FLAIR, DIR might be useful as an additional sequence when other conventional sequences are negative or reveal subtle or unclear lesions.

**KEY WORDS:** Epilepsy, DIR

**Electronic Scientific Exhibit 38**

**Postictal Imaging Findings on MR Imaging: The Great Imposters**

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**PURPOSE**

The purpose of this exhibit is to describe the spectrum of imaging findings found on MR imaging in postictal patients. In addition, we will discuss potential pitfalls which can lead to misdiagnosis and how to recognize them.

**APPROACH/METHODS**

Several cases of confirmed transient postictal findings on MR imaging were reviewed in patients presenting with seizures and compared with other potential differential diagnoses.

**FINDINGS/DISCUSSION**

Imaging is performed in patients who present with seizure to evaluate for an underlying abnormality such as a space-occupying mass or other structural/anatomical abnormality. If performed shortly after the ictal event, abnormalities may be found on MR imaging that are secondary to the physiologic mechanisms related to the seizure itself. Transient postictal imaging abnormalities on MR imaging include restricted diffusion, MR spectroscopy abnormalities, perfusion defects, T2 FLAIR hyperintensity, focal gyral swelling and parenchymal/meningeal enhancement. Follow-up imaging 12-25 days after seizure activity subsided showed complete or near-complete resolution of these abnormalities.

**SUMMARY/CONCLUSION**

Transient postictal imaging findings can be seen in patients following a seizure. It is important for the radiologist to recognize these findings because they can be confused with other diagnoses, such as tumor or infection. These patients require seizure control, and if necessary, follow-up imaging to confirm resolution of the abnormal findings.

**KEY WORDS:** Postictal

**Electronic Scientific Exhibit 39**

**Beyond Pattern Recognition: A Pictorial Review of Adult Leukoencephalopathies**

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**PURPOSE**

Imaging diagnosis of white matter diseases goes beyond pattern recognition. This presentation provides a systematic approach to the diagnosis of leukoencephalopathies, with integration of pathophysiology, clinical, biochemical, and genetic parameters as the basis for understanding of changes shown on MR imaging.

**APPROACH/METHODS**

The classification of white matter disorders have been repeatedly attempted over the years reflecting the continuously expanding clinical developments that have led to better understanding of these conditions. We will review current insights into leukoencephalopathies, including van der Knaap’s recent proposed classification. Important examples from the subcategories of this new classification will be provided.

**FINDINGS/DISCUSSION**

Selective vulnerability is an important concept that is of practical value in the imaging interpretation of leukencephalopathies. This explains that certain regions of the brain are more susceptible to specific disease states compared to others, on the basis of local histologic, physicochemical, and neuropathologic conditions. As an example, progressive multifocal leukoencephalopathy is an infection of the oligodendrocyte, and therefore preponderantly involves the white matter.
SUMMARY/DISCUSSION
This presentation attempts to provide a systematic approach to the diagnosis of white matter disorders. Review of current scientific insights and the recently proposed classification of leukoencephalopathies will be undertaken.

KEY WORDS: Leukoencephalopathies, white matter disorders, MRI

Electronic Scientific Exhibit 40

Idiopathic Inflammatory Demyelinating Diseases of the Brainstem

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PURPOSE
To review the MR imaging features of different idiopathic inflammatory demyelinating diseases that may affect the brainstem.

APPROACH/METHODS
All forms of idiopathic inflammatory-demyelinating diseases (IIDDs) may affect the brainstem usually in association with involvement of other areas of the CNS but only rarely in isolation. In this exhibit we will review the clinical and imaging features of the different IIDDs which may involve the brainstem, such as clinically isolated syndromes of the brainstem, multiple sclerosis, neuromyelitis optica and acute disseminated encephalitis. In addition we will review the role of brainstem lesions in the diagnostic criteria of multiple sclerosis and in the differential diagnosis between MS and other white matter diseases.

FINDINGS/DISCUSSION
Idiopathic inflammatory-demyelinating diseases represent a broad spectrum of central nervous system disorders that can be differentiated on the basis of severity, clinical course, and lesion distribution, as well as imaging, laboratory and pathologic findings. Brainstem inflammatory-demyelinating syndrome is frequently the first clinical manifestation of MS, although this condition also can continue as a monophasic disease. The risk of progression to MS is increased by the presence of oligoclonal bands on cerebrospinal fluid (CSF) analysis and disseminated brain lesions on MR imaging (>75% of patients). In clinically definite multiple sclerosis the brainstem frequently is involved leading to acute clinical syndromes, such as trigeminal neuralgia and internuclear ophthalmoplegia. Later on, chronic damage to the brainstem causes chronic disabling symptoms such as oculomotor disturbances. Most brainstem lesions are contiguous with the cisternal or ventricular cerebrospinal fluid spaces (around the fourth ventricle), and range from large confluent patches to solitary, well delineated paramedian lesions or discrete “linings” of the cerebrospinal fluid border zones. Predilection for these areas is a key feature that helps to identify MS plaques and to differentiate them from focal areas of ischemic demyelination and infarction that preferentially involve the central pontine white matter. Bickerstaff encephalitis is a rare form of acute brainstem syndrome considered a subgroup of acute disseminated encephalomyelitis, in which inflammation appears to be confined to the brainstem. This syndrome, which has a benign prognosis, is due to localized encephalitis in the brainstem, commonly preceded by a febrile illness. MR imaging usually shows an extensive high-signal intensity lesion on T2-weighted images involving the midbrain, the pons and sometimes the thalamus. Clinical outcome is good and parallels resolution of the MR imaging lesions. Devic neuromyelitis optica (NMO) is an uncommon and topographically restricted form of IIDD that is best considered to be a distinct disease rather than a variant of MS. NMO is characterized by severe unilateral or bilateral optic neuritis and complete transverse myelitis, which occur simultaneously or sequentially within a varying period of time (weeks or years), without clinical involvement of other CNS regions. However, some cases show brainstem involvement which should be considered atypical for MS.

SUMMARY/CONCLUSION
The brainstem may be involved in different forms of idiopathic inflammatory demyelinating diseases. The MR imaging lesional pattern of these lesions may help in suggesting the diagnosis.

KEY WORDS: Brainstem, demyelinating, multiple sclerosis
Visual Rating System for Assessing Coronal Mesial Temporal Lobe Images: A Tool in the Diagnosis of Mild Cognitive Impairment and Alzheimer Disease

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PURPOSE
Subjects with mild cognitive impairment (MCI) and mild Alzheimer disease (AD) can be distinguished from elderly subjects with no cognitive impairment (NCI) by the degree of atrophy in the entorhinal cortex (ERC) and the hippocampus (HPC), quantified by volumetric magnetic resonance image (MRI) studies and coronal reconstructed computed tomography images (CT).

APPROACH/METHODS
We have used calibrated visual rating to measure atrophy in the ERC, HPC, and perirhinal cortex (PRC) and evaluated its utility in the diagnosis of very early AD. We have developed a standardized and calibrated semiquantitative method of rating atrophy of the ERC.

FINDINGS/DISCUSSION
This computer-based visual rating system (VRS) has been implemented into the routine evaluation of medial temporal lobe structures in patients with cognitive deficits.

SUMMARY/CONCLUSION
The VRS allows the neuroradiologist to provide the referring clinician with a semiquantitative rating of the anatomical structures of interest (HPC, ERC, PRC) within the radiology report.

KEY WORDS: Alzheimer, cognitive, temporal

White Matter Hyperintensities Are Related to the Severity of Medial Temporal Atrophy: A Biomarker of Neurodegenerative Disease

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PURPOSE
Among individuals with progressive cognitive impairment, the presence of white matter hyperintensities (WMHs) on T-2 weighted MR brain scans may be associated with normal aging, cardiovascular risk factors (CVRFs), or neurodegenerative conditions.

APPROACH/METHODS
Determine the relationship of WMHs in periventricular (PV-WMHs) and centrum semiovale (CS-WMHs) regions, to severity of cognitive impairment, CVRFs, and medial temporal atrophy (MTA) a marker of neurodegenerative disease.

Participants in the Florida ADRC (n = 246) were diagnosed as cognitively normal (NCI), nonamnestic mild cognitive impairment (naMCI), amnestic MCI (aMCI) or dementia (DEM). Severity of PV-WMHs and CS-WMHs on T2-weighted axial MR scans and severity of MTA was measured on 1.5 mm thick coronal MR scans at the mammillary bodies level using a computer-assisted visual rating system. Cardiovascular risk factors score was calculated as the sum of 10 independent CVRFs.

FINDINGS/DISCUSSION
VRS ratings for CS-WMHs, but not PV-WMHs, progressively increased with severity of cognitive impairment, i.e., from NCI to naMCI to aMCI to DEM [F(3,240)=3.9; p=.009]. CS-WMHs distinguished between NCI and naMCI versus DEM by post-hoc Scheffe tests. There were weak correlations of PV-WMHs (r= .13; p<.05) and CS-WMHs (r=.15; p<.05) with CVRF, but stronger correlations with MTA (r=.38, p< .001, for PV-WMHs) and (r = .35; p <001, for CS-WMHs). When age, CVRF, WMHs and MTA were evaluated together as covariates in an ANOVA model, only MTA [F= 32.95 (143, 4); p<.001] predicted cognitive diagnosis.

SUMMARY/CONCLUSION
Although severity of WMHs increase with severity of cognitive impairment, distinguish between NCI/naMCI and dementia, and are weakly correlated to CVRFs, WMHs are more strongly associated with MTA, which was the only independent predictor of cognitive function. These findings suggest WMHs in cognitively impaired subjects, are associated primarily with neurodegenerative disease.

KEY WORDS: Visual rating system, white matter hyperintensities, neurodegenerative

Challenges of Establishing a Successful Stroke Center

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PURPOSE
To present our unique integrative approach in the management of patients presenting with acute onset of stroke at St. Luke’s Hospital Brain and Stroke Institute as a model to establish a comprehensive stroke center.

APPROACH/METHODS
Since its founding in 2001, St. Luke’s Hospital Brain and Stroke Institute has become a leading center in the management of cerebral vascular diseases in the country. It is a dedicated inpatient stroke center, which offers comprehensive state-of-the-art management of patients with brain infarction, brain hemorrhage and other cerebral vascular diseases. Our unique multidisciplinary approach combines various concerted efforts from emergency medicine, neurology, vascular surgery, interventional neuroradiology, stereotactic radiology, neurointensive care, and rehabilitation neurology.
into a highly efficient and effective way to manage our stroke patients with highly successful clinical outcomes. Furthermore, as an academic institution, we focus on education through medical research and teaching.

**FINDINGS/DISCUSSION**
This computer exhibit shows step by step the establishment of a successful stroke center. Different services required in successful stroke center are discussed by experts in their field, including transfer of patients, emergency services, nursing, special procedure coverage, neurology, neurointervention, and neurosurgery. The number of strokes treated at the St. Luke’s Stroke Center and their outcomes also are discussed. Business model and reimbursement codes also are discussed.

**SUMMARY/CONCLUSION**
This is an interactive electronic exhibit in which clinicians can appreciate our approach in the management of acute stroke patients as demonstrated in our presentation and to suggest a way to establish a comprehensive stroke center. St. Luke’s Hospital Brain and Stroke Institute is a highly specialized stroke treatment center, with each doctor having a different, stroke-related background. As medical management is an ever evolving process, we strive to continue our excellence in patient management with constant reviewing of our multidisciplinary approach and with continued research.

**KEY WORDS:** Stroke, ischemia, intervention

**Electronic Scientific Exhibit 44**

**Pictorial Essay of MR Imaging Finding of Posterior Reversible Encephalopathy Syndrome**

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**PURPOSE**
Posterior reversible encephalopathy syndrome (PRES) is not an uncommon entity. Most commonly it is secondary to hypertensive encephalopathy. There are numerous other etiologies of this condition (1). The imaging manifestation also is very variable (2). We will be presenting all the possible MR imaging manifestations in our exhibit including atypical presentations. The characteristic and described imaging findings will help the radiologist to raise the possibility of this condition and a rescan after 1-2 weeks can save brain biopsy.

**APPROACH/METHODS**
A retrospective review of clinical features and MR imaging findings of all cases of PRES from our institute was performed.

**FINDINGS/DISCUSSION**
We will present cases with classical subcortical white matter involvement, cases with isolated white matter involvement and also involvement of both white matter and gray matter. We will show cases of extensive bilateral hemispheric involvement with enhancement and diffusion abnormality. Patients who had progression to infarction and focal areas of hemorrhage also will be included. Atypical bithalamic involvement with subtle enhancement in a patient with SLE also will be presented. Significant involvement of the brainstem and cerebellum was encountered more frequently in patients with hypertensive etiologies as opposed to other etiologies which chiefly involved the supratentorial white matter. All these cases will be discussed with short relevant clinical presentation and course of the disease.

**SUMMARY/CONCLUSION**
Different clinical presentations and course with myriad imaging manifestation of PRES will be discussed in this electronic exhibit to review the imaging manifestations. As the disease is reversible, neurobiologists should know all the imaging manifestations of the disease to help the clinician and also to prevent unnecessary brain biopsy.

**REFERENCES**

**KEY WORDS:** PRES, hypertensive encephalopathy

**Electronic Scientific Exhibit 45**

**Cerebral Perfusion Patterns in Hemodynamic Stroke with Diffusion Lesions: A Practical Approach to Visual Image Interpretation**

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**PURPOSE**
The aim of this presentation is to describe a robust visual approach for the detection of the typical perfusion patterns in hemodynamic insufficiency, to clarify the mechanism of cerebral autoregulation and to describe the relevance of border zone infarctions.

**APPROACH/METHODS**
Reduction of the perfusion pressure caused by vascular stenosis or occlusion is a cause of neurologic symptoms and border zone infarcts in the most peripheral parts of the vascular system. The hemodynamics in cerebral hypoperfusion had been studied intensively with PET. Typical patterns of cerebral hypoperfusion and the mechanisms of cerebral autoregulation were identified. Several studies showed that the typical perfusion patterns of hypoperfusion also are applicable on MR perfusion imaging. However, the scientific approach in these studies with region of interest (ROI) measurements is not practicable for individual cases where the location and distribution of the perfusion alteration initially is unknown. Several cases with different duration and cause of hemodynamic insufficiency are presented. All patients were examined with color encoded CT or MR perfusion in the symptomatic phase and with diffusion-weighted sequences during the first week after symptom onset. The
typical perfusion patterns of hemodynamic insufficiency on color-encoded perfusion studies and the typical distribution of hemodynamic infarctions are described.

FINDINGS/DISCUSSION
The typical perfusion pattern in hemodynamic insufficiency compensated by autoregulation consists of an increase of the cerebral blood volume (CBV) in the affected areas. However, the disturbance of the cerebral perfusion is detected most easily on the mean transit time (MTT) maps, because the MTT shows less pronounced differences between the white matter and the gray matter. Both the increase of CBV and the decrease of cerebral blood flow (CBF) results in a prolongation of MTT in the affected area. Probably also the collateral supply from adjacent vessel territories contributes to the markedly prolonged MTT in the affected areas. Thus MTT is the most sensitive parameter map for detection of most cerebral perfusion alterations, whereas the changes of the CBV and CBF are often more subtle. For the assessment of the severity of the perfusion situation CBV and CBF are still important parameters. Increased CBV and maintained or slightly decreased CBF indicate good autoregulation, whereas normal CBV and decreased CBF are signs for an insufficient compensation for the perfusion pressure reduction. Both reduced CBV and CBF indicate an incipient breakdown of the autoregulation. The acetolamide test can further refine the assessment of the perfusion situation, but is usually neither available nor appropriate in the acute phase. The typical rosy-like infarctions in hemodynamic stroke were seen in the deep border zones and can be supposed as a marker for hemodynamic insufficiency.

SUMMARY/CONCLUSION
The perfusion pattern of hemodynamic insufficiency is characterized by increased CBV, normal or slightly decreased CBF and prolonged MTT in the affected areas, when compensation by autoregulation is adequate. Border zone infarcts occur mainly in the deep watershed areas and can be seen as a marker for hemodynamic insufficiency. Presence of border zone infarctions is an indication for further examination of the brain supplying arteries.

KEY WORDS: Hemodynamic insufficiency, border zone infarctions, cerebral perfusion

Electronic Scientific Exhibit 46
CT Perfusion in Acute Ischemic Stroke: Overview of Most Challenging Cases
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PURPOSE
To review the most challenging cases in CT perfusion (CTP) performed in acute ischemic stroke unit. To analyze the main causes of erroneous diagnosis encountered in our experience. To discuss the pitfalls in diagnostic management of these cases.

Electronic Scientific Exhibit 47
Persistent Primitive Trigeminal Arteries (PTA) and Its Variant (PTAV): Analysis of 112 cases detected in 16,447 cases of MRA over three years
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PURPOSE
Persistent primitive trigeminal artery (PPTA) and its variant (PTAV) are detected using conventional angiography or MRA in patients with no clinical findings. Prior reports are limited in number with only up to 17 cases in each. This prohibits understanding of important anatomical and embryonic details. The aim of this study was to analyze large numbers of PPTA and PTAV and evaluate the anatomical features and the meaning of Saltzman’s typing.

APPROACH/METHODS
Magnetic Resonance angiographies (MRA) of 16,447 cases between October 2005 and September 2008 were evaluated. One-hundred and twelve cases of PPTA or PTAV were detected. These were analyzed for laterality, lateral/medial type, Saltzman’s type, the degree of proximal basilar artery hypoplasia and coexistence of any asymptomatic aneurysm or other anomaly.
Electronic Scientific Exhibit 48

Diffusion Tensor Based Anatomic Illustration of Deep Grey Matter Nuclei

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PURPOSE
The purpose of this educational exhibit is to illustrate the anatomy of deep grey nuclei using high resolution Diffusion Tensor Imaging (DTI). Multiple prior studies have demonstrated utility of DTI in illustrating white matter tracts. However, few studies have dedicated to delineate the grey matter nuclei using diffusion tensor imaging.

APPROACH/METHODS
DTI data with Diffusion weighting encoded along 25 independent orientations with a b value was 1000sec/mm² and with minimal diffusion weighting (b = 33sec/mm²) were acquired. For comparative utility of DTI color coded maps, standard magnetization-prepared, rapid-acquisition, gradient-echo images will be used with the same section localization as DT images. Published cadaveric anatomic reference will be used as gold standard. The imaging will be performed at 1.5 T and 3.0 T magnets. Color-coded maps will be used for visual representation of tract information, with red, green, and blue colors assigned to right-left, anterior-posterior, and superior-inferior orientations, respectively.

SUMMARY/CONCLUSION
In this educational exhibit, the viewer will be exposed to the anatomy of deep nuclei on DTI color coded maps, which are otherwise difficult to appreciate on conventional MRI including high resolution anatomic sequences such as MPRAGE.

KEY WORDS: DTI, Anatomy

Electronic Scientific Exhibit 49

The Ten Commandments of Sulcal and Gyral Anatomy of Brain: A Primer to Eloquent Area Localization on MRI

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MOTIVATION
The summer of 1999-2000 I spent at Mount Sanai medical center new York with Prof. Thomas Naidich

LEARNING OBJECTIVES
1. To evaluate the new and previously described signs for localizing the central sulcus and related gyri in axial and Sagittal MRI Scans
2. To familiarize the cortical anatomy on Axial MRI studies
3. To impart skills for interpreting Signs useful for localization of Major sulci and gyri
4. To translate this knowledge in doing fiber tracking studies

IMAGING FINDINGS
3 Tesla high resolution isotropic T1 and T2 Axials, Sagittals and reformatted Images were used for the study. Color coded directionality DTI images and Tracto graphic 3D data are showed highlighting the use of these signs for fiber tracking eloquent tracts

Axial MRI
SFS-PRECS SIGN
PARS BRACKET SIGN
BIFID POST CS SIGN
SIGMOID CURVE OF POSTERIOR SURFACE OF PRE- CENTRAL GRYSUS AND CENTRAL SULCUS
THIN POST CG SIGN
IPS POST CS SIGN
WHITE MATTER DIGITATIONS: MEDULLARY SPIKE SIGN
MID LINE SULCUS SIGN
3D HOLISTIC USE OF ALL SIGNS ON 3D SURFACE RECONS
SAG MRI
Alligatoren sign
Macdonald sign
DTI Directionality maps:
Bee Head sign
Donald duck sign

The following Tracts are shown in relation to these signs.

REFERENCES

KEY WORDS: Central Sulcus, Pars Marginalis, Precentral Gyrus

Electronic Scientific Exhibit 50

High Spatial Resolution Diffusion Tensor Tractography of the Human Brain Cortico-Ponto-Cerebellar Pathways

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PURPOSE
Lack of adequate neuroimaging sensitivity and spatial resolution, so far, impeded depiction of crossing and parcellation of the cortico-ponto-cerebellar pathways within the brain. The purpose of the current study is to demonstrate the feasibility of parcellation of fronto-ponto-cerebellar, parieto-ponto-cerebellar, occipito-ponto-cerebellar and temporo-ponto-cerebellar tracts using fiber tractography and to show the crossings of these pathways by using deterministic approach and high spatial resolution DTI data on 3 T.

APPROACH/METHODS
Cortico-ponto-cerebellar (CPC) fibers are the largest component of the corticofugal fiber system and form the largest group of fibers in the basis pontis. These fibers consist of two neuron chains: cortico-pontine fibers which project to the pontine nuclei and ponto-cerebellar fibers which cross the midline to enter cerebellum via the middle cerebellar peduncle. Almost all of these fibers cross the midline in the basal pons and terminate in the contralateral half of the cerebellum. Several DTI studies have used voxel-based morphometry and two dimensional regions-of-interest (ROIs) analyses to study ponto-cerebellar tract in patients with adult-onset ataxic neurodegenerative diseases, multiple system atrophy, pure cerebellar syndrome, and Parkinsonian syndromes. The location and size of ROIs were not clearly defined in some of the previous studies and using two-dimensional (2D) ROIs could not reliably assess the entire 3D tract.

Subjects: Five healthy men (age range 24-37 years) were studied and written informed consent was obtained from all subjects. Conventional and DT-MRI Acquisition: Data were acquired using a Philips 3.0 T Intera system using a SENSE receive head coil. Diffusion-weighted image (DWI) data were acquired axially using single-shot multi-slice 2-D spin-echo diffusion with the balanced Icosa21 tensor encoding scheme. The b-factor = 500 sec mm-2, TR/TE = 14460/60 msec, FOV = 256 mm x 256 mm and slice thickness / gap/ #slices = 1 mm / 0 mm / 120. The EPI phase encoding used a SENSE k-space undersampling factor of two, with an effective k-space matrix of 112x112 and an image matrix after zero-filling of 256x256. Fiber Tracking: We used the FACT algorithm (DTIStudio) to reconstruct Cortico-ponto-cerebellar pathways with a fractional anisotropy (FA) threshold of 0.22 and angle threshold of 60 degrees.

FINDINGS/DISCUSSION
To our knowledge, the current study is the first to present the temporoponto-cerebellar (TPC) tract and also the crossing of different cortico-ponto-cerebellar pathways using high spatial resolution DTI measurements on healthy adults. The TPC pathway is clearly delineated and is distinguishable from occipito-ponto-cerebellar (OPC) which lies more ventro-laterally within the dorsal part of the crus cerebri. Using high spatial resolution specially reduced slice thickness (1mm) in this study reduced the partial volume effect as well as incoherency due to the fiber intercrossings within each voxel and we were able to reconstruct and show the whole trajectory and even crossing of cortico-ponto-cerebellar pathways for the first time by deterministic approach.

SUMMARY/CONCLUSION
In this report we demonstrated that using higher resolution along with thinner slices reduce the partial volume effect and enabled us to show for the first time the crossing of CPC pathways and to delineate the temporoponto-cerebellar in vivo

KEY WORDS: Diffusion tensor, Tractography, High resolution
Electronic Scientific Exhibit 51

High Resolution Atlas of Human Brain White Matter Pathways. A Diffusion Tensor Tractography Study on 3.0 T

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PURPOSE
To prospectively investigate the utility of high isotropic spatial resolution (1mm x 1mm x 1mm = 1.0 mm³) diffusion tensor imaging in mapping the projection, association, commissural, and brainstem neural fiber pathways in the healthy adult human brain.

APPROACH/METHODS
This work was approved by the local institutional review board (IRB) and was health insurance portability and accountability act (HIPAA) compliant. Subjects: Five healthy men (age range 24-37 years) were studied and written informed consent was obtained from all subjects. Conventional and DT-MRI Acquisition: Data were acquired using a Philips 3.0 T Intera system using a SENSE receive head coil. Diffusion-weighted image (DWI) data were acquired axially using a single-shot multi-slice 2-D spin-echo diffusion with the balanced Icosa21 tensor encoding scheme. The b-factor = 500 sec mm⁻², TR/TE = 14460/60 msec, FOV = 256 mm x 256 mm and slice thickness / gap / #slices = 1 mm / 0 mm / 120. The EPI phase encoding used a SENSE k-space undersampling factor of two, with an effective k-space matrix of 112x112 and an image matrix after zero-filling of 256x256. The acquisition spatial resolution for DTI data was ~ 2.29mm x 2.29mm x 1mm, and the nominal resolution after image construction was 1mm x 1mm x 1mm. Fiber Tracking: We used the FACT algorithm (DTISTudio) to reconstruct the projection, association, commissural, and brainstem pathways with a fractional anisotropy (FA) threshold of 0.22 and angle threshold of 60 degrees.

FINDINGS/DISCUSSION
We demonstrate the feasibility of fiber tracking of projection, association, commissural and brainstem pathways using high SNR, angular and spatial resolution DTI on 3T which provides data with high fidelity to map the functional networks in the human brain in both health and disease.

SUMMARY/CONCLUSION
We demonstrate for the first time the feasibility and utility of high spatial resolution DTI to show human brain white matter pathways relative to cortical and deep gray matter on healthy controls in an affordable amount of time. Our study is a good incentive to combine the anatomical (this study) with physiological (fMRI, PET) studies.

KEY WORDS: Diffusion tensor, Tractography, High resolution

Electronic Scientific Exhibit 52

Cross Sectional Imaging in Persistent Carotid-Vertebrobasilar Communications: A Pictorial Review

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PURPOSE
1. To illustrate the common as well as uncommon cross sectional imaging findings of persistent carotid-vertebrobasilar communications.
2. To describe the embryologic source of these variations
3. To explain the clinical importance of persistent anomalous carotid-vertebrobasilar connections.

APPROACH/METHODS
Cross sectional images of head and neck including computerized tomography (CT), CT angiography (CTA), magnetic resonance imaging (MRI) and magnetic resonance angiography (MRA) will be utilized to illustrate persistent vascular connections of the carotid and vertebrobasilar systems. Advantages of individual scanning technique as well as optimal scan parameters will be described. Embryological origins of these anomalies will be discussed with the help of drawings. Tables will demonstrate classification of these anomalies, based on vessel of origin and the course through the brain or skull base. Anatomical course of these vessels through various skullbase foramina and relationship with adjacent organs will be described. Corresponding Digital Subtraction Angiography (DSA) images will also be included. Cinical manifestations of the anomalies, specifically aneurysm formation and cranial nerve involvement will be explained with appropriate images.

FINDINGS/DISCUSSION
Persistent trigeminal, otic, hypoglossal and pro-atlantal intersegmental arteries are known persistent fetal anastomoses between the carotid and vertebrobasilar circulations. Although these abnormal communications have been described in detail with the help of conventional angiographic studies, fewer data exists regarding cross sectional imaging findings. Reported incidence of trigeminal artery (most common anomaly) is about 0.2%. However, with widespread utilization of cross sectional techniques, the incidence is recently noted to be approximately 1%. Development of multi-detector CT technology with the ability to acquire isotropic images and state of the art 3D reformating techniques has widened the scope of cross sectional studies and offers an excellent alternative to more invasive angiography. Similarly new innovations in MR technology and higher magnet strengths have resulted in images with exquisite detail of both intra and extacranial arterial anatomy. Cross sectional techniques also provide added information regarding adjacent normal structures.

SUMMARY/CONCLUSION
Most carotid-vertebrobasilar communications are incidental findings. However, these may be associated with clinically significant intracranial abnormalities, most commonly aneurysms or cranial nerve symptoms. Cross-sectional imaging provides excellent visualization of the abnormal conne-
tion, its course within posterior fossa or skullbase, relationship with adjacent structures, and associated complications. This exhibit will familiarize the viewer with these uncommon and often incidental anomalies.

**Key Words:** Persistent, CTA, trigeminal

### Electronic Scientific Exhibit 53

**The Central Sulcus and Beyond: What You Need to Know About Gyral and Sulcal Anatomy**

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**Purpose**

Provide a thorough, comprehensible review of the clinically relevant sulcal and gyral anatomy of the brain.

**Approach/Discussion**

Advanced imaging techniques are at the frontline of the clinical neurosciences, making knowledge of the sulcal and gyral anatomy of the brain an essential skill for the neuroradiologist. Functional imaging such as fMRI has become integral in planning for treatment of functional neurological disorders. Knowing the functional implications of underlying lesions or planned interventions, the knowledge of neuroanatomy in relation to clinical presentation, and how to effectively communicate clinically relevant imaging findings are just a few reasons highlighting the importance of this skill. With this in mind, our exhibit will review the methods for locating the central sulcus and stress the associated clinically relevant sulcal and gyral anatomy.

**Summary/Conclusion**

A neuroradiologist must possess a thorough knowledge of the sulcal and gyral anatomy of the brain for reasons listed above. With this exhibit, we aim to provide a comprehensible educational exhibit which demonstrates the relevant sulcal and gyral anatomy of the brain.

**Key Words:** Anatomy, brain, gyrus sulcus

### Electronic Scientific Exhibit 54

**Interactive Head MRI Atlas**

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**Purpose**

To create an efficient tool for displaying labeled head anatomy and function to correlate with cross-sectional imaging.

**Approach/Methods**

A healthy volunteer was scanned on a GE Signa HDx 3.0T MRI scanner. A 3D SPGR produced a T1-weighted volume with 1 mm isotropic voxels. The volume of data was segmented for anatomic labeling using software developed for segmenting data from the Visible Human Project (VHP). 3D models were made from the segmented data to use for navigation. The anatomic, segmented and function data are displayed in a viewer developed to display data from the VHP. The viewer program is run on a client computer to provide real-time updating of the images but the program and the data can be stored on a central server.

**Findings/Discussion:** To improve efficiency of identifying brain anatomy and function, we developed an interactive anatomic atlas of the head. The atlas allows the anatomy to be viewed in any cross-sectional plane with navigation provided by 3D models. Structure names are provided when the cursor passes over a pixel and information about the structure is displayed with a mouse click. The cross-sectional image can easily be adjusted to match an image on a PACS workstation to provide real-time information during a reading session.

**Summary/Conclusion**

In order to improve efficiency of identifying brain anatomy and function, we have developed an interactive head MRI atlas. The anatomic data can be viewed in any cross-sectional plane and used to make 3D models while comparing to an image on a PACS workstation.

**Key Words:** Brain, Atlas, Anatomy

### Electronic Scientific Exhibit 55

**Veins of the Central Nervous System: All You Need to Know**

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**Purpose**

The aim of this exhibit is to review the anatomy, to simplify the radiologic analysis of venous imaging and to broaden the scope of abnormalities in which the veins are implicated. A pictorial depiction of the imaging findings in a didactic format will be presented.
**APPROACH/METHODS**
This exhibit is based on a retrospective analysis of imaging findings regarding cerebral venous system pathology. There are some distinct and specific features regarding the different venous cerebral abnormalities and therefore, an attempt is made to categorize and recognize the various patterns of venous involvement.

**FINDINGS/DISCUSSION**
The following patterns of cerebral venous involvement will be discussed: 1) Anatomy of the CNS venous system. 2) Imaging of the venous system. 3) Venous thrombotic syndromes. 4) Cortical venous reflux and the risk of bleeding. 5) Venous congestion encephalomyelopathy. 6) Venous aneurysms. 7) Developmental venous anomaly and cavernomas. 8) Perimesencephalic SAH and the deep venous variations. 9) Bridging veins, and extraxial fluid collections. 10) Perivenular disease spread. 11) Venous mural invasion. A careful radiographic assessment is required to make the correct diagnosis, define an appropriate treatment plan and avoid unnecessary morbidity and mortality.

**SUMMARY/CONCLUSION**
The importance of cerebral venous system pathology is well acknowledged. There is a wide spectrum of cortical, deep and sinus venous disease. Each entity is reviewed in great detail with particular emphasis on imaging characteristics that support the diagnosis. This exhibit should help familiarize the practicing radiologist with the possible imaging findings of venous abnormalities and aid in establishing an accurate diagnosis that could facilitate patient management.

**KEY WORDS:** CNS veins, Veins anatomy

**Electronic Scientific Exhibit 56**
The Circle of Willis: Embryology, Anatomy and Variations in the Vessels that Form and Arise from the Circle of Willis

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**PURPOSE**
To review the embryology, radiological anatomy and the variation of the vessels that form and arise from the circle of Willis (COW). To highlight the importance of being familiar with such in order to manage the patient appropriately and safely.

**APPROACH/METHODS**
This will be illustrated using different modalities including conventional, CT and MR angiography. We aim to provide examples of variations that exist in the vessels forming the COW: anterior cerebral artery (ACA), middle cerebral artery (MCA), posterior cerebral artery (PCA), posterior communicating artery (PCOM), anterior communicating artery (ACOM), internal carotid artery (ICA) and the basilar artery. This will include but will not be limited to duplications, atresias, fenestrations, aberrant origin and course, and persistent fetal anatomy.

**FINDINGS/DISCUSSION**
Knowledge of the embryological development and anatomic variations of the cerebral arteries is important to avoid unnecessary investigations and to safely perform surgery and/or interventional radiology. We have provided examples of the many different developmental variations that exist using the multi-modalities currently available to assess cerebral vasculature and have highlighted the clinical importance of being aware of the anatomy, embryology and developmental variations.

**SUMMARY/CONCLUSION**
Knowledge of the embryological development, radiological anatomy and the developmental variations that exist in the vessels that form the COW is important to manage the patient appropriately and safely.

**KEY WORDS:** Anatomy, variants

**Electronic Scientific Exhibit 57**
The Limbic System: MR Imaging Display at 3.0 T and 9.4 T

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**PURPOSE**
The limbic system primarily includes the amygdala, the hippocampus, parahippocampal gyrus, cingulate gyrus, fornix, hypothalamus, and the thalamus. In addition, structures such as the mamillary body, dentate gyrus, entorhinal cortex, piriform cortex, nucleus accumbens, olfactory bulb, and orbitofrontal cortex form important additional components of the limbic system. Circuit of Papez and numerous small white matter pathways form important fiber tracts related to the limbic system. The purpose of our study was to 1. demonstrate the cytoarchitecture of the limbic system on 1.5 T, 3.0 T and 9.4 T and 2. to evaluate the white matter tracts, specifically the circuit of Papez on Diffusion Tensor Imaging (DTI).

**APPROACH/METHODS**
Formalin-fixed samples of the relevant structures of the limbic system were studied by MR Microscopy at 9.4 T with intermediate-weighted pulse sequence. The same samples were histologically analyzed using Nissl and Luxol fast blue to confirm the underlying cytoarchitectural detail. In addition, MR studies were also obtained in 16 normal human volunteers obtaining dedicated multiplanar T1W, and T2W sequences through the limbic system. Additionally, DTI sequences were obtained to demonstrate the relevant white matter tracts.

**FINDINGS/DISCUSSION**
High-field strength MR imaging at a spatial resolution of 78 x 78 x 500 micron resolves the horizontal lamination of the cortex including the 10 individual layers of the hippocampus, and the six-layered entorhinal cortex. In addition, signal intensity profiles helped to evaluate the individual nuclei of
the amygdala, the thalamus and hypothalamus. DTI images illustrate in exquisite detail the white matter tracts of the limbic system.

**SUMMARY/CONCLUSION**

MR microscopy at 9.4 T successfully depicts in exquisite detail the individual components of the limbic system. DTI images successfully help illustrate the white matter tracts.

**KEY WORDS:** Limbic System, DTI, Papez Circuit

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**Electronic Scientific Exhibit 58**

**Fat Is Your Friend: Using the Normal Fat to Evaluate Disease in the Head and Neck**

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Los Angeles, CA

**PURPOSE**

To show the diagnostic utility of evaluating the normal fat in head and neck imaging.

**APPROACH/METHODS**

Labeled CT and MR images are used to demonstrate the normal fat planes in head and neck imaging, coupled to case examples where distortion of normal fat is key to diagnosing pathology. A pre- and post-test are provided for self-assessment.

**FINDINGS/DISCUSSION**

Alterations in the normal fat are often vital to arriving at an appropriate diagnosis in head and neck imaging. These changes help map the true extent of an inflammatory or malignant process. They provide early clues to the aggressiveness of a disease process and are particularly useful in evaluating perineural and transforaminal spread of disease.

**SUMMARY/CONCLUSION**

A working knowledge of the normal fat planes in head and neck imaging is key to differentiating and qualifying disease processes. The normal anatomy is reviewed with specific case examples provided where evaluation of the fat proves friendly to evaluating disease.

**KEY WORDS:** Anatomy, Radiology, ENT

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**Electronic Scientific Exhibit 59**

**Don’t Trust Your Mirror: A Guide to Anatomic Blind Spots in Neuroimaging**

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Los Angeles, CA

**PURPOSE**

To provide an interactive learning tool highlighting key anatomic “blind spots” in Neuroimaging where pathology can often hide.

**APPROACH/METHODS**

Labeled CT and MR images are used to illustrate key anatomic locations in brain, head and neck, and spine imaging that can be easily overlooked if not specifically targeted in one’s search pattern. Case examples with pathology are provided for each anatomic location. A pre- and post-test are provided for self-assessment.

**FINDINGS/DISCUSSION**

We all hate to miss things. Unfortunately, the nature by which we process visual information combined with the increasing number of imaging requests and images per study add to the risk of interpretation oversight. Certain structures for each exam are notoriously overlooked and can harbor clinically relevant pathology.

**SUMMARY/CONCLUSION**

This learning module emphasizes the key anatomic “blind spots” in Neuroimaging that are easily overlooked unless actively included in one’s search pattern.

**KEY WORDS:** Neuroradiology, Interpretation, Anatomy

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**Electronic Scientific Exhibit 60**

**Interactive CT Sinus Anatomy Web-based Teaching Module**

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Seattle, WA

**PURPOSE**

The goal of this electronic exhibit is to review normal sinonasal anatomy, pertinent anatomic variants, and mucociliary drainage patterns including common sinus pathology which results in obstruction of the various drainage pathways. High resolution CT images of the sinuses and nasal cavities are presented detailing the anatomy in multiple planes while also allowing the user to quiz themselves throughout the teaching module.

**APPROACH/METHODS**

Advances in CT technology with 64-slice Volume Computed Technology (VCT) provides high quality images in multiple planes detailing the complex sinonasal anatomy, mucociliary drainage patterns, extent of sinus disease and anatomic variants critical for diagnosis and pre-operative planning. Images obtained with high-resolution CT maxillofacial and detailed CT sinus exams from axial images acquired at 0.625 mm slice thickness and reformatted in 1.25 mm sagittal and coronal planes are presented in an educational interactive electronic format. Users will be able to scroll through the sinuses and nasal cavity with the corresponding images displayed in multiple planes that are linked to a shaded 3D bone reformation of the face and sinuses. Additionally, special features will be available throughout the teaching module that will facilitate the learning process which users can choose to have active or in-active in order to quiz themselves during the module.

**FINDINGS/DISCUSSION**

Imaging of the sinuses has become routine in clinical practice to evaluate for sinus pathology, non-specific facial pain,
pre-operative planning for functional endoscopic sinus surgery (FESS) including post-operative follow-up. By providing an interactive electronic teaching module reviewing the complex sinonasal anatomy and mucociliary drainage patterns with special attention focused on the frontonasal drainage pathway, ostiomeatal complex and sphenoethmoidal recess, the user will become familiar with the important anatomic structures and pathways involved in inflammatory sinus disease.

**SUMMARY/CONCLUSION**
After reviewing the CT sinus anatomy module the user should be familiar with normal sinonasal anatomy, pertinent anatomic variants, mucociliary drainage patterns including common sinus pathology resulting in obstruction of the various drainage pathways. At the end of the teaching module there will be a quiz users will be able to take to assess their knowledge of sinus anatomy, variants and mucociliary drainage pathways. Please see the following url for the preliminary web-based module: http://uwmsk.org/sinusanatomy/

**REFERENCES:**
3. Laine FJ and Smoker, WRK. The ostiomeatal unit and endoscopic surgery: Anatomy, variations, and imaging findings in inflammatory disease.

**KEY WORDS:** Sinus, Anatomy, Head and Neck

**Electronic Scientific Exhibit 61**

**Computed Tomographic Appearance of Skull Base Foramina with Anatomic Variations and Clinical Implications.**

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Henry Ford Health Systems

Detroit, MI

**PURPOSE**
The skull base forms the floor of the cranial cavity and separates the brain from other facial structures. This anatomic region is complex and poses surgical challenges for radiologists, otolaryngologists and neurosurgeons alike. Working knowledge of the normal and variant anatomy of the skull base is essential for effective surgical planning in this area. It is the purpose of this educational exhibit to pictorially describe and illustrate the characteristic location and CT appearance of skull base foramina with emphasis on rarer foramina in the skull base with relevant embryology.

**APPROACH/METHODS**
Multislice helical CT allows the acquisition of very thin sections with high resolution in both the axial plane and the longitudinal axis. An approximation to isotropic voxel optimizes the multiplanar postprocessing of data volumes. This results in improved delineation of skull base and mid face neurovascular channels or foramina. These foramina may be seen as linear luencies and may be confused with other lesion such as fractures unless there is a thorough understanding of normal anatomy and awareness of the characteristic location of these skull base and midface foramina.

**FINDINGS AND DISCUSSION**
Normal CT anatomy of the skull base will be reviewed with detailed bony and suturet anatomy. Case examples are grouped in this exhibit into sections covering the anterior, middle and posterior skull base. Teaching cases showing various foramina including rarer foramina such as craniopharyngeal canal, canalis basal sinus, Hyrtyls canal, foramin of Vesalius etc will be described with their contents, embryology and pathologic examples wherever relevant.

**CONCLUSION**
After viewing this exhibit, the radiologist should have a better understanding of the CT anatomy of the skull base foramina. The foramina will be classified according to location and a better understanding will be gained by incorporating teaching cases and sketch diagrams wherever relevant.

**KEY WORDS:** Skull base, foramina, CT

**Electronic Scientific Exhibit 62**

**Web-based CT Atlas of Normal Pediatric Skull Base and Sutures**

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**PURPOSE**
Evaluation of the pediatric skull base and sutures encompasses a significant level of complexity and difficulty because of the many ossification centers and synostoses which continually change throughout early development. The purpose of this project was to create a simple to use and easily accessible atlas of normal pediatric cervical spine CT scans. The studies are organized by age and anatomical location for educational purposes and a web-based quick reference tool is HTML-linked to the labeled structures.

**APPROACH/METHODS**
A series of normal pediatric head CT scans of patients at progressive ages were collected. A specifically designed authoring program written in Visual Basic and a Microsoft Access Database for data storage were utilized. The studies were organized by series, age, and anatomical location. References to specific anatomy were created. The data and
images were then converted through the program into an interactive web program. The web pages utilize DHTML, Vbscript, and Jscript programming languages.

Findings/Discussion: The final program is easily accessible over the Internet. The user has the ability to switch between axial, coronal, and sagittal reformats. The user can choose a specific anatomical location to focus on. The selected series with the designated anatomic structure can then be sequentially scrolled across age groups. Discussions related to the ossification centers, normal variants, and normal maturation accompany each selection. The ability to visualize the maturation process of the skull base and sutures with a simple scroll provides a unique perspective not attainable with static images in books or journals.

**Summary/Conclusion**
The Pediatric Skull Base and Sutures Atlas will prove to be a useful quick reference and education tool. There are unique features and interactivity that are not possible with books and journals.

**Key Words:** Skull, pediatric, anatomy

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**Electronic Scientific Exhibit 63**

**Interactive Tutorial of Temporal Bone Anatomy and Pathology, CT/MRI Based**

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Overland Park, KS

**Purpose**
The temporal bones pose an interesting dilemma to many radiologists. This is in part because of the intricate complexity of the anatomy of the temporal bones and the infrequency of exposure to such imaging studies. It is for this reason that a refresher course in the shape and form of an automated and interactive tutorial would likely be an invaluable tool.

**Approach/Methods**
The key to this tutorial is to keep the viewer engaged. This will be attempted by using a variety of medical illustrations, 2D and 3D CT and MRI renderings with integrated audio during the tutorial. An interactive component will also be adapted to the tutorial to enable the viewer to test their knowledge as they advance through each module. Subsequent to completion of the normal anatomy modules the viewer will be introduced to the various pathologic processes that can affect the temporal bones. Again, the various modalities and tools used to demonstrate the normal anatomy will be used here and will again be followed by an interactive quiz.

**Findings/Discussion**
Knowledge of the normal temporal bone anatomy is essential in evaluating a temporal bone on CT or MRI. This will be accomplished with the use of an interactive series of slides produced with flash media player and real media. First, the tutorial will take the viewer through a series of medical illustrations demonstrating the various structures and anatomical landmarks of the temporal bones. Second, the viewer will be take through a similar tutorial using CT imaging, both 2D and 3D. Third, MRI images will be used to illustrate the temporal bone anatomy. Finally, the viewer will be subject to a quiz that will enable testing of their knowledge by clicking on the proper anatomical landmarks in order to proceed to the next section.

The second section will use a similar approach to the investigation of the various pathologic processes that affect the temporal bones. This section will include a tutorial of routine cases as well as rare cases such as intralabyrinthine schwannoma, and facial nerve hemangioma. Post surgical changes related to imaging for cochlear implants will also be illustrated and discussed. As before, an interactive quiz will be administered to test the viewer’s knowledge upon completion of the tutorial. During each quiz the viewer will have the option to review the anatomy or finding being tested by clicking on the REVIEW button to hyperlink to the location of interest in the tutorial.

**Summary/Conclusion**
Following completion of this interactive tutorial the viewer will have knowledge of the fine details of temporal bone anatomy as depicted on CT and MRI imaging modalities. The viewer will also be able to diagnose and analyze various pathologic entities as well as post surgical temporal.

**Key Words:** Temporal, anatomy

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**Electronic Scientific Exhibit 64**


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Charlottesville, VA

**Purpose**
Absence of the long process of the incus is a rare cause of conductive hearing loss. The purpose of this pictorial review is to demonstrate that high-resolution multidetector CT of the temporal bones with two- and three-dimensional reformatations helps to precisely depict absence of the long process of the incus.

**Approach/Methods**
In our institution, high-resolution CT of the temporal bones with two-dimensional reformatations is performed routinely for the work up of conductive hearing loss. Three cases of absence of the long process of the incus are presented.

**Findings/Discussion**
A retrospective review of CT scans of the temporal bones obtained for the work up of conductive hearing loss, between October 2005 and October 2008, revealed three cases of absence of the long process of the incus. The three patients are of different age groups.
SUMMARY/CONCLUSION
High-resolution multidetector CT of the temporal bones with two- and three-dimensional reformations is a powerful tool in the diagnosis of congenital malformations of the middle ear ossicles. The performance of the appropriate 2- and 3-dimensional reconstructions helps demonstrate the abnormality more precisely.

KEY WORDS: Incus, long process, CT

Electronic Scientific Exhibit 65
CT of Temporal Bone: Learning CT Anatomy with Pathologic Correlation

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Iowa City, IA

PURPOSE
Learning temporal bone anatomy is a daunting challenge for many radiologists. Our goal is to teach temporal bone anatomy utilizing simplified anatomical diagrams of temporal bone structures along with CT images of normal anatomy and correlative pathologic conditions. After reviewing this presentation the learner will be well versed with normal temporal bone anatomy and correlative pathology on CT.

APPROACH/METHODS
Anatomical diagrams of the temporal bone were created and CT sections of normal anatomy and correlated pathology of the temporal bone were collected and labeled. We assumed the middle ear is a box having six walls and described this anatomy using a simple diagram to depict the anatomical relationship between different structures.


Figure 2: Coronal and Sagittal CT image. EAC: External auditory canal, IAC: Internal auditory canal, TM: Tympanic membrane, CC: Carotid canal, CP: Cochleariform process, Co: Cochlea, Epi: Epitympanum, Sc: Scutum, TT: Tegmen tympani, VII: Facial nerve.

FINDINGS/DISCUSSION
CT is an excellent modality to visualize the different structures of the temporal bone including external, middle, and internal ear; facial nerve; jugular fossa; carotid canal. Knowledge of this anatomy is crucial in allowing the diagnosis of different pathologies of the temporal bone.

SUMMARY/CONCLUSION
Temporal bone anatomy is not as difficult as it looks if it is learned using simplified diagrams that help create a mental picture of the relationship of the different anatomical structures.

KEY WORDS: Temporal bone, facial nerve

Electronic Scientific Exhibit 66
Patterns of Bone Involvement in Neoplasms of the Paranasal Sinuses

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PURPOSE
To present a diagnostic approach to the mass lesions of the paranasal sinuses based on the pattern of bony involvement.

APPROACH/METHODS
We present CT and MR imaging examinations of neoplastic and nonneoplastic mass lesions of the sinuses to illustrate the pattern approach used at our institution.

FINDINGS/DISCUSSION
Much like in long bone tumors, the pattern of bony involvement in mass lesions of the paranasal sinuses reflects the degree of aggressiveness and the growth rate. These features are useful to establish the differential diagnosis, and aid in treatment planning. Aggressive lesions are characterized by growing soft tissue invading and destroying the bony walls. The lesion is poorly demarcated with a wide zone of transition. This pattern is seen most commonly with carcinomas, esthesioneuroblastoma, osteosarcoma, chondrosarcoma, non-Hodgkin lymphoma, metastasis, idiopathic midline granuloma, minor salivary gland malignancy and sarcomas. Benign lesions with an aggressive pattern of bone destruction include osteomyelitis, Wegener granulomatosis, juvenile nasoangiofibroma, and mucormycosis. Characteristically, infectious
processes also tend to show reactive thickening of the sinus walls and destructive appearing bony change without a mass. Fungal infections may show low signal at T1 and T2-weighted MR imaging. Lesions with intermediate degree of aggressiveness have a slower growth rate, resulting in a well defined margin, which allows one to separate the lesion from the surrounding normal bone. The adjacent bone may be thinned, bowed, eroded, or sclerotic. Inverting papilloma and infections may present with such pattern. Nonaggressive lesions can cause bone expansion alone, expansion and remodeling of the adjacent bony walls, or focal compressive deossification. Mucocele, angiomatous polyp, papilloma, enchondroma, osteoma, schwannoma and antrochoanal polypsis are typical examples of this pattern. CT and MR imaging have a complimentary role in the assessment of sinonasal masses. CT allows a good characterization of the type of bony destruction and involvement of the skull base foramina, and may outperform MRI in the detection of orbital invasion. MR imaging allows a more accurate distinction of secretions from neoplasm, and more accurate depiction of skull base, intracranial and dural invasion.

**SUMMARY/CONCLUSION**
The main criterion to determine the probable diagnosis and hence, the treatment, of masses of the sinuses is the type of bony involvement. CT and MR imaging play a complimentary role in the assessment of the extension of these lesions.

**KEY WORDS:** Sinonasal, tumor, aggressive

**Electronic Scientific Exhibit 67**

**Imaging of True Vocal Fold Paralysis**

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Los Angeles, CA

**PURPOSE**
To demonstrate the CT and MR imaging findings of vocal cord paralysis and the myriad causes of true vocal fold paralysis (TVFP). This exhibit also will review posttreatment changes in a variety of true vocal cord augmentation procedures used to correct TVFP.

**APPROACH/METHODS**
This scientific exhibit will review the normal anatomy, neural innervation, and pertinent imaging features of the larynx on both multislice CT and MR imaging.

**FINDINGS/DISCUSSION**
True vocal fold paralysis may be secondary to a central cause either intrinsic to the brainstem or skull base, within the lateral neck, or within the mediastinum. Case examples from a major academic institution on the West Coast will demonstrate the variety of lesions which may cause TVFP utilizing multislice CT, MR imaging, and PET-CT. In addition, a variety of TVF augmentation procedures and surgical procedures will be demonstrated to provide the attendee with some of the postprocedure appearances of patients who have undergone TVF augmentation procedures.

**SUMMARY/CONCLUSION**
True vocal fold paralysis can be imaged reliably utilizing multislice CT and/or MR imaging. Assessment of the patient with TVFP should entail assessment of the brainstem, central skull base, the lateral neck, and mediastinum to determine the root cause. Acute, subacute, and chronic TVFP has typical imaging features on both CT and MR imaging which will be reviewed. In addition, postprocedure imaging findings may be detected easily on CT and MR imaging.

**KEY WORDS:** True vocal fold, anatomy, paralysis

**Electronic Scientific Exhibit 68**

**What’s in a Name? Eponyms in Head and Neck Radiology**

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Los Angeles, CA

**PURPOSE**
To review some of the eponyms in head and neck radiology with historical context and relative imaging on CT and MR.

**APPROACH/METHODS**
Eponyms often are used in describing a variety of pathologic processes in radiology and head and neck radiology is no exception. This exhibit will review some of the eponyms used in head and neck radiology and will subdivide the pathologies based on area of interest including the temporal bone and skull base, salivary glands, the aerodigestive tract, the lateral neck, and a miscellaneous category. A review of the origin of the eponym/author also will be provided.

**FINDINGS/DISCUSSION**
The use of eponyms to describe a pathologic process often has been met with blank stares or head scratching or the invariable “google” search for answers.

**SUMMARY/CONCLUSION**
This exhibit hopes to educate and amuse the attendee of the wealth of eponyms which are used in head and neck radiology and to provide case examples of these pathologic processes.

**KEY WORDS:** Eponyms, Anatomy
Imaging of the Tongue

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PURPOSE
Although the tongue is a critical structure in speech and swallowing, many radiologists have limited experience in its imaging. This exhibit will review the anatomy and physiology of the tongue pertinent to radiologic diagnosis, and the wide spectrum of diseases that may affect the tongue. It is hoped that this exhibit will help to improve the accuracy of radiologic diagnosis, and highlight pertinent imaging features that are important for patient management.

APPROACH/METHODS
Clinical cases from our institutions with involvement of the tongue are reviewed and selective images will be included in the exhibit. Cases with less-recognized diagnoses, involving utilization of new techniques, or those with disease pattern and anatomical extent that raise issues regarding patient management will be highlighted. The educational material will be presented in an interactive case-based approach, with a summary following each case discussion to emphasize the differential diagnosis and major teaching points.

FINDINGS/DISCUSSION
The tongue is comprised of very complex musculature and innervation that allow it to perform delicate functions in speech and nutrition. Many diseases can affect the tongue, hindering its normal function. The spectrum of diseases that can affect the tongue is wide, including malignant and benign neoplasms, vascular lesions such as hemangioma, and congenital lesions such as lingual thyroid gland and dermoid cyst. Macroglossia can result from systemic diseases such as hypothyroidism and amyloidosis. Denervation of the tongue may lead to loss of function and pseudomass, potentially leading to misdiagnosis. Maldevelopment or malpositioning of the tongue may cause obstruction of the airway, as seen in obstructive sleep apnea. Traditionally, radiologic evaluation of tongue lesions relies on CT. However, other imaging techniques including MR imaging, cine MR imaging, iodine nuclear imaging and PET/CT can provide additional information in some cases to improve the radiologic evaluation.

SUMMARY/CONCLUSION
A wide spectrum of diseases can affect the tongue. Anatomical extent of a lesion such as in squamous cell carcinoma can have significant implication in patient management. Awareness of these imaging issues, understanding of the relevant anatomy, physiology and their alteration by diseases, and appropriate utilization of multimodality imaging will help to improve radiologic diagnosis and patient management.

KEY WORDS: Tongue, oral cavity, head and neck

Neoplastic Lesions of the Head and Neck: What Happens in Vagus stays in Vagus

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PURPOSE
1) To provide an overview of neoplasms related to the vagus nerve and an approach to the differential diagnosis. 2) To recognize the characteristic radiographic features associated with each disease process on CT, MR imaging and angiography.

APPROACH/METHODS
To our knowledge, there is limited discussion regarding the lesions of the vagus nerve in the head and neck. Notable for being the longest cranial nerve with a complex course, various benign and malignant tumors arise in association with this structure. We present: 1) relevant anatomy of the vagus nerve, 2) the following entities according to an imaging-based classification including paragangliomas (glomus jugulare, glomus vagale, carotid body tumor), schwannomas, neurofibromas, meningiomas, and squamous cell carcinoma.

FINDINGS/DISCUSSION
Structured clinical case presentation with review and demonstration of characteristic radiographic findings visualized on CT, MR imaging and angiography.

SUMMARY/CONCLUSION
Main teaching points: 1) Discuss the various benign and malignant neoplastic conditions arising along the course of the vagus nerve in the head and neck, 2) Promote recognition of key radiographic findings on various modalities to facilitate imaging-specific diagnosis.

KEY WORDS: Vagus nerve

Subcutaneous Emphysema and Its Definition of the Anatomy of the Neck: Interactive Presentation

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Boston, MA

PURPOSE
The fascia-defined space is very important in head and neck imaging to establish the differential diagnosis as well as to understand the extension pattern of the pathology. However, neck anatomy is very complex and fascial planes are difficult to define on routine imaging evaluation. The purpose of this presentation is 1) to explore the complex anatomy of the neck and define the fascia-defined neck space using cases with air in the neck, 2) To present cases where significant subcutaneous emphysema dissected along the fascial planes outlining and defining the parapharyngeal, pharyngeal, masticator, parotid, carotid, retropharyngeal, prevertebral, posteri-
or cervical and visceral spaces, and 3) to briefly review the causes and mechanism of subcutaneous emphysema within the neck, clinical indications and treatment.

**APPROACH/METHODS**

Patients with air in the neck were identified on CT retrospectively. The air in the neck originated from a variety of causes including dental procedure, esophageal perforation, laryngeal and tracheal injury, surgical procedures, and asthma or other causes of acute increase in intrathoracic pressure. Detailed evaluation and identification of the anatomy was performed and will be presented in an interactive manner.

**FINDINGS/DISCUSSION**

Imaging of patients with significant subcutaneous emphysema demonstrates a comprehensive review of the fascial planes of the neck, highlighting the numerous spaces and complex anatomy in both the suprahypopharynx and infrathyroid neck. The incompleteness of the fascial-defined spaces is demonstrated by the passage of air which tracks along the neurovascular bundles, crossing the fascia with extension into the adjacent space. The distribution pattern of the air can suggest the origin of the cause.

**SUMMARY/CONCLUSION**

We present a collection of cases of air in the neck, including severe subcutaneous emphysema which nicely demonstrates the fascial planes and numerous spaces of the neck which are difficult to define on routine CT examination. Recognition of the fascial-defined spaces in the neck is critical for understanding the extension pattern of pathology and may aid in identification of the origin of the air.

**KEY WORDS:** Head and neck, anatomy, subcutaneous emphysema

**Electronic Scientific Exhibit 72**

**Head and Neck Free Flaps: Typical Imaging Features with ENT Clinical Correlates**

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1Beth Israel Deaconess Medical Center, Boston, MA, 2Tufts Medical Center, Boston, MA

**PURPOSE**

To demonstrate typical imaging features of head and neck free flap reconstructions and provide clinical and operative correlations.

**APPROACH/METHODS**

We retrospectively reviewed imaging studies (CT and MR) in patients with head and neck free flap reconstructions. Clinical and operative photographs were obtained to emphasize correlations with typical imaging features.

**FINDINGS/DISCUSSION**

ENT surgeons harvest a number of grafts for head and neck reconstructions for restoration of anatomy and function. Some of these grafts include radial forearm free flaps, rectus abdominal flaps, and pectoralis flaps. These flaps can have very strange appearances on multi-detector CT and MR, which can be confusing for the non-experienced radiologist. Many times, not only are the flaps misinterpreted as pathology, but some of the predicted features of the flap over time, including enhancement and muscle atrophy, may also be misinterpreted as disease recurrence.

Our goals are to show typical imaging features of a series of flaps in the head and neck as well as demonstrate clinical images on where and how they are harvested. We also provide intraoperative correlations with our radiologic studies, demonstrating the gross anatomic restoration of anatomy. Finally we stress which imaging features are important in the evaluation of head and neck free flaps from the prospective of the ENT surgeon. We hope that this comprehensive review will make radiologists more comfortable in evaluation and interpretation of normal free flaps in the head and neck, with the ultimate goal of recognizing pathology, including disease recurrence.

**SUMMARY/CONCLUSION**

These series of cases emphasize the typical imaging features of head and neck free flaps. It is important for radiologists to be aware of these imaging features to avoid misdiagnosis in these often complex and challenging imaging cases.

**REFERENCES**


**KEY WORDS:** Head and neck cancer, Free flap, Surgery

**Electronic Scientific Exhibit 73**

**Laryngeal and Hypopharyngeal Neoplasms: Patterns of Tumor Spread**

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**PURPOSE**

Optimal treatment of carcinomas of the larynx and hypopharynx is highly dependent on identifying the extent of spread of the primary tumor. Treatment options include open surgical resection (supraglottic, vertical, supracricoid, or total laryngectomy), endoscopic resection, and chemoradiation. The purpose of this study is to review retrospectively the common and uncommon patterns of endolaryngeal and extralaryngeal spread in a large group of patients with advanced laryngohypopharyngeal squamous cell carcinomas to identify potential pitfalls to proper treatment.

**APPROACH/METHODS**

One hundred twenty-six cases of laryngeal (n = 88) and hypopharynx (n = 38) carcinoma were studied to identify...
common and uncommon patterns of tumor spread. Common patterns of spread included invasion of the thyroid and cricoid cartilages, extension through the thyrohyoid and cricothyroid membranes, spread into the aryepiglottic fold, inferior pharyngeal constrictor muscle, paraglottic and preepiglottic spaces, esophagus, tongue base, and superior laryngeal neurovascular bundle. The treatment implications of various patterns of tumor spread and need for precise T-staging are emphasized.

**FINDINGS/DISCUSSION**
Extralaryngeal spread along the superior laryngeal neurovascular bundle through the laryngeal foramen was the most common pattern (45%) of extension outside the larynx. Invasion of the thyroid and cricoid cartilages (35%) also were very common and more obvious than perivascular and perineural extension. In many cases spread occurred through the thyrohyoid and cricothyroid membranes along other small penetrating arteries and veins (15%). Other types of extralaryngeal spread (esophageal, prevertebral, inferior pharyngeal constrictor muscle) were less common (5%). Subtle undetected extralaryngeal spread could be traced to treatment failures by laryngeal preservation surgery in four cases.

**SUMMARY/CONCLUSION**
Successful outcome from treatment of laryngeal and hypopharyngeal neoplasms requires selection of the optimal treatment method. The outcome is highly influenced by accurate initial determination of the extent of primary tumor spread and correct T-staging. This exhibit reviews the common pathways of laryngeal and hypopharyngeal tumor spread and how this influences the choice of optimal surgical and nonsurgical treatment. The common types of surgery for various primary tumor stages and spread patterns also are reviewed.

**KEY WORDS:** Neoplasm, laryngeal, hypopharyngeal

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**Electronic Scientific Exhibit 74**

**Rhabdomyosarcoma of the Head and Neck: Typical and Atypical Clinical Presentation and Imaging Features**

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**PURPOSE**
To demonstrate the protean presentations and imaging manifestations of rhabdomyosarcomas of the head and neck.

**APPROACH/METHODS**
We retrospectively reviewed the imaging studies and presentations (CT and MR images) of patients with rhabdomyosarcomas. Rare locations and presentations were emphasized.

**FINDINGS/DISCUSSION**
We have compiled a series of 15 cases (age 11 monthS-50 years) showcasing the typical and atypical locations, presentations and imaging manifestations of this tumor. The patients presenting symptoms included the following: facial folliculitis, sinusitis, pharyngitis, proptosis mimicking thyroid eye disease, hoarseness, orthodontic problems and conjunctivitis. These tumors were located in the orbit (including isolated lacrimal gland and isolated extracocular muscle involvement), paranasal sinuses, nasopharynx, nasal cavity, skull base, larynx, parotid gland, the cheek and temporal bone. Many of the cases were extremely large and trans-spatial. Both multidetector CT and MR imaging were utilized in delineating the appearance and extent of the tumors within multiple atypical head and neck compartments. On cross-sectional imaging, these lesions were heterogeneous with enhancement in all cases. Rhabdomyosarcoma accounts for 20% of all sarcomas and is the most common sarcoma of the head and neck. Forty percent of all rhabdomyosarcomas occur in the head and neck and it continues to be the most common sarcoma in the pediatric, adolescent and young adult age groups. Common locations in the head and neck are in the middle ear, sinonasal cavity, nasopharynx and orbit. These common locations tend to produce typical presentations of the tumor including: bloody otorrhea, otitis media, pain, nasal obstruction and proptosis. This series of cases stress the importance of recognizing the imaging features and locations of these tumors in light of the fact that these tumors may mimic more common nonneoplastic pathologies by presentation.

**SUMMARY/CONCLUSION**
Rhabdomyosarcoma can mimic a number of pathologies in the head and neck both by presenting feature and locations which are reviewed in this exhibit.

**REFERENCES**

**KEY WORDS:** Rhabdomyosarcoma, Head and Neck, Pediatric

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**Electronic Scientific Exhibit 75**

**Sudden Onset Sensorineural Hearing Loss: A Pictorial Review**

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New Orleans, LA

**PURPOSE**
To have a better understand of the many potential causes of sudden onset sensorineural hearing loss.

**APPROACH/METHODS**
Pictorial review of the inner ear anatomy followed by MR and CT images depicting the various potential causes of sudden onset sensorineural hearing loss.

**FINDINGS/DISCUSSION**
Sudden onset sensorineural hearing loss (SHL) is a medical emergency for which a definitive diagnosis and treatment is largely unclear. It is defined as hearing loss greater than 30 dB in three contiguous frequencies that occurs in less than 3
days. There are many potential causes of SHL which can be broken down into broad categories such as: 1. infectious, 2. autoimmune, 3. vascular, 4. traumatic/toxins, 5. postsurgical, 6. neoplastic, and 7. congenital. However, the majority of SHL cases eludes definitive diagnosis and therefore, remains idiopathic. In this electronic scientific exhibit, we discuss the various potential causes of SHL with pictorial review and discussion of a few specific cases including: labyrinthitis ossificans following meningitis, sarcoidosis, multiple sclerosis, pontine ischemia, temporal bone fracture, stapedectomy, vestibular schwannoma, endolymphatic sac tumor, large vestibular aqueduct syndrome, and intralabyrinthine hemorrhage.

SUMMARY/CONCLUSION
This educational exhibit should help readers have a basic understanding of sudden onset sensorineural hearing loss and its potential causes, understand basic inner and middle ear anatomy, and be familiar with MR and CT findings of a few potential causes of SHL.

REFERENCES
4. Rosado W, Palacios E. Sudden onset of sensorineural hearing loss secondary to intralabyrinthine hemorrhage: MRI findings. ENT J 2008;3

KEY WORDS: Sensorineural, hearing loss

Electronic Scientific Exhibit 76
Spectrum of Blunt and Penetrating Injuries of the Head and Neck: A Radiologic Approach

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PURPOSE
To review the diverse injuries that blunt and penetrating trauma produce. A wide array of both common and unusual cases is illustrated. We discuss investigative strategies of CTA to evaluate vascular compromise in emergency cases. The goals of clinical, surgical and minimally invasive radiologic management are highlighted.

APPROACH/METHODS
We retrospectively reviewed the imaging findings of patients who presented through the emergency department of our Level I trauma center, during the past 5 years, with blunt or penetrating trauma of the head or neck. We noted both the clinical presentations, such as mechanism of injury, as well as important management decisions and outcomes.

FINDINGS/DISCUSSION
Evaluation begins with noncontrast helical CT of the head and neck which may reveal indirect signs of vascular injury, such as bone fragments, foreign bodies, emphysema and hematoma within proximity of major vessels. Depressed calvarial fractures, which can tear the dural venous sinuses or the middle meningeal arterial, should be carefully sought for. Sphenoid fractures often are associated with carotid-cavernous fistulas and petrous fractures may involve the carotid canal. Maxillofacial fractures, such as the LeFort type, also are associated with a high rate of vascular insult. Gunshot wounds require assessment of both entry and exit sites, trajectory and distribution of bullet and bony fragments. Three-dimensional CT is especially useful in this regard. The basilar cisterns should be inspected for effacement, as disautoregulation may produce cerebral edema. An extremely rare case we illustrate involves a projectile fishing weight entering through the orbit into the brain, proving fatal. In the neck, blunt vascular injuries result from decelerating or torquing forces. Dissections of both the vertebral and carotid arteries commonly occur at the skull base, where shearing forces occur, and may be clinically silent or have delayed symptoms, such as stroke or Horner’s syndrome. With penetrating trauma, air and hemorrhage near the carotid space may help direct the radiologist to a site of vascular compromise. Injuries include pseudoaneurysms, arteriovenous fistulas, and carotid occlusions or transections. Fractures through the foramen transversaria may produce vertebral dissection or occlusion. Vascular injury is especially suspect when high velocity and rotational motions occur, such as those which sports or motor vehicle collisions can generate. We demonstrate an unusual traumatic pseudoaneurysm of the subclavian artery occurring in a patient with developmental limb deformities, while participating in a wheelchair basketball tournament. In CTA evaluation, both axial images, which may reveal luminal irregularity and caliber change, as well as reformatted images, which can superbly demonstrate the entire length of the vessel, are mandatory. Treatment options include endovascular intervention and revascularization.

SUMMARY/CONCLUSION
The radiologist must be familiar with the vast spectrum of vascular injuries that may be produced during blunt or penetrating trauma of the head and neck. A thorough understanding of how the mechanisms of injury correlate to the clinical and radiologic findings can assist the radiologist in determining the most efficacious imaging approach. CT angiography is invaluable in the prompt evaluation of vascular injuries to the head and neck, which can selectively guide management.

KEY WORDS: CT angiogram, neck trauma, vascular compromise

Electronic Scientific Exhibit 77
Imaging Appearance of Granulomatous Lesions of Head and Neck

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PURPOSE
1) To review the common location and clinical presentation of different granulomatous lesions of head and neck. 2) To
demonstrate the spectrum of typical and atypical CT and MR imaging appearance of granulomatous lesions. 3) To describe the imaging features that are helpful for differentiation from malignancy.

**APPROACH/METHOD**
A spectrum of granulomatous lesions is seen in head and neck that is a difficult diagnostic challenge to radiologist and may be mistaken for malignancy.

**FINDINGS/DISCUSSION**
They are usually infectious in nature or may be of noninfective cause. CT and MR imaging are essential to demonstrate site, pattern and extent of the disease as well as for differentiation for simulating lesions.

**SUMMARY/CONCLUSION**
A thorough knowledge of location, clinical features and imaging finding of granulomatous lesions is important for definitive diagnosis.

**KEYWORDS:** Granulomatous, CT scan, MR imaging

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**Electronic Scientific Exhibit 78**

**Imaging Appearance of Vascular Malformations of Head and Neck**

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Mansoura, EGYPT

**PURPOSE**
1) To review the recent classifications of vascular malformations and hemangiomas. 2) To present the spectrum of MR imaging and contrast MR angiography characteristic of vascular malformations and hemangiomas that allow specific diagnosis. 3) To provide an algorithmic approach to vascular malformations with contrast MR angiography.

**APPROACH/METHODS**
Vascular malformations may be of high or low flow.

**FINDINGS/DISCUSSION**
High flow malformation shows signal void structure with nidus at arteriovenous malformations and direct connection at arterial malformations. Low flow malformations appear as mass with variable degree of enhancement. MR angiography shows dilated tortuous veins at venous malformations, dilated capillary at cavernous malformations and marginal enhancement at lymphatic malformations.

**SUMMARY/CONCLUSION**
MR imaging can diagnose congenital hemangiomas.

**KEYWORDS:** Vascular malformation, Hemangioma, MR imaging

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**Electronic Scientific Exhibit 79**

Withdrawn

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**Electronic Scientific Exhibit 80**

**Preoperative Localization of Parathyroid Adenomas Using Four-Dimensional Computed Tomography: Our Experience at Henry Ford Hospital**

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Detroit, MI

**PURPOSE**
Advances in imaging technology, intraoperative hormone measurement, and surgical technique now allow parathyroidectomy to be performed without absolute need for four-gland exploration. Four-dimensional computed tomography (4D CT) provides both functional and detailed anatomical information about parathyroid tumors. The purpose of this exhibit is to show the ability of 4D CT to accurately localize parathyroid adenomas and to compare it with sestamibi imaging and ultrasonography for accurate preoperative localization of parathyroid adenomas.

**APPROACH/METHODS**
A brief review of the 4D CT technique will be done including the protocol used at our institution. Role of 4D CT in preoperative localization of parathyroid adenomas will be discussed including a pictorial display of various examples of parathyroid adenomas and we also will discuss and show examples where 4D CT was superior to other imaging modalities such as radionuclide scan and ultrasound. In addition we will discuss the new classification system for parathyroid localization proposed by Rodgers et al.

**FINDINGS/DISCUSSION**
If a minimally invasive operative approach is being considered for parathyroid adenomas, preoperative localization is essential. Four-dimensional computed tomography derives its name from three-dimensional CT scanning with an added dimension from the changes in perfusion of contrast over time. Four-dimensional CT generates detailed, multiplanar images of the neck and allows the visualization of differences in the perfusion characteristics of hyperfunctioning parathyroid glands (i.e., rapid uptake and washout), compared with normal parathyroid glands and other structures in the neck. Thus, detailed information regarding both the function of the glands and anatomical location is obtained with one test.

**SUMMARY/CONCLUSION**
Four-dimensional computed tomography is an excellent imaging modality for accurate preoperative localization of hyperfunctioning parathyroid glands. This allows better surgical planning and the newly proposed classification for use in parathyroid localization allows better understanding of anatomical localization by both the radiologist and the surgeon.

**KEYWORDS:** Preoperative localization, parathyroid adenoma, 4D CT
Imaging Features of Focal Amyloid Depositions in Head, Neck and Spine

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PURPOSE
Amyloidomas are benign, “tumor-like” lesions consisting of localized deposits of amyloid and are the rarest form in the group of amyloidosis-related pathologic abnormalities. In this educational exhibit, we describe the imaging features of amyloidomas involving the intracranial compartment, head and neck and spine from a neuroradiologist’s perspective. We discuss the different imaging appearances of this entity with differential diagnosis and briefly review the pertinent literature.

APPROACH/METHODS
We retrospectively evaluated 10 patients (6 male, 4 female; age range of 27 to 62 years) with a history of amyloidoma involving the brain, head, neck and the spine over a period of last 5 years from combined neuroradiology, neurosurgery and head and neck surgery records of our institutions. Clinical findings as well as laboratory test results were made available in all cases. CT scan (n = 8) and MR imaging (n = 3) were obtained in all the patients. All patients had a surgical procedure, either in the form of complete excision or surgical biopsy and all cases were shown to be amyloidoma on pathologic examination.

FINDINGS/DISCUSSION
We identified focal amyloid deposits involving the brain parenchyma (n = 1), spinal leptomeninges (n = 1), cervical spine (n = 2), ligamentum flavum of the thoracic spine (n = 1), lumbar spine (n = 2), pelvis (n = 1), orbit (n = 1) and the larynx (n = 1). Intracranial amyloidoma appears as solitary or multiple masses with little or no mass effect, hyperattenuation on CT scans, variable T1 and T2 signal with homogeneous enhancement with contrast. Amyloidomas in the orbits and larynx are well defined masses with benign imaging features but lesions elsewhere in the head and neck, spine and at the skull base often show aggressive features and can mimic aggressive diseases like infection or malignant neoplasm. The cases of amyloidomas involving the cervical spine initially were mistaken for infection. Leptomeningeal amyloidoma appears similar to leptomeningeal infection or leptomeningeal carcinomatosis.

SUMMARY/CONCLUSION
Amyloidomas are slow growing benign lesions that have excellent prognosis as opposed to systemic amyloidosis. Imaging features are variable; hence a high degree of suspicion is required for accurate diagnosis. Complete evaluation should be performed in every case to exclude associated systemic amyloidosis and plasma cell dyscrasias.

KEY WORDS: Amyloidoma, brain, spine

Imaging the Aging Globe

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PURPOSE
To review the typical changes which may affect the globe and surrounding structures with age.

APPROACH/METHODS
With age, the globe undergoes morphologic changes with reference to its conformation as well as changes to the lens. In addition, degenerative processes may occur within the globe which may be detected with CT and MR imaging. Utilizing the head and neck teaching file from a major West Coast academic institution, the anatomy of the globe on CT and MR imaging, as well as a description of the morphologic changes which occur within the globe with age will be reviewed with pertinent CT and MR imaging. In addition, pathologic processes which may occur with the aging globe also will be reviewed.

FINDINGS/DISCUSSION
The aging globe undergoes morphologic changes in configuration as well as content. In addition a number of pathologic processes also may occur and typically are seen on CT and MR imaging of the orbit or brain but often are overlooked.

SUMMARY/CONCLUSION
This exhibit will review the age-related changes and disease processes which may involve the orbit and surrounding structures with advancing age.

KEY WORDS: Globe, anatomy, aging

Pictorial Review of Orbital Trauma

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PURPOSE
1) To provide an educational overview of orbital trauma imaging; 2) To review and illustrate common CT findings in orbital trauma; and 3) Discuss clinical relevance of the imaging findings as well as potential treatment options.

APPROACH/METHODS
We retrospectively reviewed all CT studies of patients with orbital trauma presenting during the past 3 years at our institution.

FINDINGS/DISCUSSION
The presentation will be a pictorial essay format covering the following areas: 1) Brief review of orbital anatomy; 2) CT findings in orbital trauma such as fractures, extraocular muscle herniation, globe injury, orbital hemorrhage, orbital
emphysema, lens dislocation; 3) Review of potential complications associated with orbital trauma; 4) Discussion of clinical relevance and potential treatment options.

**SUMMARY/CONCLUSION**
Computed tomography has come to play a major role in the orbital examination of acute trauma patients. Upon review of this presentation, the viewer should have an understanding of 1) Orbital anatomy; 2) CT findings in orbital trauma and potential complications; 3) Clinical relevance of imaging findings as well as possible treatment options.

**KEY WORDS:** Orbit, trauma

**Electronic Scientific Exhibit 84**

**Carotid Sheath/Space: Normal Anatomy and Pathology**

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**PURPOSE**
1. Review the gross and imaging anatomy of the carotid sheath/space. 2. Review the clinical and imaging findings of lesions in the carotid sheath/space. 3. Learn a practical approach for the evaluation of lesions in this region.

**APPROACH/METHODS**
A retrospective review of 54 cases with carotid sheath/space pathology from four institutions was performed. These cases were analyzed with regards to vasculature (size, contour, contrast opacification, displacement and filling defects), presence of mass and/or inflammatory changes. Cases also were analyzed for the presence of imaging findings secondary to cranial nerve palsies due to involvement of the nerves in the carotid sheath/space.

**FINDINGS/DISCUSSION**
The lesions illustrated are organized in the following categories: 1) Vascular - stenosis, thrombosis, dissection (primary carotid and extension from an aortic dissection), and fibromuscular dysplasia. 2) Tumors - paragangliomas and neural tumors. 3) Infections - Lemierre’s syndrome, pericarotid infection. 4) Specific patterns of denervation atrophy associated with the lesions in the carotid sheath/space.

**SUMMARY/CONCLUSION**
The carotid sheath/space extends from the skull base to the aortic arch and contains major vessels and nerves. The imaging diagnosis of lesions in carotid sheath/space requires an understanding of the anatomy and imaging characteristics of the common pathology in this region. This teaching module will enable the user to develop a systematic approach for the evaluation of lesions in the carotid sheath/space.

**KEY WORDS:** Carotid sheath

**Electronic Scientific Exhibit 85**

**Anatomical and Imaging Review of Head and Neck Plexiform Neurofibromas and Their Association with Neurofibromatosis 1**

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**PURPOSE**
To review the anatomical detail and extent of plexiform neurofibromas in the head and neck, detail their infiltrative nature through CT and multiplanar, multisequence MR imaging, correlate imaging findings with treatment options, and expound on plexiform neurofibromas association with Neurofibromatosis 1.

**APPROACH/METHODS**
Head and neck illustrative anatomy, multiplanar, multisequence MR anatomy, and CT anatomy will be reviewed of diverse, multiple infiltrative head and neck plexiform neurofibroma cases collected over nearly 10 years.

**FINDINGS/DISCUSSION**
Plexiform neurofibromas are benign proliferations of peripheral schwann cells usually appearing in conjunction with a systemic process (Von Recklinghausen Syndrome, NF-1) and may undergo malignant transformation (5-15%). Plexiform neurofibromas in association with NF-1 may present throughout the head and neck (orbit, gingiva, submandibular gland, or even sympathetic trunk) where gross and imaging anatomy, specifically MR imaging, is paramount in detailing the limits, extension, and treatment process of such an infiltrative lesion.

**SUMMARY/CONCLUSION**
Plexiform neurofibromas are rare benign tumors with profound implications due to their infiltrative and rare malignant potential. Prompt multimodality imaging, specifically MR imaging, is important to fully characterize and detail extension of lesions in order to provide information for treatment options and to help differentiate plexiform neurofibromas from similar lesions such as schwannomas.

**KEY WORDS:** Plexiform neurofibroma, neurofibromatosis 1, head and neck
**Electronic Scientific Exhibit 86**

**Endovascular Treatment of Vertebral Artery Origin Stenosis**

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**PURPOSE**
The purpose of this study is to present the immediate results and follow up of vertebral artery origin stenting in 99 patients.

**APPROACH/METHODS**
Significant vertebral artery origin stenosis was treated with primary stenting in 99 patients, aged between 40 and 74 years. Twenty-two of the patients were female while 77 of the cases were male. Vertebral artery stenosis was in 32 of the patients prior to coronary artery surgery, after a posterior system stroke, or during evaluation of a vertebrobasilar insufficiency in the remaining cases.

**FINDINGS/DISCUSSION**
All stenoses were treated successfully with stent placement. All patients had an uneventful procedure without any complication except one patient who had a left posterior cerebral artery infarction. Third-month and sixth-month clinical and color Doppler follow-up examinations were available in 23 patients, and 12th-month or later control angiography performed in 37 patients, showed significant in-stent restenosis in six cases. Four of the cases had additional balloon angioplasty or stenting, one of the cases showed total regression of the in-stent intimal hyperplasia. None of the patients had new neurologic deficit during the follow up.

**SUMMARY/CONCLUSION**
Vertebral artery origin stenoses are one of the most common causes of vertebrobasilar stroke. In the presence of concomitant carotid artery stenosis or systemic disorders, patients are under high risk even if they are on medical therapy. Primary stenting combined with medical treatment is a safe and effective treatment modality.

**KEY WORDS:** Vertebral artery origin, stenting

**Electronic Scientific Exhibit 87**

**Our Experience Using Concentric Medical MERCI Clot Retrieval System**

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**PURPOSE**
St. Luke’s Hospital on the Kansas City Plaza has performed the highest number of cases of MERCI retrievals in the country. This is a computer exhibit demonstrating our experience using MERCI devices for clot retrieval in the acute ischemic stroke setting. We will select 10 step-by-step cases to demonstrate our experience using the MERCI retrieval system.

**APPROACH/METHODS**
At St. Luke’s Hospital - Kansas City Plaza we have performed over 300 MERCI retrievals using the MERCI V, X, L, and Kmini series retrievals as well as the Outreach Distal Access Catheter. We have used admission NIH stroke scale and discharge NIH stroke scale scoring to monitor patient improvement. We also have used TIMI scoring for revascularization post MERCI procedure, and ECASS I criteria to classify secondary hemorrhages.

**FINDINGS/DISCUSSION**
Over 300 patients presenting with acute ischemic stroke have undergone mechanical embolectomy of ICA, ACA, and MCA occlusions. We have seen success rates of 70%. We will showcase 10 selected cases with this computer exhibit focusing on presentation, imaging, indications and decision for intervention, and choice of MERCI device.

**SUMMARY/CONCLUSION**
The Merci retrieval system is an effective way to achieve revascularization in the acute ischemic stroke setting. It may be used with or without t-PA, during or beyond the 3-hour time window during which IV t-PA may be administered. It offers physicians an interventional option for stroke patients that do not respond or are ineligible for IV t-PA.

**KEY WORDS:** Merci, stroke, retrieval

**Electronic Scientific Exhibit 88**

**Computer-Assisted 3D Modeling of the Skull Base Vasculature: A Neurointerventional Teaching Tool**

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**PURPOSE**
Neurointerventional techniques utilize particle and liquid embolic materials in various head and neck interventions including tumor embolizations, arteriovenous malforma-
tions, dural arteriovenous or carotid-cavernous fistulas. Transarterial embolizations are predominantly performed via external carotid artery (ECA) branches supplying these vascular lesions. However, the risk of inadvertent embolization through reflux of embolic material, capillary penetration into the vasa nervosum, or imperceptible ECA to internal carotid artery (ICA) or vertebral artery (VA) collaterals can lead to devastating complications. It is imperative for the interventional neuroradiologist to be familiar with the complex anatomy of the ECA especially supplying vital cranial nerves or collateral pathways to the ICA/VA at the skull base. Alternatively, in the setting of proximal vessel occlusions, subtle ECA-ICA/VA networks often develop and must be recognized on angiography by the discerning neuroradiologist.

**APPROACH/METHODS**
We formed an interdisciplinary research team with the goal to build a 3D interactive learning environment focusing on the principles of neurovascular anatomy as well as anatomical variations of head and neck vasculature. We concentrated on the distal ECA collateral pathways supplying either the cranial nerves or ICA/VA. Using computer modeling, a 3D interactive model was created with advanced 3D software tools on graphic stations to study the skull base anatomy including the ECA/ICA vasculature and cranial nerves with respect to osseous and soft tissue landmarks. This novel program provides the ability to simulate virtual 3D angiography in the context of relevant head and neck anatomy in any combination of traditional views, including cross-sectional, 3D spatial, surface, or regional.

**FINDINGS/DISCUSSION**
We are developing a computer-based model for studying normal and aberrant neurovascular anatomy at the skull base. Specifically, we have introduced the cranial nerve anatomy and various ECA-ICA/VA pathways into the learning program. These pertinent pathways will be displayed in an interactive 3D model and correlated with 2D conventional angiography. Examples of arterial pathways to be targeted include the following: aberrant ICA; persistent trigeminal, otic, hypoglossal arteries; middle meningeal artery via the persistent stapedial or lacrimal/ethmoidal branches; internal maxillary artery via the accessory meningeal, foramen rotundum, vidian, anterior deep temporal, infraorbital, sphenopalatine-ethmoid branches; ascending pharyngeal artery via neuromeningeal trunk clival, jugular, hypoglossal branches or superior pharyngeal, inferior tympanic, musculospinal branches; occipital artery via C1/C2 muscular, stylomastoid, transmastoid branches; facial artery via superior labial and angular branches; posterior auricular via stylomastoid canal branch; superficial temporal artery via frontal or zygomatic-orbital branch.

**SUMMARY/CONCLUSION**
Computer-based 3D modeling proves to be an excellent tool for teaching clinical anatomy. Neurovascular applications of these modeling techniques centered on the skull base at the location of vital cranial nerve supply or ECA-ICA/VA collaterals will be helpful in understanding this complex anatomy on standard 2D angiography. We hope to provide a better appreciation of these neurovascular networks and a teaching tool for neurointerventional training.

**KEY WORDS:** Vascular anatomy, embolization

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**Electronic Scientific Exhibit 89**

**Spinal Vascular Malformations**

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Johns Hopkins Hospital
Baltimore, MD

**PURPOSE**
Present standard classification of spinal vascular malformations with the help of anatomical illustrations, imaging studies and where possible intraoperative correlation.

**APPROACH/METHODS**
This review will include examples of different types of spinal vascular malformations including paravertebral arteriovenous fistulae, spinal dural arteriovenous fistulae, and spinal cord arteriovenous malformations. The presented material for this review was obtained from a prospectively maintained IRB-approved database at the Johns Hopkins University and University of Michigan Ann Arbor as well as from the teaching files of two senior authors (DG, PG). Anatomical illustrations were drawn by a medical illustrator with special expertise in vascular neuroradiology (LG).

**FINDINGS/DISCUSSION**
For this exhibit we will use a modified Merland classification to illustrate the salient features of the different types of congenital and acquired spinal vascular malformations (1). Current state of the art imaging techniques also are demonstrated and their role is discussed in the work up of these lesions. This includes the use of static and dynamic CT angiography, contrast-enhanced MR angiography, 2D and 3D digital subtraction angiography, and indocyanine green intraoperative angiography.

**SUMMARY/CONCLUSION**
With the help of this exhibit we hope to improve the knowledge of the different types of spinal vascular malformation and demonstrate the use of current high-resolution imaging techniques in the work up of these entities.

**REFERENCES**


**KEY WORDS:** Arteriovenous malformation, arteriovenous fistula, spine
Electronic Scientific Exhibit 90

Basal Cerebral Venous Drainage from Cavernous Sinus Dural Arteriovenous Fistulas

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PURPOSE
This study aimed to define the patterns of basal cerebral venous drainage (BCVD) from cavernous sinus dural arteriovenous fistulas (CSDAVFs).

APPROACH/METHODS
Forty sets of selective angiographic data from 36 patients with spontaneous CSDAVFs (age range, 53-79 years) were analyzed retrospectively for their drainage patterns. Three types of BCVD were observed, i.e., superolateral type, BCVD via the deep middle cerebral vein or uncal vein; posterolateral type, BCVD via the superior petrosal sinus and petrosal vein; and posteromedial type, BCVD via the bridging vein and the anterior pontomesencephalic vein (Figure 1). MR images and/or 3D-DSA images also were reviewed when available.

FINDINGS/DISCUSSION
Basal cerebral venous drainage from CSDAVF was found in 12 patients (30%), and the other drainage routes included the superior ophthalmic vein in 25 (63%), the inferior petrosal sinus in 17 (43%), the superficial middle cerebral vein in 15 (38%), the superior petrosal sinus in 17 (18%), and pterygoid plexus in 2 (5%), respectively. In 12 patients with BCVD, superolateral type was found in 4 (33%), posterolateral type in 5 (42%), and posteromedial type in 7 (58%) (Figure 2). Four cases of posteromedial type were associated with other types of BCVD.

SUMMARY/CONCLUSION
Cavernous sinus dural arteriovenous fistulas often are associated with BCVD via three different pathways. The posteromedial type via the bridging vein is the most frequent type of BCVD.

KEY WORDS: Dural arteriovenous fistula, cerebral vein, embolization

Electronic Scientific Exhibit 91

Stent Assistance of Intracranial Aneurysm Treatment

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PURPOSE

APPROACH/METHODS
Fifty-seven patients with intracranial aneurysms have been treated with coil embolization with stent assistance between 2000 and 2008. Of the patients 41 were female and 16 were male. Age range was 32-66 years. We have used balloon expandable stents in nine cases and self-expandable stents in the other cases. Forty-five of the aneurysms were treated with stents and coils, three of the cases treated with Onyx and stents, two of the cases were treated with stent-stent graft combination, three cases with stent graft and four cases have been treated with single stent (SILK stent).

FINDINGS/DISCUSSION
Postprocedural angiographies showed total occlusion in all cases other than two of the cases. Deployment of the stent and reconstruction of the artery was technically successful in 55 of the cases. Two cases, one with immediate stent thrombosis and one acute stent thrombosis died due to massive
infarction. Angiographic follow up was available in 27 of the surviving cases at a mean of 14 months. Two of the cases with recanalization needed additional treatment after control angiography.

SUMMARY/CONCLUSION
Assisted-coil embolization techniques include balloon remodelling and stent assistance. Balloon remodelling was the only option in the early period. For prevention of coil migration and associated thrombosis, reconstruction of the parent artery stent use have been widened. In the early period the only option for intracranial use of stents was balloon expandable, coronary stents. Because of their rigidity and navigation problem self-expandable stents have been developed, they are more flexible, mostly compatible with use of microcatheters. Stent assistance of aneurysms necessitates the use of antithrombotic and anticoagulation during and after the procedure. This is a dilemma for the cases with ruptured aneurysms especially the cases who need neurosurgical interventions like external ventricular drainage.

KEY WORDS: Aneurysm, embolization, stent

Electronic Scientific Exhibit 92
Endovascular Management of Posterior Fossa Aneurysms: Our Experience at Henry Ford Hospital
Ellika, S. K. · Horia, M. L. · Kole, M. · Sanders, W. P.
Henry Ford Health Systems
Detroit, MI

PURPOSE
The management of patients with posterior circulation aneurysms, especially those located on the basilar artery, is particularly difficult surgically since surgical exposure in the posterior fossa is complicated by proximity of the arteries to deep brainstem structures, interposed cranial nerves and perforating vessels and overall outcomes are poorer than for anterior circulation aneurysms. In this exhibit, we report our experience in the endovascular treatment of posterior circulation aneurysms.

APPROACH/METHODS
Our review includes 40 patients who had intracranial aneurysms located in the posterior circulation and were treated endovascularly. We had 24 patients with basilar aneurysms (19 basilar tips, 3 midbasilar, 1 proximal basilar and 1 distal basilar), 5 with posterior inferior cerebellar artery aneurysms, 4 vertebral artery aneurysms, 4 superior cerebellar aneurysms, 2 posterior cerebral artery aneurysms and 1 persistent trigeminal artery aneurysm. Stent-assisted coiling was done in nine patients, balloon-assisted coiling in one patient and parent vessel occlusion was performed in four patients. All patients were seen and referred for endovascular treatment by experienced vascular neurosurgeons at our institution. All procedures were performed in a dedicated interventional neuroradiology angiographic suite with biplane fluoroscopy, digital subtraction angiography, and roadmapping capabilities. Various cases and selective images will be shown which demonstrate various endovascular methods to treat such aneurysms.

SUMMARY/CONCLUSION
Angiographic appearance of posterior fossa aneurysms at different anatomical locations is illustrated. In addition we will show and discuss the treatment indications, endovascular methods including coiling, stenting and parent vessel occlusion with associated risks and complications and technical challenges in this subset of patients. Current literature comparing endovascular and surgical treatment in posterior fossa aneurysms show that clinical outcomes of patients treated endovascularly had significantly better outcomes than patients who underwent surgery. Nevertheless aneurysm located in certain critical areas in the posterior fossa (e.g., fusiform basilar artery aneurysms and posterior inferior cerebellar aneurysms) pose a significant challenge to the interventionalist.

SUMMARY/CONCLUSION
In this exhibit we describe a spectrum of posterior fossa aneurysms and the different ways to treat them endovascularly. After going through this exhibit the radiologist should be able to understand treatment indications, various methods of treatment with their challenges and limitations.

KEY WORDS: Posterior fossa, aneurysms, endovascular treatment

Electronic Scientific Exhibit 93
Clip or Coil?: A Comprehensive Approach to Cerebral Aneurysm Management
Fitzpatrick, D. · Woldenberg, R. · Black, K. · Setton, A.
North Shore University Hospital
Manhasset, NY

PURPOSE
To use a question-based format to demonstrate factors which affect management decisions of cerebral aneurysms.

APPROACH/METHODS
Chosen aneurysm cases were selected from our weekly interdepartmental cerebrovascular conference where the multidisciplinary approach to cerebrovascular cases is discussed among neurosurgery, interventional neuroradiology, neuroradiology and neurology.

FINDINGS/DISCUSSION
Our quiz-based format will present examples of a variety of factors which direct aneurysm management including: aneurysm location and morphology, ruptured versus unruptured aneurysms and clinical factors. Use of endovascular stenting will be discussed. Each aneurysm case will contain the relevant clinical history and appropriate imaging followed by the question: clip or coil? Cases will be followed by a discussion of the pertinent factors which directed treatment.

SUMMARY/CONCLUSION
Clipping and endovascular coiling are mainstays of cerebral aneurysm treatment. Our quiz-based format will illustrate how various morphologic, anatomical, and clinical factors are balanced to determine optimal cerebral aneurysm therapy. In addition, indications for stent-assisted coiling will be
demonstrated. At the conclusion of the exhibit, participants will understand the multitude of factors upon which intracranial aneurysm management is based.

**KEY WORDS:** Aneurysm, coiling, clipping

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**Electronic Scientific Exhibit 94**

**Subdural Hemorrhage in Infants and Young Children**

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University of Iowa
Iowa City, IA

**PURPOSE**

Review anatomy of the meninges with an emphasis on the “subdural space”. We will review the mechanisms of injury causing subdural hemorrhage (SDH) and discuss unique features associated with nonaccidental head injury (NAHI). The evolution of SDH on CT and MR imaging will be discussed with the consideration of dynamic physiologic phenomena taking place in the subdural space. Finally, the differential diagnosis of SDH in NAHI is reviewed.

**APPROACH/METHODS**

Cases of accidental and nonaccidental head injury were reviewed in patients 0-3 years of age from 2005-2007 at our academic institution. Representative cases demonstrating the unique features of NAHI including diffuse/multicentric SDH, interhemispheric SDH, mixed-density SDH, and acute SD hygroma will be presented and contrasted with findings of accidental head injury. The prominent subarachnoid space in infancy also is discussed.

**FINDINGS/DISCUSSION**

Abusive head trauma is the leading cause of traumatic morbidity and mortality during infancy, with NAHI being the predominant cause of SDH. Subdural hemorrhage also is the most commonly associated intracranial pathology in NAHI. The subdural hemorrhage associated with NAHI is typically thin and spread over both cortices, and often involves the posterior fossa. The mechanism of injury determines the pattern of imaging findings and clinical presentation. In addition to the previously proposed mechanisms of SDH (impact loading and angular acceleration), we observed a pattern of injury that included a focal SDH with subjacent parenchymal injury. This pattern of injury is suggestive of a deformation mediated impact injury that is unique, and related to the excessive deformability of the infants skull and developing brain. Finally, the differential diagnosis of SDH in infants and toddlers ranges from a “normal” finding at birth or related to traumatic birth, to coagulopathy and rare inborn errors of metabolism.

**SUMMARY/CONCLUSION**

Subdural hemorrhage in infants and young children are unique in their imaging findings and this is related to the unique characteristics of the skull-calvarial unit. An understanding of these unique features is important to recognize and consider in the differential diagnosis of SDH in infants and young children.

**KEY WORDS:** Subdural hemorrhage, nonaccidental head injury

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**Electronic Scientific Exhibit 95**

**Nonaccidental Pediatric Head Trauma: A Neuroimaging Pictorial Review of the Findings, Mimics and the Pitfalls**

Ozsvath, J. A. · Nguyen, V.

Long Island Jewish Medical Center
New Hyde Park, NY

**PURPOSE**

To review the epidemiology, risk factors and importance of diagnosing nonaccidental pediatric head trauma. Review the pathophysiology. Review the most reliable signs of nonaccidental pediatric head trauma on CT and MR imaging. Review varying pitfalls, mimics and current controversies relating to the diagnosis.

**APPROACH/METHODS**

Case-based pictorial review of the most reliable CT and MR neuroimaging findings of nonaccidental pediatric head trauma, the mimics and pitfalls.

**FINDINGS/DISCUSSION**

Epidemiology and risk factors of nonaccidental pediatric head trauma. Discussion of the importance of early recognition and prompt diagnosis. Discussion of the pathophysiology and how it relates to imaging findings. Discuss the most reliable signs on CT and MR imaging in a case-based fashion. Demonstrate various pitfalls and mimics in a case-based fashion. Discuss current controversies relating to the diagnosis.
SUMMARY/CONCLUSION
While the diagnosis of nonaccidental pediatric head trauma often can be a complicated task, an understanding of the most reliable neuroimaging signs of abuse and their mimics/pitfalls leads to establishing an increased level of comfort in the diagnosis.

KEY WORDS: Pediatric, head, trauma

Electronic Scientific Exhibit 96
Radiologic Evaluation of Headache in Children: Pictorial Review

Marlow, M. · Patton, A.
Mayo Clinic
Rochester, MN

PURPOSE
To present a pictorial review of the intracranial pathologic processes in children with headache.

APPROACH/METHODS
Headache is the most common neurologic symptom in adults and children. In spite of published guidelines, there is overuse of neuroimaging, as significant intracranial pathology is rarely the cause. A retrospective review of neuroimaging in children presenting with headaches will be presented.

FINDINGS/DISCUSSION
Abnormal findings on neuroimaging in children with headaches were rare. In patients who had additional clinical findings including evidence of cerebellar dysfunction, increased intracranial pressure, strabismus, seizure, personality change or a history of deterioration of school performance, the yield was increased significantly. The imaging findings of significant intracranial pathology included: Chiari malformation, hydrocephalus, subdural/epidural empyema, dural venous thrombosis, arteriovenous malformation, vein of Galen aneurysm, herpes simplex encephalitis, and miscellaneous intracranial neoplasms.

SUMMARY/CONCLUSION
There is a low yield of abnormal neuroimaging in children with headaches. An increased yield may be achieved if published guidelines are followed and imaging is restricted to those in whom there is a higher likelihood of finding pathology. This requires taking a careful history and performing a thorough examination. Familiarity of imaging findings of uncommon pathologic processes will improve prompt diagnosis of treatable diagnosis of headache.

KEY WORDS: Headache, pathology, pediatrics

Electronic Scientific Exhibit 97
Central Nervous System Malformations and Fetal MR Imaging: An Educational Exhibit

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PURPOSE
Fetal MR imaging is an excellent imaging modality that is used most often to evaluate and clarify inconclusive ultrasound findings. It also is used in patients in whom ultrasound imaging is difficult or to evaluate for sonographically occult diagnoses. Recognizing and defining the entire spectrum of CNS abnormalities in each patient is critical as it may affect fetal outcome and counseling recommendations. There are numerous potential congenital and acquired CNS malformations that are important to understand and accurately diagnose on fetal MR imaging. In this educational exhibit we will review several of these entities along with their key teaching points.

APPROACH/METHODS
We reviewed the imaging findings of multiple patients who have had fetal MR imaging in our institution in the past 5 years. The patients were scanned with ultrasound and then referred to fetal MR imaging in the second or third trimester for evaluation of a suspected abnormality. The patients were scanned on a 1.5 T magnet using a body surface coil wrapped around the maternal pelvis. Images were obtained without intravenous contrast. We obtained 6 mm slice thickness single shot-fast spin-echo (SSFSE) T2 images in coronal, axial and sagittal planes relative to the maternal abdomen. We then obtained 4 mm slice thickness SSFSE T2, T1 and diffusion-weighted images related to the fetal brain.

FINDINGS/DISCUSSION
We identified patients with intracranial abnormalities and these abnormalities then were grouped into the following categories: Posterior fossa malformations [Chiari II with myelomeningocele (n = 2), Dandy Walker Malformation and Dandy Walker Variant (n = 6), cerebellar hypoplasia (n = 1), megacisterna magna (n = 1), suboccipital meningoencephalocele (n = 1)], Midline malformations [Aquaductal stenosis (n = 3), agenesis of the corpus callosum (n = 4)], Supratentorial parenchymal abnormalities (alobar holoprosencephaly (n = 1), hemimegalencephaly (n = 1), microlissencephaly with cerebellar hypoplasia (n = 1), hemorrhage/ischemia (n = 1) and tuberous sclerosis (n = 1)], Other [lymphangioma (n = 1), hydrops (n = 1)] and vascular malformations [vein of Galen (n = 1)]. The MR findings and key teaching points will be described for each of these entities.

SUMMARY/CONCLUSION
There is an increasing role for fetal MR imaging in early diagnosis and clinical decision making. The radiologist, often as part of a fetal development team, needs to be comfortable with their ability to understand and diagnose the wide range of possible CNS malformations. The goal of this exhibit is to help make this possible.

KEY WORDS: Fetal, CNS, malformations
PURPOSE
To demonstrate utility of real time cine magnetic resonance (MR) imaging in the prenatal evaluation of fetal swallowing and CSF flow dynamics.

APPROACH/METHODS
Real-time cine fetal MR evaluations were performed in 200 patients in addition to routine fetal MR assessment. All patients were referred to our tertiary care center based on CNS and neck abnormalities which were identified or questioned by prenatal ultrasonography. The fetal age ranged from 19 to 32 weeks. Dynamic processes of swallowing in the fetus and CSF flow were evaluated with True FISP cine MR imaging. All studies were performed on a 1.5 T superconducting MR scanner.

FINDINGS/DISCUSSION
Fetal swallowing was evaluated in patients with CNS abnormalities and neck masses, and the various phases of swallowing were identifiable and data could be used in planning of fetal delivery. Of the fetuses with neck masses, cine MR imaging could identify those which had preserved swallowing, and those with impaired swallowing. Incidence of impaired swallowing was found to be more prevalent in those with predominantly solid masses/teratomas and less prevalent with the group with predominantly cystic masses and veno-lymphatic malformations. Fetuses with complex CNS abnormalities also had impaired swallowing. Cerebrospinal fluid flow could be seen at the cranio-cervical junction with demonstration of impaired flow in some patients with Chiari II.

SUMMARY/CONCLUSION
Real-time cine MR imaging appears to be technically feasible and a potential valuable tool in prenatal assessment of dynamic functions of fetal swallowing and CSF flow. The additional information can be used for both prenatal and postnatal management.

KEY WORDS: Fetal cine MRI, fetal swallowing, fetal CSF flow dynamics

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Table 1. Pharmacokinetics Parameter Estimates in Children and Adults

<table>
<thead>
<tr>
<th>Parameter</th>
<th>PK in Children Aged 2-5y (N=15)</th>
<th>PK in Children Aged 5-16y* (N=25)</th>
<th>PK in Adults (N=4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Volume of Distribution (L/kg)</td>
<td>0.20 ± 0.03</td>
<td>0.170 ± 0.026</td>
<td>0.123 ± 0.028</td>
</tr>
<tr>
<td>Total Body Clearance (L/kg)</td>
<td>0.208 ± 0.030</td>
<td>0.199 ± 0.006</td>
<td>0.163 ± 0.018</td>
</tr>
<tr>
<td>Terminal Elimination</td>
<td>1.22 ± 0.239</td>
<td>1.51 ± 0.27</td>
<td>1.21 ± 0.09</td>
</tr>
<tr>
<td>Half Life (h)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>% Injected Dose Recovered in Urine</td>
<td>81.4% ± 11.2%</td>
<td>90.8% ± 5.1%</td>
<td>85.8% ± 5.42%</td>
</tr>
</tbody>
</table>

*One child was <5 years (i.e., 3.2 years)
SUMMARY/CONCLUSION
Gd-BOPTA is well tolerated, with a safety and pharmacokinetic profile in children comparable to that in adults. Compared to Gd-DTPA, Gd-BOPTA was equally well tolerated and performed significantly better for visualization of CNS tumors in pediatric patients.

Figure 1: Recurrent pilocytic astrocytoma of left mesial parietal lobe in 12-year-old girl (Gd-DTPA, top row; Gd-BOPTA, bottom row).

KEY WORDS: Gadobenate dimeglumine, pediatric, pharmacokinetics

Electronic Scientific Exhibit 100
Imaging Spectrum of Hypoxic Ischemic Encephalopathy in Neonates

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PURPOSE
Hypoxic ischemic encephalopathy (HIE) is a common and important cause of morbidity and mortality in neonates. The clinical presentation of HIE in neonates is variable, manifesting as lethargy, hypotonia, and seizures. Neuroimaging plays an important role in the diagnosis of HIE. Imaging is important to assess its severity, for assessing prognosis, and to exclude other etiologies for neonatal encephalopathy. Radiologic diagnosis requires an understanding of the physiology of the immature brain, the pathophysiology of ischemia, familiarity with the varied spectrum of imaging findings, and consideration of relevant clinical factors. In addition, it is important to recognize common clinical mimickers of HIE. All of these aspects will be reviewed in this educational exhibit.

APPROACH/METHODS
We performed a retrospective review of radiologic and clinical records of patients with clinically recognized HIE. MR imaging was available in all patients. The MR and MR spectroscopy (when available) findings were reviewed in context of the clinical setting. The characteristic MR findings in clinical mimickers of HIE such as hypoglycemia, viral encephalitis, and toxic/metabolic etiologies also were reviewed and compared.

FINDINGS/DISCUSSION
Hypoxic ischemic encephalopathy represents a spectrum of imaging findings dependent on gestational age at the time of insult, severity and duration of the event, and time at which imaging was obtained. Although it can be confusing, there is a characteristic pattern depending on these factors. Imaging findings differ between preterm (<36 weeks) and term (37+ weeks) neonates. Mild to moderate ischemic insults manifest as periventricular white matter injury in the preterm and parasagittal cortical and subcortical injury in term neonates. These differences are attributable to the changing vascular supply of the maturing brain as the intervacular watershed zones extend peripherally from a periventricular to a parasagittal location. The pattern of injury in severe or profound hypoxia reflects the areas of the brain with the highest metabolic activity at the time of insult. Severe hypoxia-ischemia in the preterm characteristically manifests as injury to the deep gray matter structures including the thalami, basal ganglia, and brainstem nuclei while term neonates demonstrate injury to the ventral thalami, dorsal putamina, hippocampi, brainstem, perirolandic cortex, and corticospinal tracts. The most severe cases of hypoxia-ischemia result in global supratentorial injuries in both preterm and term neonates.

SUMMARY/CONCLUSION
Despite improvements in perinatal care, the incidence of HIE encephalopathy remains high, often with variable clinical outcome. Neuroimaging plays a vital role in the management of these patients. Recognition of mechanism of injury, optimal timing of imaging and familiarity with the varied imaging spectrum of HIE and its common clinical mimickers is essential for accurate and prompt radiologic diagnosis.

KEY WORDS: Hypoxic ischemic encephalopathy, neonate, imaging

Electronic Scientific Exhibit 101
Multimodality Imaging Findings of Neonatal Hypoxic-Ischemic Encephalopathy Using Conventional and Modern Techniques

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Jackson Memorial Hospital/University of Miami
Miami, FL

PURPOSE
Neonatal hypoxic ischemic encephalopathy (NIE or HIE) results from systemic hypoxemia, reduced cerebral perfusion or both. It affects 2-9 of every 1000 live births and results in significant morbidity and mortality. Long-term sequelae include but are not limited to learning disabilities, mental
retardation, epilepsy, diplegia or quadriplegia and cerebral palsy. Reduced cerebral perfusion can occur from many factors which may be prenatal, perinatal and postnatal. The pattern of cerebral injury will depend on both the severity of ischemia and the gestational age of the infant at the time of insult. In addition, different patterns of injury have been shown to have differing long-term sequelae involving motor function and cognitive impairment. The purpose of this exhibit is to describe the imaging characteristics of HIE with US, CT and MR imaging. To emphasize the imaging findings on MR spectroscopy and perfusion-weighted imaging and to discuss the strengths and weaknesses of available imaging modalities in evaluation of various patterns of HIE.

**APPRAOCH/METHODS**
A retrospective review of imaging characteristics of different modalities was performed at Jackson Memorial Hospital/University of Miami for patients with the diagnosis of HIE.

**FINDINGS/DISCUSSION**
Different patterns of injury are observed that depend on the degree of brain maturity and severity of ischemic/hypoxic event. Patterns of injury in premature neonates (less than 34 weeks of gestational age) differ from term infants. Premature infants with mild events demonstrate periventricular white matter injury, while those with severe HIE demonstrate injury to thalami, basal ganglia and brainstem. Term neonates with mild HIE demonstrate predominantly watershed areas of injury, whereas patients with severe HIE demonstrate injury to thalami, basal ganglia, perirolandic cortex and brainstem. Echoencephalography is a convenient, low cost and noninvasive modality for recognition of periventricular leukomalacia, hemorrhage and hydrocephalus. CT is a rapid modality for evaluation of hemorrhage and hydrocephalus. MR imaging is the most sensitive and specific modality for imaging of neonate with HIE. Modern imaging techniques like MR spectroscopy, diffusion-weighted imaging and perfusion-weighted imaging with relative cerebral blood flow (rCBF) and relative cerebral blood volume (rCBV) further potentiate the effectiveness of MR imaging as a diagnostic and prognostic tool.

**SUMMARY/CONCLUSION**
Prompt, comprehensive and accurate evaluation of HIE is essential as different patterns of injury may be predictive of future motor and cognitive development and may guide rehabilitation.

**KEY WORDS:** Hypoxic-ischemic encephalopathy, neonates-Infants, MR imaging

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**Electronic Scientific Exhibit 102**

When It’s Not Just Otitis Media: Review of Temporal Bone Tumors and Other Mimics of Otitis Media in the Pediatric Patient

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**PURPOSE**
Otitis media is the most common disorder affecting the temporal bone in pediatric patients. Tumors and other disorders of the temporal bone may present with clinical symptoms which mimic otitis media. These mimicking conditions progress rapidly therefore making early recognition and diagnosis essential for effective and timely treatment. The purpose of this presentation is 1) to present a review of temporal bone anatomy in the pediatric patient, 2) to present a review of typical otitis media in pediatric patients, 3) to present a review of pediatric temporal bone pathologies that may mimic otitis media, and 4) to illustrate the CT and MR imaging findings of tumors and tumor-like conditions of the temporal bone in children with discussion of the differential diagnosis.

**APPROACH/METHODS**
Pediatric patients with otitis media, temporal bone tumors and other disorders that may mimic otitis media were identified in our radiologic record retrospectively. Detailed clinical and radiologic evaluation was performed and will be presented in an interactive manner.

**FINDINGS/DISCUSSION**
Otitis media is the most common disorder affecting the temporal bone in pediatric patients; however, tumors and tumor-like conditions can mimic otitis media clinically and radiologically. The presence of cranial nerve impairment and/or apparent mass formation suggests more serious conditions than uncomplicated otitis media. In such cases, CT and MR imaging of the temporal bone can help guide the management of patients with “severe” or “atypical” otitis media. A review of typical and atypical imaging findings of otitis media and its complications as well as more serious conditions which mimic otitis media will be presented, and the differential diagnosis will be discussed. These temporal bone disorders include acute and chronic otitis media, suppurative mastoiditis, Bezold’s abscess, petrous apicitis, rhabdomyosarcoma, Langerhans cell histiocytosis, metastatic tumor, fibrous dysplasia and other fibro-osseous disease.

**SUMMARY/CONCLUSION**
We present a collection of cases of pediatric temporal bone pathologies which mimic otitis media on clinical presentation. Recognition of atypical clinical features and further characterization with CT and MR imaging of the temporal bone is essential for establishment of a timely and correct diagnosis. Histological diagnosis from imaging findings in isolation may not be possible; however, imaging can narrow the differential diagnosis and aid in potential biopsy planning.

**KEY WORDS:** Temporal bone, pediatric, otitis media

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Hemimegalencephaly: White Matter Analysis with Diffusion Tensor Imaging and Histopathologic Correlation

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Los Angeles, CA

PURPOSE
Hemimegalencephaly (HME) is a severe congenital malformation of cortical development with classic findings of enlargement of the hemicerebrum, cortical thickening, and diminished sulci in the affected hemisphere. Abnormality also is seen in the white matter. Diffusion tensor imaging (DTI) and tractography can be used to demonstrate patterns of abnormality in this condition. The purpose of this exhibit is to: 1. illustrate MR imaging and DTI findings of HME and highlight the abnormal white matter pathways in tractography; 2. identify age-stratified differences of myelination in HME; pathologic imaging correlation; 3. identify pre and postoperative differences in the white matter appreciable by MR imaging and DTI.

APPROACH/METHODS
Thirty-three cases of HME who underwent hemispherectomy at UCLA between 1999 and 2007 were reviewed retrospectively. All cases had conventional MR imaging preoperatively. Diffusion tensor imaging was obtained in eight cases. Pre and postoperative DTI were obtained in two cases. Imaging pathologic correlation was performed. Diffusion tensor imaging was obtained with a 1.5 T scanner (Siemens Sonata) using 12 direction, two b values (b=600, 1200). Postprocessing was performed with DTI studio. Major white matter (corpus callosum, frontal occipital, temporal occipital, arcuate fasciculus, uncinate fasciculus, pyramidal tracts) tractography was obtained. Postsurgical specimens were reviewed with haematoxylin and eosin staining and Kluber Barrera myelin staining.

FINDINGS/DISCUSSION
White matter myelination is asymmetric in the patients with HME. In patients less than 6 months of age, the affected side demonstrates hypermyelination, which is confirmed by Kluber Barrera myelin stain. After the age of 1 year, these same areas demonstrate hypomyelination. Tractography shows aberrant fornix with thickening of the genu of the corpus callosum. Significant asymmetry of the major white matter pathways is seen preoperatively. After surgery, DTI tractography demonstrates normal development of the white matter tracts in the nonaffected hemisphere.

SUMMARY/CONCLUSION
Diffusion tensor imaging can precisely illustrate the characteristic white matter changes of HME, including the aberrant pathways and status of myelination. Diffusion tensor imaging is helpful in understanding white matter development of the normal hemisphere. In postsurgical patients with distorted anatomy, DTI can help to identify the different white matter pathways.

KEY WORDS: Hemimegalencephaly, diffusion tensor imaging, white matter
precession (FIESTA) and half-Fourier acquisition single-shot fast spin-echo (SSFSE) in the evaluation of normal fetal brain development; and brain and spine abnormalities.

**APPROACH/METHODS**

Eighteen fetuses (16 singlets and 2 monochorionic twins) of 20-36 weeks of gestation were examined by both techniques using a 1.5 T MR scanners. We included 1 normal fetus, 1 callosal agenesis, 1 twin-twin transfusion syndrome (TTTS) with callosal agenesis of one of the monochorionic twins, 1 Dandy-Walker malformation, 2 Dandy-Walker variant, 3 mega cisterna magna, 1 Chiari malformation with myelomeningocele, 1 occipital meningocele with severe hydrocephalus, 1 lobar holoprosencephaly, 1 tuberous sclerosis, 1 unilateral ventriculomegaly, 1 aqueductal stenosis with severe hydrocephalus, 1 venous infarction with intraventricular hemorrhage and 1 sacrococcygeal teratoma.

**FINDINGS/DISCUSSION**

The specific absorption rate was lower for FIESTA than for SSFSE. FIESTA and SSFSE provide comparable image quality in the second trimester when myelination of the cerebrum has not begun. Myelination beginning at the third trimester was better delineated with FIESTA than with SSFSE. Cortical sulcation was well delineated by both sequences. All brain and spine abnormalities were correctly diagnosed by both sequences.

**SUMMARY/CONCLUSION**

FIESTA is a fast sequence, free of movement artifacts with similar image quality and significantly lower radiofrequency absorption than SSFSE. FIESTA is a safer and effective alternative in the prenatal evaluation normal fetal brain development, and brain and spine abnormalities.

**KEY WORDS:** Fetal, brain, spine

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**Electronic Scientific Exhibit 106**

**Fetal Magnetic Resonance Imaging of the Central Nervous System Malformations: An Illustrative Study**

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**PURPOSE**

Ultrasonography is the gold standard method for the prenatal evaluation of central nervous system (CNS) malformations. However, the additional information that can be provided by MR imaging has improved the role of this technique for the assessment of CNS pathologies. This exhibit aims to illustrate the main fetal MR findings in CNS malformations.

**APPROACH/METHODS**

We have collected imaging data on about 500 fetal MR imaging studies, which will be used to illustrate and emphasize key concepts regarding the most common central nervous system malformations. Findings/Discussion

The most important imaging findings in each of the following headings will be illustrated and discussed. 1. MR imaging protocol and normal anatomy patterns; 2. Brain malformations: holoprosencephaly, commissural anomalies, hemimagalencephaly, lissescephaly, schizencephaly, others; 3. Cerebellar malformations: Dandy Walker spectrum, Others; 4. Spinal cord malformations: myelomeningocele, others; 5. Mixed malformations: Chiari malformations, others.

**SUMMARY/CONCLUSION**

In summary, the major teaching points of this exhibit are: 1. The knowledge of the normal anatomy patterns during each period of the fetal development is very important when evaluating fetuses with CNS malformations; 2. Although the CNS malformations are routinely evaluated with ultrasonography, fetal MR imaging provides key findings that help defining the differential diagnosis.

**KEY WORDS:** fetal MRI, central nervous system

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**Electronic Scientific Exhibit 107**

**Meningioangiomatosis: Imaging of a Rare Disorder with Pathology Correlation**

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¹Uniformed Services University of the Health Sciences, Bethesda, MD, ²Armed Forces Institute of Pathology, Washington, DC

**PURPOSE**

Meningioangiomatosis is a rare lesion involving the cerebral cortex that demonstrates characteristics of both meningioma and angiomia, and primarily affects children and young adults. It occurs both sporadically and in association with neurofibromatosis type 2 (NF2), and patients typically pres-
ent with seizures or headache. This exhibit will review the imaging findings of this uncommon entity with pathology correlation.

APPROACH/METHODS
The imaging and pathology of seven patients (age range 18 months - 23 years; M:F 4:3) with meningioangiomatosis was reviewed retrospectively by two neuroradiologists and an experienced neuropathologist.

FINDINGS/DISCUSSION
Five of the patients presented with seizure and two presented with headache. None of our patients had the diagnosis of NF2 at presentation, but long-term follow up was not available. MR imaging was available for all seven patients, and CT was available in three cases. In four cases the lesion was found in the temporal lobe; one was located in the frontal lobe, one in the parietal lobe, and one in the insula. All three cases with CT had associated cortical calcification. In all cases, low T2 signal was present in the cortex, there was adjacent T2 prolongation, and the involved cortex had abnormal morphology. On postcontrast imaging all seven cases demonstrated some degree of abnormal enhancement. In one case, there was an associated cyst. None of our cases were multifocal, although this has been reported. One case had an associated meningioma. We will discuss the ongoing debate suggesting that “meningioangiomatosis” lesions that are associated with meningioma are different and represent infiltration of the meningioma into the Virchow-Robin spaces.

SUMMARY/CONCLUSION
These seven cases demonstrate the varied imaging findings and pathology correlation of this rare disorder.

KEY WORDS: Meningioangiomatosis, neurofibromatosis type 2, seizure disorder

Electronic Scientific Exhibit 108
Changing Concepts in Diagnosis and Management of Congenital Inner Ear Anomalies: A Pictorial Review

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PURPOSE
Congenital inner malformations constitute 20% of all cases of sensorineural loss (SNL) in children. Despite their infrequent occurrence, such cases may prove to be a diagnostic challenge to both radiologists and surgeons alike. With the advent of better, safer, and faster imaging techniques, it is now possible to detect subtle changes in the cochleovestibular anatomy. This information is invaluable to avoid surgical complications and guide parental expectations, especially with the increasing use of cochlear implants in such patients. In this educational exhibit we briefly review the current radiologic classification of inner ear anomalies and summarize the wide spectrum of these malformations.

APPROACH/METHODS
We retrospectively reviewed the imaging findings of children who underwent evaluation for SNL in the last 4 years at our institutions. Both high-resolution computed tomography (HRCT) and magnetic resonance (MR) imaging scans of the temporal bones were performed to delineate cochlear anatomy, detect malformations (if any), identify the cochlear nerve and rule out associated central auditory pathway lesions. The anomalies were grouped according to the classification based on imaging characteristics as well as time of embryologic arrest of inner ear structures (1).

FINDINGS/DISCUSSION
We identified a wide spectrum of anomalies amongst patients who had inner ear malformations. Cochlear malformations ranged from mild anomalies such as classic Mondini deformity, cochleovestibular hypoplasia to the most severe Michel anomaly. Vestibular anomalies were seen to occur in association with cochlear and semicircular canal deformities. Malformations of the semicircular canal included common anomalies such as lateral canal vestibular dysplasia (LCVD) as well as uncommon anomalies such as utriculosaccular malformation and complete aplasia of all semicircular canals. Dilated vestibular aqueduct was the most common isolated anomaly seen. Internal Auditory Canal (IAC) deformities presented as narrow or stenotic IAC with associated absence of auditory nerve or dilated IAC. We describe the salient CT and MR findings of these abnormalities. We also outline the benefits and importance of preoperative imaging related to surgical planning and complications.

SUMMARY/CONCLUSION
Bony labyrinthine abnormalities are uncommon causes of pediatric SNL. It seems likely that with widespread availability of better and safer imaging modalities, the neuroradiologist who is an integral part of a dedicated cochlear implant team, may encounter such cases with increasing frequency. The neuroradiologist should therefore be aware of the diverse presentation of inner ear anomalies and be able to correctly identify them. Accurate preoperative diagnosis forewarns a surgeon, decreases the risk of complications and improves surgical outcome. Both CT and MR imaging are important diagnostic modalities for detection of these cases.

REFERENCES

KEY WORDS: Congenital, deafness, sensorineural
3D Constructive Interference in Steady State MR Imaging Findings in Children with Congenital Horizontal Gaze Palsy

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PURPOSE
Our purpose is to describe the characteristic features of the sixth, seventh and eighth cranial nerves and brain stem in children with congenital horizontal gaze palsy seen on 3D CISS (constructive interference in steady state) MR imaging.

APPROACH/METHODS
3D CISS using a 1.5 T MR scanner in 17 patients with congenital horizontal gaze palsy were reviewed retrospectively. The sixth, seventh and eighth cranial nerves were closely evaluated and designated as being normal or hypoplastic by two neuroradiologists who were blinded to the clinical diagnosis. Brain stem morphology also was evaluated. Six cases of Duane’s retraction, six cases of Möbius syndrome and five cases of congenital horizontal gaze palsy with progressive scoliosis (CHGPPS) were seen.

FINDINGS/DISCUSSION
All six patients with Duane’s retraction demonstrated unilateral hypoplasia of the sixth cranial nerve on the affected side. The seventh and eighth cranial nerves as well as the brain stem morphology were normal. In the six cases of Möbius syndrome, hypoplasia of the sixth and the seventh nerves was observed. In two of the six cases these findings were unilateral. Absence of the ipsilateral facial colliculus and normal eighth cranial nerves were seen in all cases. All cases of CHGPPS showed brain stem hypoplasia with absence of the facial colliculi, a deep midline pontine cleft and a butterfly configuration of the medulla. A normal appearance of the three cranial nerves was seen in all cases.

SUMMARY/CONCLUSION
This retrospective review of 17 patients with congenital horizontal gaze palsy demonstrates that 3D CISS, with its high-resolution images and excellent contrast between the cranial nerves and cerebrospinal fluid, can clearly depict the characteristic abnormalities of the cranial nerves in Duane’s retraction (unilateral hypoplasia of the sixth cranial nerve, but normal brain stem), Möbius syndrome (uni or bilateral hypoplasia of both sixth and seventh cranial nerves with absence of the facial colliculi) and CHGPPS (typical brain stem abnormalities with normal cranial nerves). 3D CISS may be a useful tool for evaluating congenital horizontal gaze palsy and it is important that the neuroradiologist be aware of these findings.

KEY WORDS: Congenital horizontal gaze palsy, Duane’s retraction, Mobius syndrome

Pediatric White Matter Diseases: Imaging “Pears”

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PURPOSE
This is a pictorial review of common and rare conditions that afflict the white matter in the pediatric age group. Recognition of distinctive imaging “pearls” will highlight this presentation.

APPROACH/METHODS
This presentation will emphasize the following white matter disorders in children: 1. Vitamin deficiency (Folate), 2. Metabolic (Urea cycle disorder), 3. Mitochondrial disorders (MERRF, MELAS, etc.), 4. Drugs/toxin (e.g., Methotrexate), 5. Demyelinating processes (ADEM and tumefactive variant), 6. Ischemic/vascular injury, 7. Neoplasm, 8. Trauma, 9. Epilepsy (postictal), 10. Neonatal [diffuse excessive high signal intensity (DEHSI) in term and preterm babies]. Key imaging features of each entity will be presented. Correlation with pertinent biochemical, genetic as well as clinical parameters will be undertaken.

FINDINGS/DISCUSSION
Afflictions of the white matter in children are distinct from those seen in adults. These conditions pose a diagnostic challenge as their clinical presentation is frequently nonspecific and the imaging findings may be overlapping. This is best exemplified by one of our patients with developmental delay, who was seen by multiple physicians without a clear diagnosis and left untreated for years. He was later found to have Folate deficiency, a treatable condition. This underscores the difficulty when nonspecific imaging findings are accompanied by vague clinical presentation. The appropriate diagnosis requires knowledge of the large spectrum of causes with similar imaging findings.

Abnormal myelination in 4-year-old with Folate deficiency sparing only corpus callosum. Patient was misdiagnosed and left untreated for years.
Cystic white matter changes in urea cycle disorder.

**SUMMARY/CONCLUSION**
Recognition of imaging “pearls” that point to the correct diagnosis is important as some conditions that affect the white matter may be treatable. Integration of neuroradiologic findings with clinical and other parameters may offer the highest diagnostic yield.

**KEY WORDS:** Dysmyelinating disorders, white matter diseases, metabolic disorders

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**Electronic Scientific Exhibit 111**

**Nephrogenic Systemic Fibrosis: What’s Up Doc?**

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**PURPOSE**
Nephrogenic systemic fibrosis (NSF) is a new rare idiopathic condition that affects patients with renal failure, characterized by cutaneous sclerosis that can often result in contractures, pain and functional disability as well as systemic complications. Originally known as nephrogenic fibrosing dermopathy because of its dominant cutaneous findings, the nomenclature was revised in recent years to reflect an increased understanding of its systemic effects. The purpose of this presentation is to describe the most important features related to NSF and to discuss the current recommendations regarding the use of gadolinium-based agents in patients with renal failure.

**APPROACH/METHODS**
The presentation will be organized by topics and will include: definition, epidemiology, pathophysiology, clinical manifestations, diagnosis, differential diagnosis, treatment, recommendations, and conclusion.

**FINDINGS/DISCUSSION**
Nephrogenic systemic fibrosis was first recognized in several patients in 1997 and was first described in literature in 2000. Although the precise cause of NSF is unknown, it only occurs in patients with renal failure, acute or chronic, particularly in those with chronic kidney disease stage 4 or stage 5 requiring dialysis. Patients who have had, or who are awaiting, liver transplantation also are thought to be at an increased risk of developing the disease. Grobner was the first to propose that magnetic resonance contrast media that contain gadolinium might be a trigger of NSF in January 2006. The total number of NSF cases is probably approaching 1000 patients these days.

**SUMMARY/CONCLUSION**
We believe that many radiologists, nephrologists, dermatologists and other physicians are still unaware that NSF may be a serious late adverse reaction to GBCA and hope we have provided as much information as possible to ensure a better knowledge of this rare but important condition.

**KEY WORDS:** Gadolinium, NSF (nephrogenic systemic fibrosis), adverse reaction

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**Electronic Scientific Exhibit 112**

**Sacroplasty: An Appraisal of the Current Trends and a Glance into the Future**

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**PURPOSE**
Sacroplasty is a recently described technique that entails injection of bone cement into osteoporotic sacral insufficiency fractures (SIF) or painful metastatic lesions of the sacrum. The purpose of this exhibit is to critically review and inspect the published medical literature on sacroplasty. We aim to highlight imaging features and some of the potential pitfalls. We present various challenges and offer a critical comparative analysis of various described techniques and outcome studies.

**APPROACH/METHODS**
Clinical presentation. Review of the current literature was performed. We describe pathogenesis, clinical presentation and imaging findings in both SIF and metastatic disease of the sacrum. We outline the various techniques of performing sacroplasty. Available outcome studies were reviewed critically.

**FINDINGS/DISCUSSION**
Sacral insufficiency fractures are treatable cause of significant morbidity and adversely affect the quality of life in at-risk groups and the elderly. They can be difficult to diagnose and the imaging appearance may be misleading. Sacroplasty produces relatively long-lasting improvements in pain, mobility, and the ability to perform activities of daily living. This procedure is applicable for both benign SIF and metastatic disease of the sacrum. We outline the various techniques of performing sacroplasty. Available outcome studies were reviewed critically.

**Spine**
112-120
SUMMARY/CONCLUSION
Although a relatively new procedure, sacroplasty is a modern marvel of medicine focused on improving activities of daily living in elderly patient promising pain-free aging with minimal if any complications. We believe that there will be greater inclination towards sacroplasty as the initial treatment option in near future.

KEY WORDS: Sacroplasty, sacral fractures, new technique

Electronic Scientific Exhibit 113
Metabolic Conditions Affecting the Spinal Cord: MR Imaging Findings
Spampinato, M. V. · Agarwal, A. K. · Rumboldt, Z.
Medical University of South Carolina Charleston, SC

PURPOSE
To review cases of signal alteration of the spinal cord on MR imaging due to systemic metabolic diseases, to discuss their imaging features and provide comprehensive differential diagnosis.

APPROACH/METHODS
We will present cases of myelopathy secondary to systemic metabolic diseases chosen from our teaching file. This includes nutritional deficiencies and systemic toxicities. Selected cases are presented to demonstrate the spectrum of the causes of intramedullary signal alteration due to underlying metabolic derangements. The clinical and radiologic findings are discussed along with follow up and cord changes after treatment.

FINDINGS/DISCUSSION
Metabolic conditions affecting the spinal cord are less common than metabolic disorders of the brain and peripheral nerves. Metabolic myelopathies can be secondary to nutritional deficiencies, among which the most common is vitamin B12 deficiency, and due to other less common metabolic conditions. Subacute combined degeneration is a term used to describe a myelopathy secondary to vitamin B12 deficiency, characterized pathologically by demyelination of the posterior column. The same clinical and pathologic picture has been described after exposure to nitrous oxide, in patients with and without vitamin B12 deficiency. Myelopathy secondary to copper deficiency, an extremely rare condition, can have imaging appearance similar to subacute combined degeneration of the spinal cord. The prevalence and imaging characteristics of diabetic myelopathy and hepatic myelopathy are not established. Diabetic myelopathy is very frequent, in fact spinal cord abnormalities are seen in up to 41% of autopsies in diabetic patients.

SUMMARY/CONCLUSION
Myelopathies can be secondary to systemic metabolic conditions, among which the most common is vitamin B12 deficiency. Majority of these conditions are treatable and full recovery can be achieved with an early diagnosis and treatment.

REFERENCES

KEY WORDS: Metabolic, cord, MRI

Electronic Scientific Exhibit 114
The “Dye-ing” Art
Lee, J. Y. · Wolfenberg, R. · Walz, D. · Spitz, D.
1North Shore University Hospital, Manhasset, NY, 2New England Baptist Hospital, Boston, MA

PURPOSE
Myelography often is performed secondary to surgeon preference and practice patterns. 1) Present various clinical scenarios with imaging findings to demonstrate the utility of conventional and CT myelography in disease detection and diagnosis. 2) Examine current ACR appropriateness criteria for its continued role in the evaluation of spinal disorders.

APPROACH/METHODS
1) Review of indications, contraindications and complications including clinical scenarios in which myelography may serve as the imaging modality of choice (contraindication to MR imaging, postoperative cases, lack of correlation of clinical findings with MR imaging). 2) Discuss practice guidelines and ACR appropriateness criteria. 3) Myelographic technique and spine anatomy.

FINDINGS/DISCUSSION
Clinical case presentation.

SUMMARY/CONCLUSION
Main teaching points: 1) CT and conventional myelography remain as invaluable tools in the investigation of spinal disease and should be recognized for their utility in certain clinical applications. 2) Myelography can achieve imaging of comparable clinical yield compared to MR imaging when used appropriately and performed correctly. 3) Knowledge of the current guidelines and indications where myelography should be considered is essential.

KEY WORDS: Myelography, CT

Electronic Scientific Exhibits
Spine Assistant: Initial Impressions of a Tool to Efficiently Generate Spine Reports

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PURPOSE
Evaluation of the spine can be a complicated process with reporting requirements for multiple levels. In addition, accepted descriptive terminology is not always followed in reporting. This creates the potential for miscommunication and errors both in reporting and subsequent clinical management. We introduce a new reporting tool and report its effect on the reporting workflow.

APPROACH/METHODS
In 2001, the Combined Task Force of the North American Spine Society, American Society of Spine Radiology, and American Society of Neuroradiology released a consensus document entitled “Nomenclature and Classification of Lumbar Disc Pathology” in an effort to standardize the language of reporting spinal imaging findings. The definitions and guidelines set forth in this paper were used to construct a web-based program in a graphical format to quickly generate reports compliant with Task Force descriptions. The project in its current form may be accessed at www.SpineAssistant.com. This tool then was introduced into the clinical workflow at our home institution. Usage patterns and changes in the workflow of reporting, including those of residents, neuroradiology fellows, and attendings then were observed. In addition, feedback also was collected from orthopedists and neurosurgeons regarding the change in reporting format.

FINDINGS/DISCUSSION
Aims: 1) To increase awareness and correct use of accepted descriptions of disk pathology through use as an educational tool in the training of radiology trainees and as a refresher for those already in practice. 2) To streamline and improve the reporting of spine pathology by providing a tool to efficiently generate well organized reports that clearly communicate pathology. Simple measurement and classification tools in graphical format with easily referenced schematics to teach or clarify preferred correct disk nomenclature and classification of disk pathology are provided. 3) To develop a foundation for a DICOM-SR spine classification system.

SUMMARY/CONCLUSION
We introduce a web-based report generation tool to quickly, systematically, and efficiently produce spine reports that are compliant with accepted nomenclature and classification of disk pathology. In addition, we observe and report changes in reporting workflow at our home institution after the introduction of this tool into the clinical environment.

KEY WORDS: Spine, reporting, workflow

Don’t Make a Rod for Your Own Back: Know Your Thoraco-Lumbar Spine Instrumentation

Booth, T. C. 1 · Haridas, A. 2 · Chandrashekar, H. 2 · Madigan, J. 2 · Robertson, F. 2 · Kandasamy, N. 1 · Langdon, J. 4
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PURPOSE
To improve the reader’s evaluation of the postoperative lumbar spine. Cases of patients requiring spinal instrumentation are shown. On completion the reader will be able to: 1. Understand the indications for instrumentation; 2. Describe the surgical aims (provide stability, reduce or correct deformity and pain); 3. Discuss the surgical approaches (anterior, posterior, minimally invasive); 4. Identify instrumentation (the hardware and the bone grafts); 5. Select appropriate imaging techniques (including appropriate MR imaging sequence).

APPROACH/METHODS
Interesting cases will be presented in an illustrated quiz format. Key points will be highlighted in each case. Included is a: 1. Discussion of indications and surgical aims; 2. Description of the imaging techniques and instrumentation.

FINDINGS/DISCUSSION
1. Indications for instrumentation described are scoliosis and other spinal abnormalities, degenerative disease, spondylolisthesis, trauma, instability, infection and neoplasm; 2. The surgical approaches discussed include posterior and short segment anterior instrumentation in scoliosis, posterior and anterior instrumentation in the degenerative spine and following trauma, as well as thoracotomy, sternotomy and anterior abdominal approaches; 3. The instrumentation described includes pedicle screws, rods, cross links, hooks, sublaminar wires, rectangular frame, plates, interbody fusion cages as well as bone grafts; 4. Appropriate imaging techniques discussed include radiographs, CT and MR imaging as well as the implication of titanium hardware, frequency encoding gradient strength and hardware orientation.

SUMMARY/CONCLUSION
1. Instrumentation is used to stabilize the spine, reduce or correct deformities and fractures and replace abnormal vertebrae; 2. A bone fusion usually is attempted with the insertion of hardware to prevent failure; 3. Surgical procedures often consist of posterior (posterior element) and less often anterior fixation or a combination of both (i.e., 360 degree fixation); 4. Instrumentation and surgical technique evolves - radiologists need to be familiar with device and biomechanical principles by working with their surgical colleagues.

KEY WORDS: Instrumentation, hardware, metalwork
Electronic Scientific Exhibit 117

Know Your Nuts and Bolts: Postoperative Evaluation of Thoraco-Lumbar Spine Instrumentation

Booth, T. C.1 · Haridas, A.2 · Kandasamy, N.3 · Chandraшекar, H.2 · Madigan, J.2 · Langdon, J.4 · Robertson, F.2
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PURPOSE
To improve the reader’s evaluation of postoperative lumbar spine complications, cases of patients requiring spinal instrumentation are shown. On completion the reader will: 1. Understand the indications for instrumentation; 2. Describe the surgical aims (provide stability, reduce deformity and pain); 3. Evaluate the postoperative spine (hardware position, bone graft fusion and potential complications); 4. Select appropriate imaging techniques according to complication (including appropriate MR imaging sequence).

APPROACH/METHODS
Interesting cases will be presented in an illustrated quiz format. Key points will be highlighted in each case. Included is a: 1. Discussion of indications and surgical aims; 2. Description of the imaging technique and instrumentation; 3. Postoperative evaluation; 4. Implication of complications.

FINDINGS/DISCUSSION
1. Indications described are scoliosis and other spinal abnormalities, degenerative disease, spondylolisthesis, trauma, instability, infection and neoplasm; 2. Appropriate imaging techniques discussed are radiographs, CT, CT myelogram, MR imaging, ultrasound, fluoroscopy and diagnostic injection; 3. Key parameters to optimize MR imaging are described - titanium hardware, frequency encoding gradient strength and hardware orientation; 4. The postoperative spine evaluation is discussed focusing on hardware position, bone graft fusion and the complications - neurologic, pseudo-arthritis, instrument failure, screw pull out or fracture, movement of cage position, pain and infection.

SUMMARY/CONCLUSION
1. Instrumentation is used to stabilize the spine, reduce or correct deformities and fractures and to reconstruct spine following a corpectomy or vertebrectomy for compressive lesions like tumor, infection (e.g., tuberculosis and degenerative disk disease); 2. A bone fusion usually is attempted with the insertion of instrumentation for stabilization; 3. Radiographs and CT form the mainstay of postoperative evaluation although there are indications for MR imaging, fluoroscopy and ultrasound; 4. Primary complications are neurologic, pseudo-arthritis, instrumentation failure, pain and infection.

KEY WORDS: Instrumentation, hardware, metalwork

Electronic Scientific Exhibit 118

Primary and Secondary Sacral Neoplasia: An Interactive, Pictorial Review with High-Resolution 3 T Magnetic Resonance and Multidetector Computed Tomography Imaging

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PURPOSE
Though primary sacral neoplasms account for a small percentage of primary spinal tumors, their often initial insidious growth can delay patient presentation until neurovascular or organ involvement occurs. The purpose of this electronic exhibit is to illustrate, by pictorial review, the spectrum of sacral neoplasms, as demonstrated by modern high resolution 3 T magnetic resonance and multidetector computed tomography imaging techniques. The imaging findings will be discussed in the context of and their relevance to clinical and surgical decision making and therapeutic choices.

APPROACH/METHODS
Illustrative examples encompassing a wide breadth of sacral neoplastic pathology were selected from a population of patients who underwent high resolution 3 T magnetic resonance and multidetector computed tomography imaging from 2000-2008 at our institution.

FINDINGS/DISCUSSION
A gamut of both benign and malignant, primary and metastatic sacral neoplasms were chosen for this interactive and illustrative pictorial review. Depicted pathologies included aneurysmal bone cyst, osteochondromatosis, osteoblastoma, giant cell tumor, Langerhans cell histiocytosis, teratoma, schwannoma, ependymoma, plasmacytoma, chordoma, chondrosarcoma, osteosarcoma, Ewing’s sarcoma, and secondary metastatic lesions. The relevant differential diagnostic considerations as well as important anatomical landmarks for clinical and surgical decision making were dynamically integrated with the pictorial content.

SUMMARY/CONCLUSION
Neuroradiologists must be aware of the broad spectrum of primary sacral neoplasms in their consideration of sacral masses. This presentation effectively illustrates the modern high-resolution imaging appearance of a gamut of primary and secondary sacral neoplastic entities, emphasizing distinguishing features of the tumors, appropriate differential considerations, and integrating relevant clinical, therapeutic factors.

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**KEY WORDS:** Sacral tumors, pictorial review, MRI

**Electronic Scientific Exhibit 119**

The L5 Nerve Root: A Pictorial Review of Its Anatomy and Pathology

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**PURPOSE**

Provide a thorough description of the L5 nerve root anatomy as it emerges from the thecal sac, and its course along the spinal canal, lateral recess, lateral canal, neural foramen, and extraforaminal-far lateral region. Demonstrate the most common pathologic conditions which affect the nerve roots along their pathway.

**APPROACH/METHODS**

This focused anatomical and pathologic review is demonstrated through cross-sectional imaging of the lumbar spine utilizing a multislice 64 dual source CT scan, a 1.5 T MR imaging, 3D reconstructions and graphics: Nerve roots: An anatomical description is performed on the nerve roots and their branches: recurrent meningeal nerve, ventral nerve root, dorsal nerve root, dorsal root ganglion, and the spinal nerve. Anatomical Landmarks: These include: 1) The L4-L5 intervertebral disk and the L5 origin (at the disk - superior end plate junction). 2) The boundaries and relationships that the L5 nerve root has within the spinal canal, lateral recess, lateral canal, neural foramina and extra foraminal region. At the L5-S1 level, illustrations demonstrate how the L5 superior articular facets, ligament flavum and osteophytes cause L5-S1 foraminal stenosis and secondary L5 nerve root impingement. Pathology: L5 nerve root compression is caused by a variety of pathologic conditions affecting the L4-L5 intervertebral disk space, lateral canal, neural foramen and extraforaminal-far lateral region. These include: • Intervertebral disk pathologies such as bulgings, protrusions, and herniations which can be central, paramedian, foraminal or extraforaminal in location (with extrusion or migration). Transosseous disk herniation due to avulsion of the apophyseal rim of the L5 vertebral endplate. • Secondary nerve root compression by different types of foraminal stenosis which include: caudo-cephalic stenosis, anteroposterior stenosis, and pinhole stenosis. • Spinal degenerative instability at the L4-L5 level (with anterolisthesis or retrolisthesis), and the mechanism by which compression of the thecal sac and L5 nerve roots occur: • Spondylolisthesis with spondylosis at L5-S1 with secondary entrapment of L5 nerve root. • Double compression for L5 nerve root (at the L4-L5 nerve root origin, and as the nerve exits at the L5-S1 level).

**FINDINGS/DISCUSSION**

The purpose of evaluating the origin and entire course of the L5 nerve roots is not to find causes of diskogenic pain or pain secondary to a degenerated disk. The real purpose is to accurately identify the lesions that cause L5 radicular pain. This approach ultimately will lead to an adequate patient care and will provide the exact information that the surgeons need to know.

**SUMMARY/CONCLUSION**

This anatomical review facilitates the identification of L5 nerve root compression along the entire L5 nerve root pathway, independently of the pathologic cause. This knowledge allows an effective and reliable method for the diagnosis of lumbar spine pathology, which ultimately results in a more precise diagnosis and a decrease in the number of failed back surgeries.

**KEY WORDS:** L5 Nerve, anatomy, pathology

**Electronic Scientific Exhibit 120**

Withdrawn
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