An educational grant in support of the NER Foundation Symposium 2007: The Aging Brain.

Bayer Healthcare Pharmaceuticals/NER Foundation Fellowship in Basic Science Research

Annual Bayer Healthcare Pharmaceuticals Outstanding Presentation Award in General Neuroradiology

Annual educational grant in support of the Maintenance of Certification (MOC) and Self Assessment Modules (SAM) programming live and on the ASNR website.
Dear Colleagues,

Welcome to the ASNR 45th Annual Meeting and NER Foundation Symposium 2007. David M. Yousen, MD, MBA, President-Elect/Program Chair, has assembled a program with thought-provoking and significant educational and scientific sessions for this year’s program.

The NER Foundation Symposium 2007: The Aging Brain will bring us all up to speed on an important area of neuroradiology research and clinical care. Discussions will focus on brain volume and intracranial atherosclerosis as well as on important trends and opportunities for the future.

The Annual Meeting features more than 40 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 Interventional and Therapeutic Neuroradiology (ASITN) and the American Society of Spine Radiology (ASSR), covering a wide range of topics for both the sub-specialist in neuroradiology and the general neuroradiologist.

In addition to the focus sessions, the meeting will offer Advanced Imaging Seminars, expanded ELC Workshops and Lectures, the ASNR Business Center, How-To Sessions, and daily Maintenance of Certification (MOC) review sessions. Again this year, we are pleased to provide Audience Response Plus (AR+) throughout the entire program.

Our Annual Meeting provides a unique opportunity to better understand how the ASNR assists its members in the practice of neuroradiology during a time of rapid change. We can all look forward to renewing old friendships and making new ones as we exchange ideas and expand our knowledge. Please join us at the “All That Jazz” Reception with the technical exhibitors on Tuesday evening. The Scientific Exhibition will be open for viewing during the evening. Be sure to spend some free time during your stay by participating in our optional tour program offered throughout the week.

I wish to extend a special thanks to Dr. David Yousen and to the following Co-Chairs for their efforts in organizing the program:

American Society of Functional Neuroradiology (ASFNR) ............................................Jeffrey R. Petrella, MD
American Society of Head and Neck Radiology (ASHNR) .............................................Timothy L. Larson, MD
American Society of Interventional and Therapeutic Neuroradiology (ASITN) ..............Mary E. Jensen, MD
American Society of Pediatric Neuroradiology (ASPNR)................................................Nancy K. Rollins, MD, FAAP
American Society of Spine Radiology (ASSR).................................................................Alyssa T. Watanabe, MD

On behalf of the entire Executive Committee, welcome to Chicago, Illinois for the ASNR 45th Annual Meeting and NER Foundation Symposium 2007 -- where advanced technology, clinical imaging and interventional neuroradiological excellence come together.

Sincerely,

Robert I. Grossman, MD
ASNR President
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2006-2007 ASNR Executive Committee

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About Chicago, Illinois

The ASNR 45th Annual Meeting and NER Foundation Symposium 2007 host venue is the Hyatt Regency Chicago, Chicago’s premier downtown hotel located just steps from Chicago’s Magnificent Mile, offering immediate access to shopping, entertainment, parks, museums and other cultural attractions.

With over 31 miles of lakefront, 15 miles of bathing beaches and 550 parks, the possibilities for an outdoor adventure in Chicago’s downtown are endless. Be sure to stroll through Millennium Park and enjoy extraordinary art and architecture, catch a free concert at the Jay Pritzker Pavilion or escape to the luscious gardens that make this centrally located park a reflection of Chicago’s culture and personality. Drop by the Lincoln Park Zoo, one of North America’s last free zoos, and visit with exotic animals from around the world, all within view of Chicago’s impressive skyline.

Not in the mood for the great outdoors? Chicago offers 54 museums, 200 theaters and over 15,000 restaurants for you to enjoy. Chicago’s downtown Museum Campus is home to three of Chicago’s most beloved museums: The Field Museum of Natural History, (home of Sue, the largest, most complete and best preserved Tyrannosaurus Rex ever discovered), The Shedd Aquarium (the largest indoor aquarium in the world and home of one of the largest and most diverse shark habitats in North America) and the Adler Planetarium (the first planetarium in the Western Hemisphere). Other internationally renowned institutions include the Museum of Contemporary Art, the Museum of Science and Industry and the Art Institute of Chicago, whose collections of Impressionist paintings is second only to the Louvre in Paris.

Walking Map of Chicago

Enjoy your stay in Chicago!

ASNR would like to thank Northstar Travel Media, LLC for the use of their Chicago, Illinois map.
General Information

Meeting Registration
Registration will take place in the Grand Ballroom Registration Foyer in the Hyatt Regency Chicago. The registration desk will be open during the following hours:

- Friday, June 8 ...............................5:00 pm - 8:00 pm
- Saturday, June 9 .............................8:00 am - 6:00 pm
- Sunday, June 10 .............................6:30 am - 6:00 pm
- Monday, June 11 .............................6:30 am - 6:00 pm
- Tuesday, June 12 ..............................6:30 am - 6:00 pm
- Wednesday, June 13 .........................6:30 am - 6:00 pm
- Thursday, June 14 .............................6:30 am - 6:00 pm

Speaker Ready Room Location & Hours
Hyatt Regency Chicago - Columbus AB
- Saturday, June 9 ..............................7:00 am - 6:00 pm
- Sunday, June 10 through Thursday, June 14 ..............................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, ASITN, ASPNR, or ASSR Member ............................................Blue
- Non-Member .................................................Green
- Fellow/Trainee ...............................................Tan
- Other Professional .................................Yellow
- Guest ..........................................................Tan
- Exhibitor ......................................................Gold
- Staff ..........................................................Purple

Committee/Specialty/Regional Society Meetings
Please refer to the Daily Postings on the Meetings & Announcements Board located in Riverside Center East of the Hyatt Regency Chicago.

Meetings & Announcements Board
The Meetings & Announcements Board is located in Riverside Center East of the Hyatt Regency Chicago. Please refer to the Daily Postings on the Meetings & Announcements Board for information on committee meetings.

CME & E-Access Message Pavilion
New this year - 2 locations!

Location 1: Hyatt Regency Chicago — Columbus CD
- Saturday, June 9 ..............................1:00 pm - 9:00 pm
- Sunday, June 10 through Thursday, June 14 .........................6:30 am - 9:00 pm

Location 2: Hyatt Regency Chicago — Riverside Center West
- Tuesday, June 12 ..............................10:00 am - 4:00 pm
- Wednesday, June 13 through Thursday, June 14 .........................9:45 am - 4:00 pm

Hyatt Regency Chicago Information
Hyatt Regency Chicago
151 East Wacker Drive
Chicago, Illinois 60601
Phone: 312-565-1234

Coat Check
Grand Ballroom Registration Foyer
(East Tower/Gold Level)
Hours of Operation:
- Saturday, June 9 ..............................8:00 am - 6:00 pm
- Sunday, June 10 through Thursday, June 14 .........................6:00 am - 9:00 pm

Emergency Service Procedure
Within the Hyatt Regency Chicago:
In the event of a medical emergency, please contact Security Control immediately. Attendees may contact Security Control by dialing extension 55 from any house phone located in the facility. Emergency personnel will be dispatched immediately to your location.

The caller should provide the following:
1. Determine name of specific meeting room or exhibit hall where the situation has occurred.
2. Identify yourself as an ASNR attendee, reference your exact location, and provide details on the nature of the emergency situation.
3. Provide a brief but concise description of the problem, be prepared to answer any questions that the operator may ask you, and remain on the line.

Contacting Security Control will greatly minimize response time in the event an emergency medical unit needs to report to the hotel. Security personnel can quickly assess the situation and bring emergency personnel directly to the scene, saving precious minutes. For this reason, the Hyatt Regency Chicago management requests that attendees not contact 911 directly.

Nearest Hospital/Urgent Care
Northwestern Memorial Hospital
251 East Huron Street
Chicago, Illinois 60611
Phone: 312-926-2000
General Information (continued)

Pharmacy & Drug Stores

Walgreens Pharmacy
300 North Michigan Avenue, Chicago, Illinois
Phone: 312-558-9079
Pharmacy Hours: Monday - Friday, 8:00 am - 6:00 pm
Saturday and Sunday, Closed

Walgreens (24-Hour Pharmacy)
757 North Michigan Avenue, Chicago, Illinois
Phone: 312-664-8686
Hours: Open 24 hours

Photocopy Service

Pitney-Bowes
Located within the Hyatt Regency Chicago on the Bronze, Concourse Level of the East Tower.
Phone: 312-239-4410
Hours: Monday - Friday: 6:15 am - 7:00 pm
Saturday: 8:00 am - 5:00 pm
Sunday: 9:00 am - 6:00 pm

Food Service

ASNR Food Service will be served in Riverside Center West during technical exhibition hours or in the Grand Ballroom Foyer.
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, June 10 .................................Columbus H-L
Monday, June 11 through
Wednesday, June 13 .............Grand Ballroom Foyer/
Columbus H

How-To Session Breakfasts
Sunday, June 10 through
Wednesday, June 13 ....................Grand Ballroom C-F

Morning Breaks
Sunday, June 10 .................................Columbus H-L
Monday, June 11 ......Grand Ballroom Foyer/Columbus H
Tuesday, June 12 through
Thursday, June 14 ........................Riverside Center West

Box Lunches
Sunday, June 10 .................................Columbus H-L
Monday, June 11 ......Grand Ballroom Foyer/Columbus H
Tuesday, June 12 through
Thursday, June 14 ........................Riverside Center West

How-To Session Lunches
Sunday, June 10 through
Wednesday, June 13 ....................Grand Ballroom C-F

Afternoon Breaks
Saturday, June 9 through
Sunday, June 10 .................................Columbus H-L
Monday, June 11 ......Grand Ballroom Foyer/Columbus H
Tuesday, June 12 through
Thursday, June 14 ........................Riverside Center West

Meeting Location: Hyatt Regency Chicago
NOTE: All scientific sessions are located in the East Tower/Gold Level of the Hyatt Regency Chicago. All scientific and technical exhibits are located on the East Tower/Purple Level of the Hyatt Regency Chicago.

Registration
Grand Ballroom Foyer

CME Pavilion Terminals
Columbus Room CD
Riverside Center West

E-Access/Messaging Center
Columbus Room CD
Riverside Center West

How-To Breakfast/Lunch Sessions
Grand Ballroom C-F

Focus/Scientific Paper Sessions
Grand Ballroom C-F, Columbus I-L, Grand Ballroom A and Grand Ballroom B

Electronic Learning Center (ELC)

Workshops & Lectures
Columbus G

EXHIBITS

Scientific Exhibits, Electronic Scientific Exhibits (eSE), Scientific Posters
Riverside Center East

Technical Exhibits
Riverside Center West

MISCELLANEOUS

American Board of Radiology (ABR) Desk
Grand Ballroom Foyer

ABR Exam Room
Columbus G

American Journal of Neuroradiology (AJNR) Desk
Grand Ballroom Foyer

American Medical Association (AMA) Desk
Grand Ballroom Foyer

Coat Check
Grand Ballroom Foyer

Headquarters Office
Grand Suite 3

Meetings & Announcements Board and Job Postings Board
Riverside Center East

Past-Presidents’ and Executive Committee Office
Grand Suite 2B
Optional Tour Desk Hours

Hyatt Regency Chicago - Truffles Hall (West Tower/Blue Level)
Saturday, June 9 ....................................................................................................................11:00 am – 4:00 pm
Sunday, June 10 through Thursday, June 14 ..........................................................................8:00 am – 12:00 pm

Guest Hospitality

Hyatt Regency Chicago
Truffles Hall (West Tower/Blue Level)

The Guest Hospitality area, available to ASNR registered guests, provides complimentary food service and visitor information. Teens and younger individuals who are with registered guests, but are not themselves registered, may also visit the hospitality room. Afternoon snacks and beverages will be offered on Saturday, June 9. Continental breakfast and beverages will be available from Sunday, June 10 - Thursday, June 14.

Guest Hospitality is a great place to start your mornings and plan the remainder of your day. It’s an ideal location to see old friends and meet new acquaintances.

A representative will be available to acquaint you with suggestions on what to see and do while in Chicago. Be sure to stop by to pick up visitor information and brochures available in Guest Hospitality on citywide attractions, downtown maps, and shopping and restaurant guides to assist you in planning your week.

Guest Hospitality Hours

Hyatt Regency Chicago
Saturday, June 9 ............................11:00 am – 4:00 pm
Sunday, June 10 through
Thursday, June 14 ......................8:00 am – 12:00 pm

Social Program

“All That Jazz” Reception with Technical Exhibitors

Hyatt Regency Chicago
Riverside Center West
Tuesday, June 12, 2007
6:30pm - 8:00pm

The “All That Jazz” Reception with the Technical Exhibitors offers the perfect opportunity to see this year’s Technical Exhibits, the ASNR’s annual showcase for the newest products and services for the field of Neuroradiology. Enjoy complimentary pre-dinner hors d’oeuvres and beverages while you learn about the newest technologies. Connect with old friends, make new ones and meet representatives from the companies participating in this year’s technical exhibition. This casual social setting allows plenty of time for informal discussion with the company representatives, so bring your product and service challenges and come in search of solutions to the place where advanced technology and diagnostic and interventional neuroradiological excellence come together. The Chicago Jazz Quartet will set the atmosphere for the evening, performing originals and classic tunes from well-known artists like Frank Sinatra, Ella Fitzgerald and Nat King Cole. The Scientific Exhibit (poster, scientific and electronic scientific exhibits) will also be available for viewing throughout the evening’s reception.

Ticket required for admission

A ticket to the Reception is included in the fee for registration categories that include Tuesday, June 12 and in the Guest Hospitality fee.
ASNR FUTURE ANNUAL MEETINGS

46th Annual Meeting
June 1 - 5, 2008 | Ernest N. Morial Convention Center
New Orleans, Louisiana

2009
47th Annual Meeting
May 16 - 21
Vancouver Convention and Exhibition Centre
Vancouver, B.C., Canada

2010
48th Annual Meeting
May 15 - 20
Hynes Convention Center
Boston, Massachusetts

2011
49th Annual Meeting
June 4 - 9
Washington State Convention and Trade Center
Seattle, Washington

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

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

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
Stater 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

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

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

Thirty-Third Annual Meeting
March 3-7, 1994
Opryland Hotel and
Conference Center
Nashville

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

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

Thirty-Sixth Annual Meeting
May 18-22, 1997
Metroid Toronto Convention Centre
Toronto

Thirty-Seventh Annual Meeting
May 13-17, 2002
Vancouver Convention & Exhibition Centre
Vancouver

Thirty-Eighth Annual Meeting
April 28 - May 2, 2003
Marriott Wardman Park Hotel
Washington, DC

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

Forty-First Annual Meeting
May 21-27, 2005
Metro Toronto Convention Centre
Toronto

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

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

Forty-Fourth Annual Meeting
May 23-27, 1999
San Diego Convention Center
San Diego

Forty-Fifth Annual Meeting
April 4-8, 2000
Hyatt Regency Atlanta
Atlanta

Forty-Sixth Annual Meeting
April 23-27, 2001
Hyenas Convention Center
Boston

Fortieth Annual Meeting
May 13-17, 2002
Vancouver Convention & Exhibition Centre
Vancouver
<table>
<thead>
<tr>
<th>Year</th>
<th>President</th>
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<tbody>
<tr>
<td>1962-64</td>
<td>Juan M. Taveras, MD*</td>
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<tr>
<td>1964-65</td>
<td>Mannie M. Schechter, MD*</td>
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<tr>
<td>1965-66</td>
<td>Donald L. McRae, MD*</td>
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<tr>
<td>1966-67</td>
<td>Ernest H. Wood, MD*</td>
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<td>1967-68</td>
<td>Harold O. Peterson, MD*</td>
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<tr>
<td>1968-69</td>
<td>Colin B. Holman, MD</td>
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<tr>
<td>1969-70</td>
<td>Giovanni Di Chiro, MD*</td>
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<tr>
<td>1970-71</td>
<td>D. Gordon Potts, MD</td>
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<tr>
<td>1971-72</td>
<td>Norman E. Chase, MD</td>
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<tr>
<td>1972-73</td>
<td>Fred J. Hodges, III, MD</td>
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<tr>
<td>1973-74</td>
<td>T. Hans Newton, MD</td>
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<tr>
<td>1974-75</td>
<td>Hillier L. Baker, Jr., MD</td>
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<tr>
<td>1975-76</td>
<td>Irvin I. Krecheff, MD</td>
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<td>1976-77</td>
<td>Norman E. Leeds, MD</td>
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<td>1977-78</td>
<td>Sadek K. Hilal, MD*</td>
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<td>1978-79</td>
<td>Stephen A. Kieffer, MD</td>
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<td>1979-80</td>
<td>David O. Davis, MD</td>
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<tr>
<td>1980-81</td>
<td>George Wortzman, MD</td>
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<tr>
<td>1981-82</td>
<td>Gabriel H. Wilson, MD</td>
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<td>1982-83</td>
<td>Arthur E. Rosenbaum, MD</td>
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<td>1983-84</td>
<td>O. Wayne Houser, MD</td>
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<td>1984-85</td>
<td>Samuel M. Wolpert, MD</td>
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<td>1985-86</td>
<td>R. Thomas Bergeron, MD</td>
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<tr>
<td>1986-87</td>
<td>Derek C. Harwood-Nash, MD*</td>
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<td>1987-88</td>
<td>Michael S. Huckman, MD</td>
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<td>1988-89</td>
<td>Anne G. Osborn, MD</td>
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<td>1989-90</td>
<td>Joseph F. Sackett, MD</td>
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<tr>
<td>1990-91</td>
<td>Anton N. Hasso, MD, FACR</td>
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<td>1991-92</td>
<td>R. Nick Bryan, MD, PhD, FACR</td>
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<td>1992-93</td>
<td>David Norman, MD</td>
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<td>1993-94</td>
<td>Glenn S. Forbes, MD</td>
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<td>1994-95</td>
<td>Robert M. Quencer, MD</td>
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<td>1995-96</td>
<td>Robert R. Lukin, MD</td>
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<td>1996-97</td>
<td>Burton P. Drayer, MD</td>
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<td>1997-98</td>
<td>Richard E. Latchaw, MD</td>
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<td>1998-99</td>
<td>A. James Barkovich, MD</td>
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<td>1999-00</td>
<td>Eric J. Russell, MD, FACR</td>
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<td>2000-01</td>
<td>William S. Ball, Jr., MD</td>
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<td>2001-02</td>
<td>William P. Dillon, MD</td>
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<td>2002-03</td>
<td>Patrick A. Turski, MD</td>
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<td>2003-04</td>
<td>Charles M. Strother, MD</td>
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<td>2004-05</td>
<td>Victor M. Haughton, MD</td>
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<tr>
<td>2005-06</td>
<td>Patricia A. Hudgins, MD</td>
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</tbody>
</table>

**FOUNDING MEMBERS**

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

*deceased
Robert M. Quencer, MD

Dr. Quencer was born and raised in New Jersey, and in 1955 he entered Cornell University, graduating in 1959 with a Bachelor of Science degree. He was commissioned in the United States Navy in June 1959, and his first duty station was in Kaohsiung, Taiwan, where he served as part of the Military Assistance Advisory Group to the Southern Taiwan Command. Following that tour of duty he was assigned to the Headquarters of the Commandant of the Third Naval District in New York City.

At the completion of the 2-year military obligation, Dr. Quencer returned to Cornell University to pursue studies towards a Master of Science, with the intent of subsequently obtaining a PhD in biochemistry. After one year in graduate school, his professional goals changed and he sought admission to medical school following completion of his MS degree. The MS degree was awarded in June 1963, with the defense of his thesis on the “The Kinetics Autoxidation of Methyl Linoleate: the Effect of Added Antioxidants and a New Method for the Evaluation of Antioxidants” (with the publication of his first peer paper in the Journal of the American Oil Chemists’ Society in 1964).

Dr. Quencer entered the Upstate Medical School (Syracuse) in September 1963, was elected to Alpha Omega Alpha, and was graduated with the MD degree in 1967. He originally intended to pursue a career in surgery; however, after spending one summer as a surgical and medical extern at a University of Colorado affiliated hospital, it quickly became clear to him that Radiology was the dominant specialty in determining diagnoses, and in guiding subsequent patient management. With this realization, he applied for a residency in Radiology (encompassing both diagnostic radiology and radiation therapy), and was accepted for a position at the Columbia-Presbyterian Medical Center. Following an internship year in Internal Medicine at Jackson Memorial Hospital (Miami), he returned to New York City, where he completed his residency at Columbia, and an NIH-sponsored fellowship in neuroradiology at the Neurological Institute of New York (NI). As a resident, he published his first paper in a radiology journal -- “Perforated Ureter Secondary to a Urethral Calculus” (Radiology 1972). As a fellow in neuroradiology, he was influenced greatly by the faculty at NI - Dr. Ernest Wood, Dr. Sadek Hilal, Dr. Michael Tenner, and Dr. Robert Waldron—and determined to pursue a career in academic neuroradiology. During his radiology residency and neuroradiology fellowship, he and Dr. Tenner assembled a large exhibit entitled “Angiographic Localization of Mass Lesions Within and Adjacent to the Third Ventricle,” which was his first original work in neuroradiology. It was presented at three national meetings, including the American Roentgen Ray Society in September 1971.

In 1972, Dr. Quencer joined the faculty at Downstate Medical Center (Brooklyn) as a member of the neuroradiology section and, during his four years on the faculty there, he published (as either first author or as co-author) a number of papers on a variety of neuroradiology subjects, including venous abnormalities of congenital lesions, pediatric skull fractures, percutaneous spinal cord punctures, myelocystography, jugular venography, angiography of normal and abnormal ocular circulation, and the postoperative myelogram. In 1976, he left New York to become Chief of the Neuroradiology Section at the University of Miami/Jackson Memorial Medical Center; and in 1979, was promoted to the rank Professor of Radiology, Neurological Surgery, and Ophthalmology. When MR became an accepted clinical tool, he became Chief of the section of MR Imaging in 1984, and then in 1992, was chosen as the Chair of the Department of Radiology at the University of Miami and Chief of Radiology Services at Jackson Memorial Hospital. During his 30 years at the University of Miami, Dr. Quencer along with his colleagues have published over 200 peer-reviewed papers on a wide range of topics in neuroradiology. He has authored/co-authored 18 scientific exhibits, and 26 book chapters/books, has been the Principal Investigator of a section on a NIH-sponsored Program Project on the Imaging/Histology of Spinal Cord Injury. He has been a Visiting Professor at over 40 institutions worldwide, and has given the annual lectureship in honor of notables in the field of neuroradiology, including those named for Drs. Kricheff, Newton, Heinz, and Scatliff. Among his published works, he considers his most meaningful to be those which have dealt with the postoperative spine, acute spinal cord trauma, sequela of chronic spinal injuries, intraoperative cranial and spinal neurosonography, motion suppression techniques in MR imaging, evaluation of CSF flow dynamics on MR, and normal white matter maturation by CT/histology in a primate animal model. In 1990, he was inducted as a Fellow of the American College of Radiology and, in 1995, he was the recipient of the first chair in radiology at the University of Miami - The Robert Shapiro Professor of Radiology. He has also served as an NIH Advisory Consultant, and has been a Member of Special NIH Review Committees on a number of grant proposals.

In 1995, he served as President of the ASNR, and during that year helped to guide the process toward meaningful qualifications needed to become ABR-eligible for the CAQs. During the Annual ASNR meeting that year he had the pleasure of presenting to Drs. Taveras and Newton the first Gold Medals given by the Society. In 1998, the Society selected him to become Editor-in-Chief of the American Journal of Neuroradiology, and he served in that position until December 2005. With that 8-year period as Editor-in-Chief, plus the time served as Associate/Deputy Editor (first under Dr. Taveras, and then under Dr. Huckman), he had a major hand in the development of the Journal over a 21-year period of time. In 2006, Dr. Grossman named Dr. Quencer as an Editor Emeritus of the AJNR. For the past three years, Dr. Quencer has served as the RSNA Sub-Committee Chair for Neuroradiology and, beginning in 2008, he will become the Scientific Program Chairman for the RSNA.

Dr. Quencer’s wife, Christine, a graduate of the University of Wisconsin, worked as a physical therapist at both the Massachusetts General Hospital and at Roosevelt Hospital in New York City. Later she trained as a diagnostic medical sonographer, and worked at the Downstate Medical Center and at Jackson Memorial Hospital. She has also earned a Master’s of Science degree in Epidemiology at the University of Miami. They have two sons, Kevin (who is a second-year law student at Washington and Lee University), and Keith (who is a third-year medical student at the University of Florida).
Awards and Honors

Past ASNR Gold Medal Award Recipients

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

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

1997
Derek C. Harwood-Nash, MB, ChB., DSc, FRCPC, 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, FCR
Anne G. Osborn, MD, FCR

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

2005
Samuel M. Wolpert, MD

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

Past ASNR Honorary Member Recipients

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

2007 ASNR Honorary Member

There is no Honorary Member in 2007.
Awards and Honors

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

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

Clifford R. Jack, Jr., MD

Dr. Clifford R. Jack, Jr., is a professor of Diagnostic Radiology at the Mayo Clinic in Rochester, Minnesota. In 1985, he joined the Neuroradiology staff at Mayo. Presently, he is a clinician investigator, with 100% effort devoted to research and full funding from NIH research grants. He is a faculty member of the Neuroscience and the Biomedical Engineering tracks in the Mayo graduate school. Dr. Jack has authored or co-authored over 175 peer-reviewed papers, 240 abstracts, and 25 books or book chapters. He has been principal investigator or co-investigator of numerous NIH grants, and has been continuously funded by the NIH for over sixteen years. In addition, he served on a number of NIH study sections and federal advisory panels.

Dr. Jack’s research group is engaged in developing and validating magnetic resonance imaging techniques for diagnosis and measuring progression of Alzheimer’s disease and related disorders. His research lab has 14 members, and the lab is pursuing a number of directions. The central organizing theme is multimodality imaging of brain changes over time, with serial imaging studies in relation to disease progression. The laboratory efforts encompass developing image-processing algorithms, MR spectroscopy, functional magnetic resonance imaging of mental task activation, diffusion MR imaging, perfusion MR imaging, FDG PET, and amyloid labeling PET compounds. His research program at the Mayo Clinic is tightly integrated into NIH-funded longitudinal, clinical, and epidemiological research projects in normal aging, Alzheimer's disease, and other dementias.

Dr. Jack’s research group also collaborates with a number of investigators outside Mayo, and is the Imaging Center for several large national multi-site studies. He is director of the MRI Core of the Alzheimer’s Neuroimaging Initiative. In addition to human imagining research, Dr. Jack’s research group also collaborates with investigators at the University of Minnesota on high field MRI of Alzheimer’s amyloid plaques in transgenic mice.

Past Award Recipients:

2006 No Award Given
2005 Dixon M. Moody, MD, FACR
2004 Robert I. Grossman, MD
Awards and Honors

ASNR 2006 Outstanding Presentation Awards

ASNR is pleased to announce the winners of the Outstanding Presentation Awards given annually to the top paper or poster presentation from the prior Annual Meeting in general neuroradiology and the four neuroradiology specialties. A $1,000 award was given to each winner.

General Neuroradiology

HYPR Tricks: Theory and Initial Clinical Experience
Turski, P.A.1 • Wu, Y.1 • Wieden, O.1 • Korosec, F.1
• Brittain, J.2 • Rowley, H.1 • Keintz, B.1 • Turk, Q.1
• Mistretta, C.1
1University of Wisconsin, Madison, WI
2General Electric Healthcare, Waukesha, WI

Bayer Healthcare Pharmaceuticals, Inc.*
Best Paper Award in General Neuroradiology
Results of the Diffusion-Weighted Imaging Evaluation for Understanding Stroke Evolution Study
Marks, M.P.1 • Moseley, M.1 • Thijs, V.2 • Lansberg, M.1
• Bammer, R.1 • Wechsler, L.3 • Schlaug, G.4 • Skalabrin, E.5 • Albers, G.1 • The DEFUSE Study Group
1Stanford University Medical Center, Stanford, CA
2UZ Gasthuisberg, Lueven, BELGIUM
3University of Pittsburgh Medical Center, Pittsburgh, PA
4Beth Israel Deaconess, Boston, MA
5University of Utah, Salt Lake City, UT

Functional Neuroradiology

Whole-Brain High Angular Resolution Diffusion Imaging within a Clinically Feasible Acquisition Time
Mukherjee, P.1 • Hess, C.P.1 • Han, E.T.2 • Xu, D.1
• Vigneron, D. B.1
1University of California San Francisco, San Francisco, CA
2General Electric Healthcare, Menlo Park, CA

Head and Neck Radiology

Volumetric 64-Slice CT of the Temporal Bone after Cochlear Implant: Electrode Localization within the Cochlear Scalae
Lane, J. I.1 • Witte, R. J.1 • Shallop, J.1 • Driscoll, C. L. W.1
Mayo Clinic, Rochester, MN

Interventional Neuroradiology

(The Michael Brothers Memorial Award)
The Impact of Various Types of Bioactive Bioabsorbable Polymeric Coils on Thrombus Organization Process in the Experimental Aneurysms
Yuki, I.1 • Lee, D.1 • Murayama, Y.1 • Chiang, A.1
• Vinters, H. V.1 • Nishimura, I.1 • Wang, J.1 • Ishii, A.1
• Wu, B. M.1 • Vinuela, F.1
University of California, Los Angeles, Los Angeles, CA

Pediatric Neuroradiology

(The Derek Harwood-Nash Award)
Incidence and Evolution of Intracranial Hemorrhage in Asymptomatic Full-Term Infants Using MR Imaging and Ultrasound Examination
Eaton, J.P.1 • Rooks, V.J.1 • Petermann, G.1
Tripler Army Medical Center, Tripler AMC, HI

Spine

Plasma-Mediated Radiofrequency-Based Ablation in Conjunction with Percutaneous Cement Injection for Treating Painful Vertebral Compression Fractures Resulting from Metastasized Malignancy
Georgy, B.1 • Wong, W.2
1Valley Radiology Consultants, Escondido, CA
2University of California San Diego, San Diego, CA

*Formerly Berlex

5642 Roman Nmrl 1_40_wb:front_matter_07  4/25/07  10:45 PM  Page XIV
Awards and Honors

2007-2008 Bayer Healthcare Pharmaceuticals, Inc.*/NER Foundation Fellowship in Basic Science Research Award

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

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”

The recipients of the 2007-2008 fellowships are:

Myria Pettou, MA, MBChB
University of Michigan, Ann Arbor, MI
“Investigation of Axonal Loss, Demyelination and Response to Treatment in a Mouse Model of Multiple Sclerosis Using Diffusion Tensor Imaging”

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

*Formerly Berlex
Awards and Honors (Continued)
Past Bayer Healthcare Pharmaceuticals, Inc.*/NER Foundation Fellowship in Basic Science Research Award

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

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

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

1998-99
William F. Marx, MD,
University of Virginia
“Endovascular Treatment of Experimental Aneurysms Using Biologically Modified Embolic Coils: Promotion of Permanent Occlusion via Intraneurysmal 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”

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

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

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

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

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

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

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

Susan M. Kealey, MD,
Duke University Medical Center
“Correlation of MR Permeability Measurements with Histologic Markers of Angiogenesis in Rodent High-Grade Brain Tumors Before and After Treatment with 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”
Awards and Honors

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

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

The recipient of the 2007 award is:
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”

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 Adjunct to Extracranial Cortical Stimulation for the Treatment of Chronic Facial Pain”

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

Past Neuroradiology Education and Research (NER) Foundation Outcome Research Grant Recipient

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

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 2007.

Past Neuroradiology Education and Research (NER) Foundation Outcome Research Grant Recipient

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
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Awards and Honors

2006-2007 NER Foundation/Boston Scientific 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.

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 Vasculair 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 ASNR Cornelius G. Dyke Memorial Award

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

The recipient of the 2007 award is:

Yulin Ge, MD
New York University, School of Medicine, New York, NY

“Quantitative Assessment of Iron Accumulations in the Deep Gray Matter of Multiple Sclerosis by Magnetic Field Correlation Imaging”

Dr. Yulin Ge is assistant professor of Department of Radiology in New York University School of Medicine. He received his medical degree in Shandong Medical University in 1989 and completed his Diagnostic Radiology residency training in 1995 in Beijing Titan Hospital, China. Selected by the Chinese Medical Association, in 1996, Dr. Ge became a Takeda Scholar (sponsored by Takeda Pharmaceutical Company) for neuroimaging fellowship training in Kumamoto University, Japan. In May 1998, he was recognized as a Symposium Scholar at XVI International Symposium Neuroradiologicum & ASNR meeting (Philadelphia, PA) for his work presented at that meeting. Then he joined the Department of Radiology in University of Pennsylvania as a research fellow. In August, 2001, he became a faculty member at the New York University School of Medicine and presently is an Assistant Professor of Radiology.

Dr. Ge’s main research interest has been focused on multiple sclerosis, head trauma, and neurodegenerative diseases. He has authored more than 40 publications with first-authoring over 20 of them and 3 book chapters. His special interests in multiple sclerosis using cutting-edge quantitative MRI have significantly improved our understanding of pathophysiology and natural history of this disease. He has been an investigator of several NIH grants and also serves as a reviewer for 3 medical imaging journals. Dr. Ge’s career goal is to become an outstanding clinical investigator in neuroimaging research.
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 Pulsatle Motion Origin of Spinal CSF Flow Phenomenon”

1987
No Award

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

1989
Allen D. Elster, MD
“Euroropium-DTPA: Development and Testing of a Gadoluminium Analogue Traceable by Fluorescence Microscopy”

1990
Marvin D. Nelson, Jr., MD
“The Search for Human Telencephalic Ventriculofungal 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
“Wallerian 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 Caroid Artery Plaques Embolize? A Flow Dynamics Study”
David F. Kallmes, MD
“Guglielm Detachable Coil Embolization for Unruptured Aneurysms in Neurosurgical Candidates: A Cost Effectiveness Exploration”

1998
No Award

1999
Aquil 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 Intraneurysmal 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”
Continuing Medical Education (CME)

Scientific Program and Meeting Evaluation
The 2007 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 Columbus CD and in Riverside Center West at the Hyatt Regency Chicago. Please complete the evaluations for each session to assist in planning future meetings and to help us maintain accreditation of future programs.

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 2007 and ASNR 45th Annual Meeting, all evaluations must be entered by the end of the meeting. The CME Pavilion replaces the CME booklet of previous years and is the only method available for receiving your CME credit.

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 2007 and ASNR 45th 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 2007 and ASNR 45th Annual Meeting CME Certificate.

Following the meeting, the ASNR 2007 CME certificate site will be available online 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 Grand Ballroom Registration Foyer of the Hyatt Regency Chicago.

Accreditation Statement
The American Society of Neuroradiology is accredited by the Accreditation Council for Continuing Medical Education (ACCME) to provide continuing medical education for physicians. The American Society of Neuroradiology takes responsibility for the content, quality, and scientific integrity of the CME activity. The American Society of Neuroradiology designates this educational activity for a maximum of 31.75 AMA PRA Category 1 Credit(s)™. Physicians should claim credit commensurate with the extent of their participation in the activity.

Target Audience
The ASNR 45th 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 45th Annual Meeting Educational Objectives

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

**General Programming**
- Interpret the role of cardiac and coronary imaging in the management of acute neurologic emergencies and to become familiar with cardiac image interpretation
- Classify the different basal ganglia disorders based on clinical manifestations of disease and imaging characteristics
- Diagnose patterns of infections in pediatric and adult patients and to know the demographics of the different entities
- Distinguish the importance of signal intensity abnormality in the spinal cord in the setting of degenerative spondylotic disease
- Review surgical interventions in the setting of deep brain stimulators and cervical spine fusions
- Demonstrate the basic knowledge of voice recognition, MIRC and Personal Technologies
- Review the importance of PACS issues such as database migration and training
- Demonstrate a basic understanding of PACS and Speech Recognition
- Review the importance of system integration in Imaging Informatics
- Review the importance of MIRC
- Demonstrate a basic knowledge of PowerPoint, Photoshop and Advanced web page development

**Advanced Imaging Programming**
- Describe the basis and application of diffusion weighted imaging in acute stroke and brain tumors
- Define the state of the art in clinical MR perfusion imaging
- Discuss the theory and application of permeability imaging
- Distinguish the various technical methods that can be used for functional brain mapping (including BOLD, ASL and VASO)
- Discuss emerging techniques for rapid and ultra-rapid imaging

**Maintenance of Certification (MOC) Programming**
- Identify a limited differential diagnosis for a mass in the neck or brain
- Define the basic patterns of spectroscopic metabolites that suggest neoplasms of various kinds as opposed to non-neoplastic lesions
- Identify non-diskogenic sources of back pain
- Compare the indications and contra-indications of thrombolytic therapies
- Classify congenital disorders of the brain into infratentorial and supratentorial entities

**Interventional Programming**
- Discuss the imaging and treatment of tumors and vascular malformations involving the spinal cord and column
- Identify the current endovascular trials in acute stroke therapy with respect to trial design, end points, and outcomes
- Outline the currently available imaging modalities used in the evaluation of subarachnoid hemorrhage and its complications
- List the endovascular therapies for subarachnoid hemorrhage - induced vasospasm
- Review the appropriate screening parameters used in the workup of incidentally discovered intracranial aneurysms

**Spine Programming**
- Review the etiology and biomechanics of degenerative spine disease and contemporary imaging techniques for evaluating the spine
- Discuss the applications and technical aspects of fluoroscopic and CT-guided interventional spine procedures for diagnosis and pain management
- Review congenital spine malformations and describe imaging features and techniques for evaluating the pediatric spine
- Describe vertebroplasty and kyphoplasty procedures, including their relative benefits, applications and potential complications

**Functional Programming**
- Review the biological principle of angiogenesis and its relevance to brain tumor physiology and treatment
- Demonstrate how imaging of angiogenesis may play a role in diagnosis and treatment monitoring of patients with brain tumors
- Review current understanding of the pathophysiology of Alzheimer’s disease, including promising treatments developed on the basis of this knowledge
- Explore the role of molecular imaging in Alzheimer’s diagnosis and treatment monitoring
- Review current understanding of the pathophysiology of brain attack, including the latest therapeutic options
- Demonstrate how physiologic imaging can play a critical role in the selection of patients eligible for acute stroke therapy

**Head and Neck Programming**
- Define and understand the normal anatomy of the sinonasal cavity and its relationship to critical adjacent structures
- Detect signs of pathology and be able to differentiate inflammatory from malignant disease
- Compare the role of CT, MRI and CT/PET in evaluating the extent of disease
- Describe standard surgical approaches and differentiate signs of recurrent disease from the normal post treatment appearance
- Review the normal spatial anatomy of the upper aerodigestive tract and recognize the appearance of developing malignancy
- Identify contemporary staging of squamous cell carcinoma in this region
- Identify the normal post-treatment appearance on CT, MRI or CT/PET and be able to differentiate successful treatment from recurrent disease
- Define the normal anatomy of the temporal bone and understand the role of CT and MRI in evaluation of the mastoid, middle and inner ear
- Detect and describe signs of active or previous inflammatory disease in the mastoid and middle ear.
- List signs that would point to the presence of cholesteatoma
- Describe the common surgical procedures used in mastoid surgery and recognize signs of residual or recurrent disease

**Pediatric Programming**
- Identify common cerebral malformation presenting in childhood
- Distinguish the phakomatoses that are present during childhood
- Compare the response of the pediatric brain to ischemic and traumatic injury and distinguish imaging findings of ischemic findings of ischemic vs. traumatic injury
- Detect problems and pitfalls with study design, patient accrual and data assessment in clinical research investigating the pediatric brain
- Describe the potential for multi institutional and multi disciplinary research; identify current areas of active investigation and participating sites
- Recommend dialogue between ASPNR members and the NIH
- Distinguish pediatric intracranial neoplastic disease from that seen in adults
- Analyze the variable response of the immature brain to therapy for childhood cancers
- Define the adverse effects of chemotherapy and radiation on the pediatric brain as seen by newer MR techniques
ELC Workshops

Electronic Learning Center (ELC) workshops provide the opportunity for practicing neuroradiologists and neuroradiologist educators to learn new electronic methods in an interactive small group environment. The workshop format allows for hands-on and experiential learning with computers, software, and knowledgeable assistants. The faculty and assistants at the workshop include both PC and Mac users. This year’s program will build on the sessions offered at the 2006 meeting.

• Attendance is limited to 60 participants
• ELC Workshops are not included in the Annual Meeting registration fee
• A ticket is required for admission
• Tickets are offered on a first-come, first-served basis for $50 Members/Non-members/Other Professionals and $10 for Fellow/Trainees
• Two participants are allowed per computer during the workshop

ELC Workshop A: Introduction to PowerPoint

Monday, June 11 10:15am – 11:45am
Monday, June 11 1:15pm – 2:45pm
David S. Martin, MD; John L. Go, MD; Barton F. Branstetter IV, MD

The goal of this workshop is to instruct registrants in the creation of educational presentations by learning the core concepts of Microsoft PowerPoint software. Learn how lecture material can be developed for display using LCD projectors. Learning Objectives of this workshops include: creating a new presentation from scratch; using the Office and Presentation Assistants; copying, deleting and modifying the sequence of slides; working with Clip Art, pictures, and other objects; preparing an entire presentation; saving a presentation in normal and HTML formats; and printing audience and speaker notes.

ELC Workshop B: Advanced PowerPoint

Monday, June 11 3:15pm – 4:45pm
Tuesday, June 12 3:15pm – 4:45pm
H. Christian Davidson, MD; Adam E. Flanders, MD

This workshop will address the more advanced techniques of PowerPoint presentation construction, including insertion of graphs or tables, linking of objects, transitions, animations, and adding sounds or video clips. Learn how to create more dynamic presentations by making items appear and disappear on slides and inserting “hidden” controls in the slides. The lectures will demonstrate how to link one PowerPoint presentation to another to control the flow of information and enable toggling between presentations. Lastly, comments will be made on the appropriate use of multimedia components for keeping a talk interesting yet avoiding audience distraction by too much flash.

ELC Workshop C: Teaching File Creation

Tuesday, June 12 10:30am – 12:00pm
Adam E. Flanders, MD

The digital teaching file (DTF) is growing in importance in institutions where the transition from hard copy film to PACS has occurred. The RSNA’s Medical Imaging Resource Center (MIRC) project has developed software to help a user to install and run a DTF system that integrates with PACS. This software can provide authoring tools for the creation of a DTF, and allow an institution to participate in the MIRC community by sharing its DTF content with other institutions. This workshop will allow participants a hands on experience in the creation of a MIRC DTF. The purpose of this course is to teach participants how to obtain and run this software to create their own teaching file systems using the RSNA’s software.

ELC Workshop D: Adobe Photoshop and Elements

Tuesday, June 12 1:15pm – 2:45pm
Wednesday, June 13 3:15pm – 4:45pm
Richard M. Berger, MD

This workshop will enable the attendee to become more familiar with the more advanced graphics editing techniques and options available in Adobe Photoshop Elements. This hands-on, interactive workshop will provide participants with the opportunity to learn how to edit images from any origin. Topics covered will include determining optimal image size and resolution for print, PowerPoint, and email graphics: adding text and arrow annotations; re-windowing and leveling; cropping and removing extraneous text and markings; and converting to gray scale. Attendees will also use the more common graphics tools such as airbrush, blur, rubber stamp, eyedropper, magic wand, paint bucket, and others.

ELC Workshop E: Advanced Web Design

Wednesday, June 13 1:15pm – 2:45pm
Dale A. Charletta, MD

This hands-on expert experience will cover the effective use of, and creating, advanced content for the internet. The session will cover various editors available for creating web pages in HTML as well as how to insert XML. Familiar tools, such as Microsoft Word and Netscape Communicator, will be discussed with a focus on the use of images, links, tables, and uploading content via FTP to a web server. Advance topics such as DHTML, CCS, Javascript, JAVA, PERL, and other languages used for web page creation will also be discussed.
The addition of a speech recognition system can significantly reduce report turn around time for an institution. The older process of dictation, free text typing, manually transcribing, reviewing, editing, and finally signing reports can take days for report turn around, but speech recognition can change this from days to minutes, greatly impacting patient care. Our communication with clinicians, as radiologists must be as efficient as possible, for the best in health care. The opportunities involved with speech recognition include structured reporting, macros, and standardization of vocabulary, which can greatly affect health care in several ways.

These 2 lectures will give the attendee both an introduction and an advanced look at PACS. It is important to understand the basics of a PACS so that the user can maximize the efficiency capabilities of a particular system. The first lecture will introduce the basics of PACS and important issues including hardware and software. The second lecture will discuss more advanced issues, such as system integration and database migration. There are several options for an institution after outgrowing or just outliving your PACS, and the most vital of these may be the migration of the database. The perfect solution for one institution may not be the best for another, but it is critical to consider system integration and future PACS database translation when negotiating a contract for any PACS installation.
ASNR BUSINESS CENTER

Synopsis: The ASNR Business Center will offer executive lectures encompassing topics pertinent to management and administration for both private practice and academic departments. Business Center lectures will be given in two blocks, each of which is 90 minutes in duration. Within each block, two speakers are scheduled for 40-45 minute didactic lectures with 5-10 minutes of question and answer time.

Monday, June 11, 2007 - Day 1

1:15pm - 2:00pm

“Effective Leadership Skills”
Norman J. Beauchamp, Jr., MD, MHS
Professor and Chair, Department of Radiology, University of Washington

Effective leadership in neuroradiology is essential to the success of our specialty. Unfortunately, these roles are of increasing complexity with limited opportunity for leadership training. In this presentation, leadership skills essential for success will be presented.

2:00pm - 2:45pm

“Advanced Leadership: Solving Wicked Problems”
Gregory L. Katzman, MD, MBA
Associate Professor, Neuroradiology & Biomedical Informatics
Chief, Clinical Research, University of Utah Health Sciences Center

“Wicked problems” are those that arise from tricky and often emotional situations which must be approached differently than everyday common, benign problems. This requires mastering facets of advanced leadership which will be presented from a theoretical perspective and then illustrated by real world radiology department examples.

2:45pm - 3:10pm Afternoon Break

3:15pm - 4:00pm

“Managing Your Turf: An Academic Medical Center Perspective”
Norman J. Beauchamp, Jr., MD, MHS
Professor and Chair, Department of Radiology, University of Washington

This is both the most exciting as well as potentially the most challenging time in academic neuroradiology. The contributions of diagnostic and interventional procedures are now the primary driver of improved capacity to treat neurological disorders. A significant threat to bringing this potential to patients are turf issues that can result in a lowered standard of care, compromised training, and escalating cost. In this presentation, turf issues in neuroradiology will be reviewed and strategies for seeking collaborations that brings value to patients and limits those that do not will be discussed.

4:00pm - 4:45pm

“Strategic Planning in Academia”
David M. Yousem, MD, MBA
Vice Chairman for Radiology for Program Development, Professor of Radiology, Director of Neuroradiology
Johns Hopkins Medical Institution

Radiology departments in academic medical centers face a unique constellation of pressures. These include an increasing uninsured population and escalating technology costs, both within the backdrop of declining payments and often lower available capital equipment funds. Recruitment and retention is difficult and not likely to improve significantly in the near future. Faculty ED coverage 24/7 may be soon be imminent. Proper strategic planning in this environment places a significant burden upon leadership and approaches will be presented.

Goals: We will discuss radiology practice leadership and strategy within both the private practice and academic environments, contrasting their differences and similarities.

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.

Tuesday, June 12, 2007 - Day 2

1:15pm - 2:00pm

“Strategic Planning in Private Practice”
Jonathan Breslau, MD; Radiological Associates of Sacramento Medical Group, Inc.

This session will complement the previous “Strategic Planning in Academia” presentation. Although there are similarities to academic medical centers in some aspects of strategic planning, others are quite different and require another approach.

2:00pm - 2:45pm

“Strategic Challenges to Radiology in the 21st Century”
Frank J. Lexa, VII, MD, MBA
Professor, Wharton Graduate School of Business

This session will cover the most significant current and near term future threats to the practice of radiology. We will cover how to take a balanced view of predictions of the future, why many of them are wrong, and how to do better. The factors that are driving these crises will be analyzed and some strategic responses both individual and collective will be proposed.

2:45pm - 3:10pm Afternoon Break

3:15pm - 4:00pm

Jonathan Breslau, MD; Radiological Associates of Sacramento Medical Group, Inc.

Interspecialty turf battles are becoming commonplace, and the Stark in-office exception has made private practice especially vulnerable to practice encroachment. Given the current environment in which imaging occurs, approaching turf issues often requires a focused approach. Such topics will be discussed and the private practice perspective will be explored.

4:00pm - 4:45pm

“300 Million Customers: Patient Perspectives on Service and Quality in Radiology”
Frank J. Lexa, VII, MD, MBA
Professor, Wharton Graduate School of Business

This session will open by discussing the need for greater attention to service and quality and the impact upon our practices. We will cover why practices and patients have heterogeneous needs and how to meet them. Data on how patients perceive quality and fill out scorecards and report cards will be discussed. We close with a brief overview of how to implement service improvement initiatives.
How-To Sessions (As of 04/27/07)

In addition to the Technical Exhibition, the leadership of the ASNR is pleased to announce the tenth 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 Sunday, June 10 through Wednesday, June 13.

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. Indications, problems, and solutions relating to imaging techniques will be addressed including Clinical 3T Imaging, Practical Neuro CTA, and advances in MR Imaging to name a few.

Sunday, June 10 .......................6:30 am - 7:30 am
Title and Speakers To Be Determined

Wednesday, June 13 ...............12:10 pm - 1:10 pm
Title and Speakers To Be Determined

Tuesday, June 12 ....................6:30 am - 7:30 am
“CTA and Extended Perfusion CT: Protocol Considerations and Contrast Optimization”
Lawrence N. Tanenbaum, MD, FACR

“How: NSF, Renal Disease and Gadolinium-Based MR Contrast Agents: Where Do We Stand Today?”
Emanuel Kanal, MD

Sunday, June 10 ...................11:50 am - 12:50 pm
“Mismatch Imaging for Acute Stroke Triage: The Next Standard of Care”
Michael H. Lev, MD

“The Role of Standardized Quantitative Analysis Tools in Brain PET Interpretation of Dementia”
Kevin L. Berger, MD

Monday, June 11 .....................6:30 am - 7:30 am
“Volumetric Imaging at 3T”
Patrick A. Turski, MD, FACR

“Head and Neck Imaging Using IDEAL”
Allison M. Grayev, MD

“MR: The Role of MR in Acute Ischemic Stroke”
R. Gilberto Gonzalez, MD, PhD

PLEASE NOTE: Due to the direct financial support from these companies and the commercial content, CME credit will not be granted for these sessions.
Grand Ballroom, Columbus Hall and Grand Suites
Note: A missing number indicates an abstract has been withdrawn.

Shared eSE Exhibits

Stand Alone eSE Exhibit

eSE Presentation 42 is assigned one (1) computer only. Check eSE area for details.
**Printed and Electronic Scientific Exhibits (eSE)**

**SCIENTIFIC EXHIBITS**

<table>
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<tr>
<th>Topic</th>
<th>Pages</th>
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<td>Anatomy</td>
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<td>Head and Neck</td>
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<td>Interventional</td>
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<td>Pediatrics</td>
<td>76-79</td>
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<tr>
<td>Spine</td>
<td>80-87</td>
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</tbody>
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**Note:**
A missing number indicates an abstract has been withdrawn.

**ELECTRONIC SCIENTIFIC EXHIBITS (eSE)**

Shared

- Adult Brain .................................. 1-21
- Anatomy ..................................... 22, 25, 27-30
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- Spine ........................................ 45

**Stand Alone**

- Adult Brain ................................. 42

**Note:**
A missing number indicates an abstract has been withdrawn.

**ELECTRONIC SCIENTIFIC EXHIBITS (eSE)**

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**Printed and Electronic Scientific Exhibits (eSE)**

**ELECTRONIC SCIENTIFIC EXHIBITS (eSE)**

**Shared**
- Adult Brain .................................. 1-21
- Anatomy ..................................... 22, 25, 27-30
- Interventional ............................... 31
- Pediatrics ................................. 32-38
- Head and Neck ............................... 39-41, 43, 44
- Spine ........................................ 45

**Stand Alone**
- Adult Brain ................................. 42

**Note:**
A missing number indicates an abstract has been withdrawn.

**Shared eSE Presentations 1-22, 25, 27-41, 43-45**
can be accessed from any shared eSE computer. **eSE Presentation 42** can be accessed on the assigned computer only.
SCIENTIFIC POSTERS

Adult Brain ................. 1-129
Anatomy ................... 130-140
Head and Neck .......... 141-149
Interventional .......... 150-196
Pediatrics ............... 197-211
Socioeconomic .......... 212
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Note: A missing number indicates an abstract has been withdrawn.
Technical Exhibits

(As of 04/23/07)

Riverside Center West
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<th>Technical Exhibits (As of 04/23/07)</th>
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</thead>
<tbody>
<tr>
<td><strong>Hyatt Regency Chicago — Riverside Center West</strong></td>
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<tr>
<td>Tuesday, June 12 .................................................................10:00 am – 4:00 pm</td>
</tr>
<tr>
<td>Tuesday, June 12 - “All That Jazz” Reception .........................................6:30 pm – 8:00 pm</td>
</tr>
<tr>
<td>Wednesday, June 13 through Thursday, June 14 .......................................9:45 am – 4:00 pm</td>
</tr>
<tr>
<td>ASNR/NER Foundation......................... Booth # 804</td>
</tr>
<tr>
<td>2210 Midwest Road, Suite 207</td>
</tr>
<tr>
<td>Oak Brook, Illinois 60523-8205</td>
</tr>
<tr>
<td>American Board of Radiology (ABR) ......Booth # 806</td>
</tr>
<tr>
<td>5441 East Williams Boulevard, Suite 200</td>
</tr>
<tr>
<td>Tucson, AZ 85711</td>
</tr>
<tr>
<td>Accumetrics................................Booth # 807</td>
</tr>
<tr>
<td>3985 Sorrento Valley Boulevard</td>
</tr>
<tr>
<td>San Diego, CA 92121</td>
</tr>
<tr>
<td>Advanced Imaging Research, Inc......... Booth # 317</td>
</tr>
<tr>
<td>4700 Lakeside Avenue, Suite 400</td>
</tr>
<tr>
<td>Cleveland, OH 44114</td>
</tr>
<tr>
<td>American Radiology Solutions ............Booth # 709</td>
</tr>
<tr>
<td>1838 Greene Tree Road, Suite 450</td>
</tr>
<tr>
<td>Baltimore, MD 21208</td>
</tr>
<tr>
<td>Amirsys........................................Booth # 106</td>
</tr>
<tr>
<td>2180 South 1300 East, Suite 405</td>
</tr>
<tr>
<td>Salt Lake City, UT 84106</td>
</tr>
<tr>
<td>ArthroCare Interventional Therapies ......Booth # 702</td>
</tr>
<tr>
<td>680 Vaqueros Avenue</td>
</tr>
<tr>
<td>Sunnyvale, CA 94085</td>
</tr>
<tr>
<td>Bayer Healthcare Pharmaceuticals, Inc... Booth # 411</td>
</tr>
<tr>
<td>P.O. Box 1000</td>
</tr>
<tr>
<td>Montville, NJ 07045</td>
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<tr>
<td>Boston Scientific Company....................Booth # 617</td>
</tr>
<tr>
<td>47900 Bayside Parkway</td>
</tr>
<tr>
<td>Fremont, CA 94538</td>
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<tr>
<td>Bracco Diagnostics..............................Booth # 202</td>
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<tr>
<td>107 College Road East</td>
</tr>
<tr>
<td>Princeton, NJ 08540</td>
</tr>
<tr>
<td>Cardinal Health................................ Booth # 813</td>
</tr>
<tr>
<td>1450 Waukegan Road</td>
</tr>
<tr>
<td>McGaw Park, IL 60085</td>
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</tbody>
</table>
Technical Exhibits Continued (As of 04/23/07)

Lippincott, Williams & Wilkins..................Booth # 102
1578 Fordham Street
Bolingbrook, IL 60490

MicroVention - Terumo........................Booth # 605
75 Columbia, Suite A
Aliso Viejo, CA 92656

Micrus Endovascular.........................Booth # 600
821 Fox Lane
San Jose, CA 95131

National Library of Medicine (NLM)........Booth # 705
Regional Medical Library, Box 357155
University of Washington
Seattle, WA 98195

Neurognostics, Inc..............................Booth # 201
10437 Innovation Drive, Suite 309
Milwaukee, WI 53226

NeuroLogica Corporation......................Booth # 611
14 Electronics Avenue
Danvers, MA 01923

NordicImagingLab..............................Booth # 200
Moellendalsveien 65C
Bergen, Norway N-5009

Philips..........................................Booth # 405
33 Thompson Hill Road
Milford, CT 040

Radius Medical.................................Booth # 711
15 Craig Road
Acton, MA 01720

Sacred Heart Medical Center..............Booth # 702b
P.O. Box 1479
Eugene, OR 97440

Siemens Medical Solutions USA, Inc........Booth # 111
51 Valley Stream Parkway
c/o HB3
Malvern, PA 19355

Stryker Interventional Pain..................Booth # 217
4100 East Milham Avenue
Kalamazoo, MI 49001

Springer.......................................Booth # 110
233 Spring Street
New York, NY 10013

TeraRecon, Inc...............................Booth # 805
2955 Campus Drive, Suite 325
San Mateo, CA 94403

Toshiba.......................................Booth # 205
2441 Michelle Drive
Tustin, CA 92780

U.S. Radiology On-Call......................Booth # 811
2461 Santa Monica Boulevard, Suite 108
Santa Monica, CA 90404

Virtual Radiologic............................Booth # 701
5995 Opus Parkway, Suite 200
Minneapolis, MN 55345

Vital Images....................................Booth # 118
5850 Opus Parkway, #300
Minnetonka, MN 55343

Xoran Technologies.........................Booth # 817
309 North First Street
Ann Arbor, MI 48103
Paul A. Anderson, MD
University of Wisconsin

Hyun W. Bae, MD
The Spine Institute in Santa Monica

William S. Ball, Jr., MD
University of Cincinnati

Daniel P. Barbioriak, MD
Duke University Medical Center

Jacqueline A. Bello, MD
The Spine Institute in Santa Monica

William S. Ball, Jr., MD
University of Cincinnati

Daniel P. Barboriak, MD
Duke University Medical Center

Jacqueline A. Bello, MD
Albert Einstein College of Medicine,
Montefiore Medical Center

David A. Bennett, MD
Rush University Medical Center

William G. Bradley Jr., MD, PhD, FACR
University of California, San Diego Medical Center

Allan L. Brook, MD
Montefiore Medical Center

Graeme M. Bydder, MB, ChB
Hammersmith Hospital

In Sup Choi, MD
Tufts University School of Medicine

Hugh D. Curtin, MD
Massachusetts Eye & Ear Infirmary

Andrew M. Demchuk, MD, FRPC
University of Calgary, Canada

Colin P. Derdeyn, MD
Washington University School of Medicine

John A. Detre, MD
University of Pennsylvania School of Medicine

Mark M. Dewhirst, DVM, PhD
Duke University Medical Center

Rosalind B. Dietrich, MD
University of California, San Diego Medical Center

Aaron S. Field, MD, PhD
University of Wisconsin Medical Center

Elliott K. Fishman, MD
Johns Hopkins University

Adam E. Flanders, MD
Thomas Jefferson University

Afshin Gangi, MD, PhD
University of Strasbourg, France

Lawrence E. Ginsberg, MD
University of Texas, M.D. Anderson Cancer Center

Christine M. Glastonbury, MBBS, FRANZCR
University of California, San Francisco

Dorith Goldsher, MD
Rambam Health Care Campus, Israel

R. Gilberto Gonzalez, MD, PhD
Massachusetts General Hospital

P. Ellen Grant, MD
Massachusetts General Hospital

Helen E. Gruber, PhD
Carolina Medical Center

Joshua A. Hirsch, MD, FSIR
Massachusetts General Hospital,
Harvard Medical School

Andrei I. Holodny, MD
Memorial Sloan-Kettering Cancer Center

Alena Horska, PhD
Johns Hopkins University

Jill V. Hunter, MD, MBBS, FRCR
Texas Children’s Hospital

C. Carl Jaffe, MD
National Cancer Institute,
National Institutes of Health

Mary E. Jensen, MD
University of Virginia Health Systems

Reza Jahan, MD
University of California, Los Angeles

Blake A. Johnson, MD
Center for Diagnostic Imaging, Minnesota

John A. Kessler, MD
Northwestern Memorial Hospital

Pooja Khatri, MD
University Hospital/University of Cincinnati
College of Medicine

Chelsea Kidwell, MD
Georgetown University Stroke Center

Frank R. Korosec, PhD
University of Wisconsin Hospital and Clinics

John I. Lane, MD
Mayo Clinic

Fred H. Lainingham, MD
St. Jude Children’s Research Hospital

Timothy L. Larson, MD
Seattle Radiologists

Meng Law, MD, MBBS, FRACR
Mount Sinai Medical Center

Doris D. Lin, MD, PhD
Johns Hopkins Hospital

Luigi Manfre, MD
A.O. Cannizzaro Hospital, Italy

Carolyn C. Meltzer, MD
Emory University

Phillip M. Meyers, MD
Columbia and Cornell University Medical Centers

Michelle A. Michel, MD
Medical College of Wisconsin

David J. Mikulis, MD
Toronto Western Hospital, Canada

Suresh K. Mukherji, MD
University of Michigan Health Systems

Gary M Nesbit, MD
Oregon Health and Science University

Abraham M. Obuchowski, MD
University of Maryland Medical System

Zoltan Patay, MD
St. Jude Children’s Research Center

Alice C. Patton, MD
Mayo Clinic

Jeffery R. Petrella, MD
Duke University School of Medicine

C. Douglas Phillips, MD, FCR
University of Virginia Health Systems

Michael D. Phillips, MD
Cleveland Clinic

Tina Young Poussaint, MD
Children’s Hospital Boston

Bidyut K. Pramanik, MD
New York University School of Medicine

James M. Provenzale, MD
Duke University Medical Center

Ansaar T. Rai, MD
West Virginia University, Morgantown

David A. Reardon, MD
The Preston Robert Tisch Brain Tumor Center
at Duke University

Gautham P. Reddy, MD
University of California, San Francisco

Timothy P.L. Roberts, PhD
The Children’s Hospital of Philadelphia

Howard A. Rowley, MD
University of Wisconsin

Hilda E. Stambuk, MD
Memorial Sloan-Kettering Cancer Center

Jeffrey A. Stone, MD
Medical College of Georgia

Joel D. Swartz, MD
Germantown Imaging Associates

David S. Titelbaum, MD
Shields Health Care, Massachusetts

Patrick A. Turski, MD, FACR
University of Wisconsin

Johan W. Van Goethem, MD, PhD
University Hospital of Antwerp, Belgium

Peter C. Van Zijl, PhD
Johns Hopkins University Medical School

Gilbert Vézina, MD
Children’s National Medical Center

Naomi Winick, MD
University of Texas Southwestern Medical Center
at Dallas

Franz J. Wippold, II, MD
Mallinckrodt Institute of Radiology

Robert A. Zimmerman, MD
Children’s Hospital of Philadelphia
Scientific Program Overview (As of 04/23/07)

Meals and Breaks: Breakfasts, Morning and Afternoon Coffee Service, and Box Lunches will be provided throughout the week. PLEASE NOTE: Annual Meeting food service locations vary throughout week based on Technical Exhibit hours and How-to Session programming.

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

ASNR 45TH ANNUAL MEETING

Monday, June 11

6:30am - 7:55am
Breakfast

6:30am - 7:30am
How-To Session Breakfast
Sponsor: GE Healthcare

7:40am - 7:45am
(1) Opening Remarks
Page: 1

7:45am - 8:45am
(2) Maintenance of Certification (MOC)
- Head and Neck Review Session (AR+)
Page: 1

8:45am - 9:45am
(3) General Session: Cardiac Imaging for the Neuroradiologist
Page: 1

9:45am - 10:10am
Morning Break

10:15am - 12:00pm
(4) Parallel Scientific Paper Sessions
(A) Adult Brain: Neoplasms I (Page: 2)
(B) Head and Neck: Pharynx, Larynx, Soft Tissue and Sinonasal (Page: 10)
(C) Anatomy & Techniques (Page: 17)
(D) Adult Brain: Degenerative/Demyelinating/Metabolic Disease I (Page: 25)

10:15am - 11:45am
(5) ELC Workshop A: Introduction to PowerPoint
Page: 32

12:00pm - 1:10pm Lunch Break

12:10pm - 1:10pm
How-To Session Lunch
Sponsor: GE Healthcare

1:15pm - 2:45pm
(6) Brain Tumors (ASFNR)
Page: 32

1:15pm - 2:45pm
(8) ELC Workshop B: Introduction to PowerPoint
Page: 35

1:15pm - 2:45pm
(9) ASNR Business Center Programming: Part I
Page: 36

2:45pm - 3:10pm
Afternoon Break

3:15pm - 4:45pm
(10) ASNR Business Center Programming: Part II
Page: 37

3:15pm - 4:45pm
(11) Parallel Scientific Paper Sessions
(A) Head and Neck: Temporal Bone and Miscellaneous
(Page: 37)
(B) Adult Brain: Degenerative/Demyelinating/Metabolic Disease II (Page: 43)
(C) Adult Brain: Vascular Extracranial and Intracranial
(Page: 50)
(D) Adult Brain: Functional Imaging (Page: 56)

3:15pm - 4:45pm
(12) ELC Workshop B: Advanced PowerPoint
Page: 62

4:45pm - 6:15pm
(13) Temporal Bone - Advanced Anatomy, Imaging of Inflammatory Disease and Post-Treatment Evaluation (ASHNR)
Page: 62

4:45pm - 6:15pm
(14) Case-Based Review Session (ASPNR) (AR+)
Page: 63

4:45pm - 6:15pm
(15) Advanced Imaging Seminar - Diffusion
Page: 63

4:45pm - 5:45pm
(16) ELC Lecture A: Speech Recognition
Page: 65

1Note: Programming is currently under review for Self Assessment Modules (SAM) credit through the American Board of Radiology (ABR) for approval.
Scientific Program Overview  (As of 04/23/07)

Tuesday, June 12

6:30am - 7:55am  
Breakfast

6:30am - 7:30am  
How-To Session Breakfast  
Sponsor: Bracco

7:45am - 8:45am  
(17) Maintenance of Certification (MOC) -  
Brain MRS Review Session (AR+)  
Page: 67

8:45am - 10:00am  
(18) General Session: Neurodegenerative Disorders  
Page: 68

10:00am - 10:25am  
Morning Break

10:30am - 12:00pm  
(19) Parallel Scientific Paper Sessions  
(A) Pediatrics: Diffusion Tensor Imaging (Page: 70)  
(B) Vascular Interventional (Page:77)  
(C) Head and Neck: Orbit, Face, New Techniques, Other  
(Page: 83)  
(D) Pediatrics: Miscellaneous Neoplasms, Trauma, Other  
and New Techniques (Page: 89)

10:30am - 12:00pm  
(20) ELC Workshop C: Teaching File Creation  
Page: 96

12:00pm - 1:10pm  
Lunch Break

12:10pm - 1:10pm  
How-To Session Lunch  
Sponsor: Siemens Medical Solutions USA, Inc.

12:10pm - 1:10pm  
(21) American Society of Pediatric Neuroradiology (ASPNR) Annual Business Meeting (Members Only)  
Page: 96

12:10pm - 1:10pm  
(22) American Society of Functional Neuroradiology (ASFNR) Annual Business Meeting (Members Only)  
Page: 96

1:15pm - 2:45pm  
(23) Alzheimer’s Disease (ASFNR) (AR+)  
Self-Assessment Module (SAM)¹  
Page: 97

1:15pm - 2:45pm  
(24) Upper Aerodigestive Tract - Tumor Detection, Staging and Post-Treatment Evaluation (ASHNR)  
Page: 98

1:15pm - 2:45pm  
(25) ELC Workshop D: Adobe Photoshop and Elements  
Page: 100

1:15pm - 2:45pm  
(26) ASNRC Business Center Programming: Part I  
Page: 100

2:45pm - 3:10pm  
Afternoon Break

3:15pm - 4:45pm  
(27) ASNRC Business Center Programming: Part II  
Page: 100

3:15pm - 4:45pm  
(28) Parallel Scientific Paper Sessions  
(A) Adult Brain: fMRI (Page: 101)  
(B) Spine: Spinal Injections and Vertebroplasty (Page: 107)  
(C) Pediatrics: Developmental/Congenital Malformations and Neonatal Imaging (Page: 112)  
(D) Interventional: New Devices and Techniques  
(Page: 117)

3:15pm - 4:45pm  
(29) ELC Workshop B: Advanced Powerpoint  
Page: 123

4:45pm - 6:15pm  
(30) Stroke (ASFNR)  
Page: 123

4:45pm - 6:15pm  
(31) Malformations, Phakomatoses and Ischemic/Traumatic Injury (ASPNR) (AR+)  
Self-Assessment Module (SAM)¹  
Page: 125

4:45pm - 6:15pm  
(32) Advanced Imaging Seminar - Techniques For Functional Imaging  
Page: 126

4:45pm - 5:45pm  
(33) ELC Lecture B: PACS Introduction & PACS Migration  
Page: 128

6:30pm - 8:00pm  
“All That Jazz” Reception with Technical Exhibitors

¹Note: Programming has been reviewed and qualified for Self Assessment Modules (SAM) credit through the American Board of Radiology (ABR).
Wednesday, June 13

6:30am - 7:55am
Breakfast

6:30am - 7:30am
How-To Session Breakfast
Sponsor: Siemens Medical Solutions USA, Inc.

7:45am - 8:45am
(34) Maintenance of Certification (MOC) - Spine and Pediatrics Review Session (AR+)
Page: 129

8:45am - 9:45am
(35) General Session: CNS Infections
Page: 129

9:45am - 10:10am
Morning Break

10:15am - 11:00am
(36) ASNR Presidential Address
Robert I. Grossman, MD, ASNR President
Page: 131

11:00am - 11:10am
(37) ASNR Award Announcements
Page: 131

11:10am - 11:40am
(38) Nanomedicine and the Future of Neuroradiology - William S. Ball, Jr., MD
Page: 131

11:40am - 12:00pm
(39) American Society of Neuroradiology (ASNR) Annual Business Meeting (Members Only)
Page: 132

12:00pm - 1:10pm
Lunch Break

12:10pm - 1:10pm
How-To Session Lunch
Sponsor: Philips Medical Systems

1:15pm - 2:45pm
(40) Current Concepts In Spinal Instability (ASSR)
Page: 132

1:15pm - 2:45pm
(42) Clinical Research In Pediatric Neuroradiology - Pitfalls and Projects (ASPNR)
Page: 134

1:15pm - 2:45pm
(43) ELC Workshop E: Advanced Web Design
Page: 135

2:45pm - 3:10pm
Afternoon Break

3:15pm - 4:45pm
(44) Parallel Scientific Paper Sessions
(A) Spine: Neoplasms and Other (Page: 135)
(B) Adult Brain: Cerebrovascular Occlusive Disease I (Page: 141)
(C) Pediatrics: Cerebrovascular Diseases, Degenerative, Demyelinating, Metabolic Disease (Page: 148)
(D) Interventional: Aneurysms I (Page: 154)

4:00pm - 5:30pm
Fellows Welcome Reception (By Invitation Only)

4:45pm - 6:15pm
(46) Cancer and the Pediatric Brain - Diagnosis and the Effects of Treatment (ASPNR)
Page: 161

4:45pm - 6:15pm
(47) Acute Stroke Trials (ASITN)
Page: 163

4:45pm - 6:15pm
(48) Diagnostic Imaging in the Spine (ASSR) (AR+)
Self-Assessment Module (SAM)\(^2\)
Page: 164

4:45pm - 6:15pm
(49) Advanced Imaging Seminar - Perfusion
Page: 166

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1\(^{Note:}\) Programming is currently under review for Self Assessment Modules (SAM) credit through the American Board of Radiology (ABR) for approval.

2\(^{Note:}\) Programming has been reviewed and qualified for Self Assessment Modules (SAM) credit through the American Board of Radiology (ABR).
Thursday, June 14

6:30am - 7:55am
Breakfast

7:45am - 8:45am
(50) Maintenance of Certification (MOC) - Vascular
and Interventional Review Session (AR+)
Page: 169

8:45am - 9:45am
(51) General Session: Spine
Page: 169

9:45am - 10:10am
Morning Break

10:15am - 12:00pm
(52) Parallel Scientific Paper Sessions
(A) Interventional: Aneurysms II (Page: 171)
(B) Interventional: New Devices and Equipment
   (Page: 177)
(C) Adult Brain: Cerebrovascular Occlusive Disease II
   and Epilepsy (Page: 183)
(D) Trauma: Head and Spine (Page: 190)

12:00pm - 1:10pm
Lunch Break

12:10pm - 1:10pm
American Society of Spine Radiology (ASSR)
Annual Business Meeting
(Members Only)
Page: 196

1:15pm - 2:45pm
(53) Spinal Interventions Update (ASSR)
Page: 196

1:15pm - 2:45pm
(54) Subarachnoid Hemorrhage and Aneurysms
   (ASITN)
Page: 198

2:45pm - 3:10pm
Afternoon Break

3:15pm - 4:45pm
(55) Parallel Scientific Paper Sessions
(A) Adult Brain: Cerebrovascular Occlusive Disease III
   (Page: 199)
(B) Interventional: Stroke and Arteriovenous
   Malformations/Fistulae (Page: 205)
(C) Spine: Spinal Cord & Degenerative Inflammatory
   Infections (Page: 211)
(D) Adult Brain: Neoplasms II and New Techniques
   Post-Processing (Page: 219)

4:45pm - 6:15pm
(56) Advanced Imaging Seminar - Faster and Faster
Page: 226

6:15pm - 6:30pm
Closing Remarks
Monday Morning

7:40 AM – 7:45 AM
Grand Ballroom C-F

(1) Opening Remarks
   — Robert I. Grossman  MD, ASNR President

Monday Morning

7:45 AM – 8:45 AM
Grand Ballroom C-F

(2) Maintenance of Certification (MOC) – Head and Neck Review Session – Audience Response Plus+ (AR+)*
   — Hilda E. Stambuk, MD
   — Bidyut K. Pramanik, MD

Moderator:  Laurie A. Loevner, MD

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

**Formerly Berlex

Monday Morning

8:45 AM – 9:45 AM
Grand Ballroom C-F

(3) General Session: Cardiac Imaging for the Neuroradiologist
   — Elliott K. Fishman, MD

(4) Coronary Artery CTA Interpretation
   — Elliott K. Fishman, MD

(5) Cardiac CT: Sources of Stroke
   — Gautham P. Reddy, MD

Moderator:  Bruce A. Wasserman, MD

Coronary Artery CTA Interpretation

Elliott K. Fishman, MD

LEARNING OBJECTIVES
Upon completion of this presentation, participants will be able to:
1) Analyze the brain’s temperature.

PRESENTATION SUMMARY
Although 64-slice MDCT has revolutionized many applications of CT, the true “killer application” has been cardiac CT evaluation. Although results from 16-slice MDCT scanners were promising, 64-slice MDCT has provided a study that has had a 99% negative predictive value and an approximately 90% positive predictive value. The key has been a combination of high temporal (83-180 msec) and spatial (.35-.4 mm) resolution. Cardiac CT requires a gated acquisition and is optimized in a patient with a heart rate of under 65 BPM. Beta blockers are used routinely to get these target heart rates and nitroglycerine often is used for vessel dilatation. Scan times per study are usually 7-10 seconds and,
Cardiac CT: Sources of Stroke

Gautham P. Reddy, MD

Dr. Reddy is an Associate Professor of Radiology at the University of California San Francisco. He serves as Chief of Cardiac and Pulmonary Imaging and the Director of the Diagnostic Radiology Residency Program. A graduate of Harvard University and George Washington University, he completed his internship in Medicine at the University of Southern California, residency in Radiology at Thomas Jefferson University, and fellowship in Cardiac and Pulmonary Radiology at University of California San Francisco. Dr. Reddy's interests are cardiovascular CT and MR imaging, especially applications involving ischemic and congenital heart disease. He has coauthored a number of journal articles and book chapters, as well as the book: Case Review: Cardiac Imaging and the CDrom: Cardiac MR Imaging. He has presented a number of lectures at national and international conferences. He codirected the Cardiopulmonary Imaging Categorical Course at the 2005 meeting of the ARRS. He has received the Hideyo Minagi Outstanding Teacher Award of the UCSF Department of Radiology and an award for Excellence in Direct Teaching from the Haile Debas Academy of Medical Educators at UCSF School of Medicine. Dr. Reddy serves on the executive committee of the Society of Thoracic Radiology and on the boards of directors of three other nonprofit organizations.

LEARNING OBJECTIVES
Upon completion of this presentation, participants will be able to:
1) Discuss importance and frequency of cardiac sources of stroke.
2) Review various cardiac sources or causes of stroke.
3) Recognize CT appearance of cardiac sources of stroke.
4) Illustrate treatment options for cardiac abnormalities that have the potential to cause a stroke.

PRESENTATION SUMMARY
The heart is the source of stroke in a number of patients: it has been reported that up to 20% of all patients with stroke have a cardiac source. Traditional evaluation of the heart is performed with transthoracic or transesophageal echocardiography. Electrocardiographically gated multidetector CT is a reliable method of cardiac imaging that can be used to identify potential sources of stroke. In addition, because CTA now is used more commonly for evaluation of suspected stroke, it would be ideal to use CT to assess not only the cerebral vessels/brain and the heart for a source of stroke in a single examination. Cardiac sources of stroke that can be imaged by CT include: 1) Cardiac thrombus: Atrial - mitral stenosis, atrial fibrillation; Ventricular - coagulation disorder, aneurysm; Valvular - endocarditis; Dilated cardiomyopathy - ischemic, non-ischemic; Atrial septal aneurysm. 2) Cardiac tumor: Myxoma; Primary malignant: angiosarcoma; Metastasis. 3) Paradoxical embolism; Intracardiac shunt or patent ductus aneurysm. 4) Compromised blood flow; Atrial fibrillation; Aortic stenosis; Left ventricular failure. 5) Systemic hypertension. Many of these entities can be treated with anticoagulation, although anticoagulation itself carries risks, including hemorrhagic stroke. Some intracardiac devices and surgical procedures also can be used to reduce the risk of stroke in the patients with certain cardiac abnormalities.
directly acquired from the T2* signal intensity time curve without complex mathematical modeling. The purpose of our study was to determine whether peak height and percent signal recovery derived from dynamic susceptibility-weighted contrast-enhanced perfusion MRI (DSC pMRI) would predict diffuse astrocytoma grade.

**MATERIALS & METHODS**

DSC pMRI was performed in 119 treatment-naive diffuse astrocytoma patients (11 Grade 2, 20 Grade 3, 88 Grade 4). Regions of interest were drawn around the contrast-enhancing lesion (CEL) and the peritumoral lesion (PTL), defined by the abnormal T2 signal surrounding the areas of necrosis and contrast enhancement. Perfusion parameters rCBV, peak height and percent signal recovery were calculated for CEL and PTL and correlated with histopathologic grade.

**RESULTS**

There was a strong correlation between mean and maximum rCBV measurements and average and maximum peak height values within CEL and the peritumoral lesion, for individual and combined diffuse astrocytoma grades. The strongest correlation was noted between mean CBV and average peak height within CEL (r = 0.86, p < 0.0001) as well as within the peritumoral lesion (r = 0.8, p < 0.0001) (Graphs A and B). Comparison of different grades showed that with increasing diffuse astrocytoma grade, there was an increase in average peak height within CEL (p < 0.0001) and the peritumoral lesion (p = 0.001), and a decrease in minimum percent signal recovery within CEL (p < 0.0001) (Graphs C and D).

**CONCLUSION**

Our study results demonstrate strong correlation between rCBV and peak height, consistent throughout all diffuse astrocytoma grades. In addition, our results suggest that peak height, a measure of tumor vascularity, and percent signal recovery, a measure of capillary permeability, derived from DSC pMRI without complex postprocessing are predictive of tumor grade for diffuse astrocytomas.

**KEY WORDS:** Astrocytoma, perfusion MR imaging, tumor grade
CONCLUSION
The results of our study suggest that rCBV and peak height (measures of tumor vascularity) as well as percent signal recovery (a measure of capillary permeability) derived from DSC pMRI may provide complementary information to the MIB-1 labeling index and may help predict survival in diffuse astrocytoma patients.

KEY WORDS: Astrocytoma, MIB-1, perfusion MR imaging

Paper 8 Starting at 10:31 AM, Ending at 10:39 AM
MR Imaging and Dynamic Susceptibility Contrast-Enhanced Perfusion in the Evaluation of Cerebellar Hemangioblastoma and Juvenile Pilocytic Astrocytoma

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New York University
New York, NY

PURPOSE
The differentiation of hemangioblastoma from juvenile pilocytic astrocytoma (JPA) can be a diagnostic challenge and is important for preoperative management. Hemangioblastomas have been shown to express high levels of vascular endothelial growth factor (VEGF) in the stromal cells, resulting in increased tumoral and peritumoral vascularity and permeability. This may manifest as increased peritumoral edema on conventional imaging and increased tumoral and peritumoral regional cerebral blood volume (rCBV) on perfusion imaging. The purpose of this study is to compare the MR imaging and perfusion findings between hemangioblastoma and JPAs.

MATERIALS & METHODS
Ten patients with hemangioblastoma and ten patients with JPAs underwent conventional MR imaging and dynamic susceptibility contrast (DSC) MR imaging before resection. T2-weighted sequences were evaluated and peritumoral signal abnormality was graded as absent, minimal, mild, moderate, or severe. Tumoral and peritumoral rCBV measurements were calculated by using standard intravascular indicator dilution algorithms. The results were compared with pathologic findings.

RESULTS
Moderate peritumoral edema was observed in six out of 10 patients with hemangioblastoma. None or minimal peritumoral edema was observed in the JPAs studied. Mean ± SD tumoral and peritumoral rCBV was 8.2 ± 1.5 and 2.4 ± 1.0 in the 10 cerebellar hemangioblastomas and was 1.3 ± 0.2 and 1.0 ± 0.4 for the juvenile pilocytic astrocytomas. The difference in the tumoral and peritumoral rCBVs between hemangioblastomas and JPAs were statistically significant (P < 0.05, Student t test).

CONCLUSION
On conventional imaging, the presence of peritumoral edema favors the diagnosis of hemangioblastoma. In addition, DSC MR imaging demonstrates significantly increased tumoral and peritumoral rCBV in hemangioblastomas as compared to JPAs. These results are helpful in preoperative differentiation of hemangioblastoma from JPA.

KEY WORDS: Hemangioblastoma, juvenile pilocytic astrocytoma, perfusion imaging

Paper 9 Starting at 10:39 AM, Ending at 10:47 AM
Correction of Confounding Leakage and Residual Susceptibility Effects in Dynamic Susceptibility Contrast MR Imaging Using Dual-Echo SPIRAL

Paulson, E. S. · Prah, D. E. · Schmainda, K. M.
Medical College of Wisconsin
Milwaukee, WI

PURPOSE
We demonstrate here that the combination of a dual-echo, single-shot SPIRAL acquisition and postprocessing algorithm can correct dynamic susceptibility contrast (DSC) MRI time courses for both confounding dipolar T1 and T2 effects as well as residual susceptibility effects as is common in brain tumors.

MATERIALS & METHODS
Perfusion-weighted images were acquired on nine patients with intracranial tumors using a single-shot, dual-echo, GRE-SPIRAL-out sequence: FOV=24 cm, matrix=64x64, slice thickness=5 mm, skip=1.5 mm, TE1=3.3 msec, TE2=30 msec, TR=1000 msec, slices=12, reps=180. A standard dose of gadodiamide (0.1 mmol/kg, Omniscan) was injected at the 60th time point. Three sets of ΔR2*(t) curves were derived from signal intensity data: (I) ΔR2*(t), constructed using the second echo time series of the dual-echo acquisition, (II) ΔR2*(t), constructed using the ratio of the second to first echo time series (1), (III) ΔR2*(t), constructed by correcting ΔR2*(t) for dipolar T2 and residual susceptibility effects by nonlinear fitting of a model that accounts for first pass and residual susceptibility/dipolar T2 effects (2). To compare the methods, estimates of rCBV were obtained by numerically integrating each AR2*(t) (i.e., I, II, and III) and then normalizing the rCBV estimates to the mean normal appearing white matter rCBV value (3).
RESULTS
Figure A displays $\Delta R^2*(t)$ curves for the tumor voxel depicted in Figure B. The black curve in Figure A and rCBV map in Figure C were generated from method I. Effects of contrast agent extravasation are apparent from the postbolus signal falling below its prebolus baseline value and by a lack of blood volume in regions of tumor. The dark gray curve in Figure A and rCBV map in Figure D were generated from method II, which effectively compensates for dipolar T1 leakage effects and prevents an underestimation of rCBV. However, as indicated by the elevated postbolus baseline, dipolar T2 and/or residual susceptibility effects still exist which can lead to an overestimation of rCBV. The light gray curve in Figure A and rCBV map in Figure E were generated from method III. Similar results were obtained for all nine patients studied.

CONCLUSION
A dual-echo acquisition method combined with a postprocessing algorithm may be a more accurate method of performing DSC-MRI studies in brain tumors.

REFERENCES

KEY WORDS: Cerebral blood volume, dual-echo acquisition, contrast agent leakage correction

This work was supported by NIH/NCI and GCRC grants CA082500 and M01-4400058.

Paper 10 Starting at 10:47 AM, Ending at 10:55 AM
Perfusion CT Evaluation Using Different Arterial Input Function: Role of Absolute Perfusion Parameters versus Normalized Ratios in Brain Tumors

Ellika, S. K. · Jain, R. · Schultz, L. R. · Scarpace, L. · Patel, S. C.
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Detroit, MI

PURPOSE
The purpose of this study was to evaluate the variability in the absolute perfusion parameters and compare this with the variability of the normalized ratios using different arterial input functions in patients with brain tumors.

MATERIALS & METHODS
We evaluated 14 patients with treatment-naïve brain tumors using first-pass perfusion CT (PCT) imaging. Perfusion maps of cerebral blood volume (CBV), cerebral blood flow (CBF), and mean transit time (MTT) were generated with CT perfusion software using three different arterial input functions (AIF) - contralateral anterior cerebral artery (CACA), contralateral middle cerebral artery (CMCA) and ipsilateral middle cerebral artery (IMCA) keeping other parameters constant. Absolute perfusion parameters were measured from the tumor and also from the contralateral and ipsilateral normal-appearing white matter. Three regions of interest (ROIs) were kept constant for calculating perfusion parameters using different AIF. Normalized ratios were calculated for CBV, CBF and MTT by dividing the absolute value of the tumor with that from the same (nCBV$_{swm}$) and contralateral (nCBV$_{cwm}$) white matter. Mean coefficient of variability (CV) was measured for absolute values (AV) and for normalized ratios for three different AIF and was compared using pairwise p-value analysis (Wilcoxon signed rank test).

RESULTS
CV was measured for CBV, CBF and MTT and it showed decreased values for the normalized ratios as compared to the absolute values for all the three parameters. The mean CV for CBV for AV, nCBV$_{swm}$ and nCBV$_{cwm}$ were 10.77, 10.62 and 9.42 respectively. The mean CV for CBF for the AV, nCBF$_{swm}$ and nCBF$_{cwm}$ were 20.21, 14.16 and 14.18 respectively. The mean CV for MTT for AV, nMTT$_{swm}$ and nMTT$_{cwm}$ were 20.20, 14.13 and 14.65 respectively. Tables showing the descriptive statistics will be incorporated.

CONCLUSION
Coefficients of variability were the least using normalized ratios for all the perfusion parameters as compared to the
absolute values though was not statistically significant. Hence, using normalized ratios might be more useful than the absolute perfusion parameters in patients with focal lesions.

**KEY WORDS**: Arterial input function, absolute values, normalized ratios

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### Paper 11 Starting at 10:55 AM, Ending at 11:03 AM

**Value of Perfusion Cerebral Blood Volume Measurements in Predicting Time to Progression/Outcome in Gliomas Compared with Histopathologic Assessment**


New York University Medical Center
New York, NY

**PURPOSE**

Histopathology is the standard reference for determining tumor biology and assessing outcome in gliomas. However, histopathology is limited by sampling error, by inter and intraobserver variability, and by the dynamic nature of gliomas, whereby tumors can dedifferentiate into more aggressive tumor. The purpose is to determine if cerebral blood volume (CBV) measurements can predict clinical outcome in high-grade and low-grade gliomas (LGG and HGGs) irrespective of pathology and specifically whether gliomas with high initial CBV show more rapid progression than those with low CBV.

**MATERIALS & METHODS**

One hundred eight-nine patients with histologically proved glioma comprising of low-grade astrocytoma (LGA, n = 28); LG oligodendrogliomas (LGO, n = 14); LG oligoastrocytomas, n = 11); anaplastic astrocytomas (AA, n = 72), anaplastic oligodendroglioma (AOA, n = 12), and glioblastoma multiforme (GBM, n = 52) were studied with dynamic susceptibility contrast perfusion MR imaging (DSC MRI). Patients were followed up clinically and with MRI (median follow up = 3.2 years). Wilcoxon rank sum test were used to compare patients in different response categories. Log-rank test were used to evaluate the association of rCBV with time to progression using Kaplan Meier curves. Binary logistic regression was used to determine whether age, gender and rCBV were associated with an adverse event (progression or death).

**RESULTS**

The mean rCBV ± SD for patients with each clinical response are: complete response (n = 4, 1.41 ± 0.13); stable disease (n = 41, 2.36 ± 1.78); progression (n = 130, 4.84 ± 3.32) and death (n = 36, 3.82 ± 1.93). Kaplan Meier estimates of median time to progression (days) demonstrated that patients with a rCBV < 1.75 had a median time to progression of 3585 days whereas patients with a rCBV > 1.75 had a time to progression of 265 days. P values from logistic regression demonstrated that age and rCBV were significant predictors of disease progression and death, whereas gender was not (p = 0.001, <0.001, and 0.971 respectively).

**CONCLUSION**

DSC MRI can be used to predict median time to progression in gliomas, independent of pathology. Gliomas with high rCBV (> 1.75) have a significantly more rapid time to progression than gliomas with a low rCBV. This may influence the extent of neurosurgical resection as well as the role of postoperative radiation and chemotherapy, adding rCBV to current known prognostic factors: age, histology, Karnofsky score and extent of resection.

**KEY WORDS**: Glioma, perfusion, outcome

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### Paper 12 Starting at 11:03 AM, Ending at 11:11 AM

**Dependency of Tumor and Normal Brain Relative Cerebral Blood Volume on Choice of DSC MR Imaging Data Acquisition and Analysis Methods**

Paulson, E. S.; Prah, D. E.; Schmainda, K. M.

Medical College of Wisconsin
Milwaukee, WI

**PURPOSE**

The goal of this study was to determine how differences in DSC MR imaging (MRI) data acquisition and analysis methods influence relative cerebral blood volume (rCBV) estimates in tumor and normal brain.

**MATERIALS & METHODS**

Three sets of experiments were designed to evaluate four published DSC MRI data acquisition methods (Table 1) and six published DSC MRI data analysis methods. For the first and second sets of experiments two acquisitions were performed in series on the same patients, with injection of contrast agent during the first acquisition serving as a loading dose for the second acquisition. Relative CBV was estimated using: 120-point trapezoidal integration of $\Delta R2^*(t)$ without (I), and with (II) correction for leakage effects (4), (III) integration of a gamma-variate fit to $\Delta R2^*(t)$ (1, 2), (IV) trapezoidal integration of $\Delta R2^*(t)$ after postbolus correction (3), (V) negative enhancement integral of S(t) (6), and (VI) maximum signal drop of S(t) (2, 3). For comparison, rCBV estimates were normalized to mean white matter rCBV.

**RESULTS**

Figures 1-4 display mean rCBV estimates as a function of analysis method for each of the acquisition methods in Table 1. A disparity in mean rCBV was found to exist among and between acquisition and analysis methods, especially in regions of tumor. As demonstrated by negative tumor rCBV values in Figure 1, extravasation of contrast agent can result in an underestimation of rCBV if data analysis or data acquisition methods (Figures 2-4) are not used to prevent or correct for competing T1 leakage effects. Additional rCBV variability may be attributable to T2 leakage or residual susceptibility effects.
Table 1: DSC-MRI Data Acquisition Methods

<table>
<thead>
<tr>
<th>Acquisition Method</th>
<th>Subjects</th>
<th>Experiment Number</th>
<th>Acquisition Order</th>
<th>Pulse Sequence</th>
<th>Flip Angle</th>
<th>Number of Echoes</th>
<th>Echo Time (TE)</th>
<th>Gd-DTPA Dose</th>
<th>Gd-DTPA Injection</th>
<th>Pre-Load Administered</th>
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</thead>
<tbody>
<tr>
<td>A [1]</td>
<td>n=9</td>
<td>1/1</td>
<td>1/1</td>
<td>GRE-EPI</td>
<td>90 degrees</td>
<td>1</td>
<td>30 msec</td>
<td>0.1 mmol/kg</td>
<td>60th time point</td>
<td>No</td>
</tr>
<tr>
<td>B [2,3]</td>
<td>n=6</td>
<td>2/1</td>
<td>1,2/2</td>
<td>GRE-EPI</td>
<td>35 degrees</td>
<td>2</td>
<td>54 msec</td>
<td>0.1 mmol/kg</td>
<td>15th time point</td>
<td>No</td>
</tr>
<tr>
<td>C [4]</td>
<td>n=15</td>
<td>1,2/3</td>
<td>3/ (N/A)</td>
<td>GRE-EPI</td>
<td>90 degrees</td>
<td>2</td>
<td>30 msec; 30 m</td>
<td>0.2 mmol/kg</td>
<td>60th time point</td>
<td>Yes</td>
</tr>
<tr>
<td>D [5]</td>
<td>n=4</td>
<td></td>
<td></td>
<td>GRE-SPIRAL</td>
<td>90 degrees</td>
<td>3</td>
<td>3.3 msec; 30 m</td>
<td>0.1 mmol/kg</td>
<td>60th time point</td>
<td>No</td>
</tr>
</tbody>
</table>

CONCLUSION

In terms of best tumor-to-normal brain contrast and consistency across analysis methods the most robust DSC MRI data acquisition methods appear to C and D (Figs 3 and 4).

REFERENCES

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KEY WORDS: Cerebral blood volume, contrast agent leakage correction, brain tumor

This work was supported by NIH/NCI and GCRC grants CA082500 and M01-4400058.

Paper 13 Starting at 11:11 AM, Ending at 11:19 AM

Apparent Diffusion Coefficient and Cerebral Blood Volume in Brain Gliomas: Relation with Tumor Microvessel Density and Tumor Cell Density Based on Stereotactic Biopsies

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PURPOSE

Apparent diffusion coefficient (ADC) and relative cerebral blood volume (rCBV) measurements have been related respectively to tumor cellularity and tumor vascularity in gliomas. However there is no report on a direct correlation between ADC and rCBV with these histologic features. The purpose of this study was to regionally compare ADC and rCBV measurements with cell and microvessel densities in brain gliomas, thanks to the parallel analysis of stereotactic biopsies and co-registered MR images.

MATERIALS & METHODS

Seventeen patients (eight men, nine women; age range, 19-78 years), with brain gliomas underwent PET and MR imaging including diffusion-weighted imaging and dynamic susceptibility contrast-enhanced imaging before biopsy. Eighty-two biopsy samples were obtained on trajectories targeted towards high PET tracer uptake areas. We categorized all samples as “peritumoral,” “infiltrated tissue” and “bulk tumor” and quantified cell density and microvessel density. The samples were immunohistochemically stained using a monoclonal antibody against the CD34 antigen in order to assess microvessel density. ADC and rCBV values were measured at the stereotactic coordinates of the biopsy sites and were normalized to the contralateral white matter (Fig 1). ADC and rCBV ratios were compared to quantitative histology using Spearman correlation test.

RESULTS

Considering all samples, correlation coefficients between rCBV ratios and cell density and microvessel density were respectively, 0.44 (P = 0.001) and 0.27 (P = 0.02) (Fig 2a-b). There was no correlation between ADC ratios and either cell
density or microvessel density (respectively: $r = 0.08$, $r = -0.19$) (Fig 2c-d). When considering bulk tumor samples only, all correlation coefficients were higher and correlation coefficients between ADC and microvessel density reached statistical significance ($r = -0.41$).

CONCLUSION

Both cell and microvessel densities seem to affect rCBV values in gliomas. This regional analysis does not confirm the previously reported inverse correlation between ADC and cell density.

KEY WORDS: Gliomas, perfusion-weighted, diffusion-weighted

Paper 14 Starting at 11:19 AM, Ending at 11:27 AM

Glioblastoma Multiforme: Prediction of Outcome Using Anatomical and Dynamic Susceptibility-Weighted Perfusion MR Imaging

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San Francisco, CA

PURPOSE

The variability observed in the survival of glioblastoma multiforme (GBM) patients, confers the need for the identification of patients who may benefit from more or less aggressive therapy. The vascularity of gliomas plays a critical role in determining malignant potential and prognosis, and T2*-weighted perfusion MR imaging (MRI) has been a promising tool in determining the degree of tumor angiogenesis and capillary permeability. The purpose of our study was to determine whether hemodynamic variables derived from perfusion MRI correlate with time-to-progression (TTP) and overall survival in GBM patients.

MATERIALS & METHODS

Dynamic susceptibility-weighted contrast-enhanced perfusion MR imaging (DSC pMRI) and conventional anatomical MRI were performed in 98 patients with treatment-naïve GBM. At the time of our analysis, 60 patients were dead (mean survival = 12 months) and 38 were alive (mean follow up = 25 months). Fifty patients had evidence of progression (mean TTP = 7 months). Regions of interest were drawn around the contrast-enhancing lesion (CEL) and the peritumoral lesion (PTL), defined by the abnormal T2 signal surrounding the areas of necrosis and contrast enhancement. Relative cerebral blood volume (rCBV), peak height (PH) and percent signal recovery (PSR), derived from DSC pMRI, were calculated for relative CEL and PTL (corrected for overall tumor volume). Survival and progression analyses were performed using anatomical MRI and DSC pMRI parameters.

RESULTS

In addition to advancing age ($p = 0.01$), the most powerful imaging predictor of poor survival in GBM was smaller relative volume of the peritumoral lesion ($p = 0.01$). The second significant predictor of shortened survival was larger relative CEL volume ($p = 0.02$). Among the DSC pMRI variables, lower average percent signal recovery within the peritumoral lesion was the most significant predictor of shorter survival ($p = 0.05$). Higher rCBV in the peritumoral lesion correlated with shorter time to progression ($p = 0.04$).

CONCLUSION

The results of our study showed that the most significant imaging predictor of poor outcome in patients with GBM is a smaller peritumoral lesion volume followed by larger contrast enhancing lesion volume. Among the DSC pMRI variables, higher rCBV and lower percent signal recovery in the peritumoral region correlated significantly with shorter time-to-progression and overall survival, respectively. We conclude that both anatomical and DSC perfusion MR imaging provide complementary information on GBM biology that may predict clinical outcome.

KEY WORDS: Glioblastoma multiforme, perfusion MR imaging, survival

Paper 15 Starting at 11:27 AM, Ending at 11:35 AM

Dynamic MR Imaging-Targeted Biopsy of Cerebral Gliomas: A Correlative Study with Histopathologic and Angiogenic Results

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1 German Cancer Research Center, Heidelberg, GERMANY, 2 University of Heidelberg, Heidelberg, GERMANY

PURPOSE

The aim of our study was to assess the vascularity of malignant cerebral gliomas by dynamic contrast-enhanced MR imaging and to use these data for a neuronavigated biopsy with immuno-histologic correlation.

MATERIALS & METHODS

Twelve patients with GBM underwent dynamic MR imaging-targeted biopsy and resection. For dynamic MR imaging, we used a 2D fast GRE sequence. Twenty-two serial acquisitions were acquired after a 30s injection of 0.1 mmol/kg of
Gd-BOPTA (MultiHance®). After postprocessing using a two-compartment pharmacokinetic model, the parameters amplitude (A) and the redistribution constant (kep) were color coded and overlayed on a 3D neuronavigation dataset (Figure 1). The data were transferred into the operation room to navigate the biopsy following resection. Biopsy were taken from areas with high and low values of A and kep. The specimens were analyzed using different staining and immunohistochemical analyses of vascular growth factors.

**RESULTS**

The postoperative/postbiopsy vascular density staining (CD 31 and CD 34 staining) correlated (p < 0.001) with the pharmacokinetic parameter Amplitude A, the tumor vascularity. On histology, 15 different angiogenic growth factors could be identified. In 10 patients, these factors could be correlated with the preoperative dynamic MR imaging data. A correlation (p < 0.01) between both A and kep was found with the highly expressed factors VEGF, HGF and angiogenin.

**CONCLUSION**

Dynamic MR imaging-targeted biopsy allowed to depict the highly vascularized and more malignant tumor parts with high expression VEGF, HGF and angiogenin. The method proved to reliably present the malignant tumor parts which can be used as a kind of virtual biopsy.

**KEY WORDS:** Glioblastoma, Dynamic contrast-enhanced MR imaging, molecular diagnostics

**Paper 16 Starting at 11:35 AM, Ending at 11:43 AM**

**Acquisition of 7T 3D MRS Imaging Data from Patients with Brain Tumors**

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¹University of California San Francisco, San Francisco, CA, ²GE Healthcare, San Francisco, CA

**PURPOSE**

The goal of this study was to demonstrate the feasibility of applying 3D proton MRSI to patients with brain tumors using a whole body 7T MR scanner and to examine the differences in metabolite levels within regions of tumor relative to normal tissue.

**MATERIALS & METHODS**

Ten patients with previously treated gliomas were scanned using a 7T MR scanner (GE Healthcare Technologies, Waukesha, WI) a commercial quadrature for excitation and 8-channel phased array for reception (Nova Medical, Wilmington, MA). High-resolution gradient-echo images were acquired for anatomical reference. The 3D PRESS localized MRSI data were obtained in 17 minutes with TR = 2 s, TE = 144 ms or 90 ms, 2048 patients, 5000 Hz bandwidth, CHESS water suppression, 12 x 12 x 8 phase-encoding and elliptical k-space sampling with a nominal voxel size of 8 or 10 mm. Pulses used to define the PRESS selected volume were custom-designed, phase-modulated, symmetric-sweep, high-bandwidth, spectral-spatial pulses. The selected volume was over-prescribed to reduce chemical shift effects and low power, high bandwidth, very selective saturation (VSS) pulses were employed to sharpen the volume selection profile. The MRSI data were apodized with a 4Hz Lorentzian function, fourier transformed and phase corrected. Signals from the elements of the elements of the phased-array coil were combined using methods previously developed in our group.

**RESULTS**

The 7T high-resolution anatomical images visualized differences in image contrast corresponding to small vessels and regions of hyperintensity that reflected tumor, edema or treatment effects. While signal losses were observed in the MRSI data for regions close to the sinuses, the higher order shimming routine provided a significant improvement in spectral linewidth and data quality in other regions of the brain. In regions of normal-appearing brain the ratios (median +/- sd) of choline to N-acetylasparate (NAA) and choline to creatine were 0.46 +/- 0.09 and 0.95 +/- 0.11 respectively. There were voxels in all patients for which the estimated choline to NAA index (CNI) and choline to creatine (CCrI) index were greater than two standard deviations above the variations in normal tissue. The median of the maximum CNI values was 7.5 (range 2.9 to 18.3) and the median of the maximum CCrI was 5.0 (range 2.4 to 13.4).

**CONCLUSION**

MRSI data were obtained at 7T within a clinically acceptable examination time. While further work needs to be done to elucidate the relaxation times of the individual metabolites, it was clear that there were differences in the relative levels of choline, creatine and NAA in tumor compared with normal brain tissue from the contralateral hemisphere that could be used for diagnosis and directing patient care.

**KEY WORDS:** H-1 MRSI, glioma, 7T
Accuracy of DSC-pMRI in Assigning Percentages of High-Grade Malignant Features in Masses Recurring After Surgical and Radiation Treatment of Brain Neoplasms

Gasparetto, E. L. · Patell, S. · Pawlak, M. A. · Wolf, R. · Woo, J. · Krejza, J. · Rosenfeld, M. · O’Rourke, D. · Lustig, R. · Melhem, E. R.

1University of Rio de Janeiro, Rio de Janeiro, BRAZIL, 2University of Pennsylvania, Philadelphia, PA

PURPOSE
The goal of our study was to assess the accuracy of dynamic susceptibility-contrast perfusion MR imaging (DSC-pMRI) in assigning percentages of high-grade malignant features in masses recurring after surgical and radiation treatment of brain neoplasms.

MATERIALS & METHODS
We retrospectively selected 30 patients with high-grade primary or secondary brain neoplasm, who underwent surgical resection and radiation therapy, developed a mass suspicious for recurrent neoplasm on follow-up evaluation, subsequently, underwent MR imaging including DSC-pMRI followed by total gross resection of the recurrent mass. The DSC-pMRI was performed with a contrast-enhanced T2-weighted single-shot spin-echo echo-planar sequence, and the relative cerebral blood volume (rCBV) maps were calculated. The histological specimens were evaluated and defined as grade 1 (less than 20% of high-grade features in the specimen) and grade 2 (≥ 20% of high-grade features in the specimen). The contrast-enhancing mass volume region of interest (ROI) was manually defined. In addition, rCBV of normal white matter was calculated and used in further calculation of intensity thresholds. Lesion volume ROI was used as a mask for registered rCBV map to create rCBV lesion volume. This volume was then thresholded using values obtained on the basis of normal white matter rCBV values. For this analysis, we calculated 31 threshold values from one to four times the white matter rCBV with 0.1 increment. Receiver operating characteristic (ROC) curves were constructed to assess the best performance of all the different thresholds.

RESULTS
Thresholds of 1.9, 2.0 and 2.1 times the white matter rCBV values had the best performance in differentiating grade 1 and grade 2 lesions, with sensitivity and specificity of 94.1% and 92.3%, respectively. The thresholds 2.2 and 2.3 also demonstrated good performance, with sensitivity of 88.2% and specificity of 92.3%. The highest sensitivities were seen for thresholds up to 2.1, with decreasing specificity (from 92.3% to 23%) as white matter intensity threshold was decreased. The highest specificities were demonstrated for thresholds higher than 1.9, with decreasing sensitivity (from 94.1% to 41.2%) as white matter intensity threshold was increased.

CONCLUSION
Thresholds between 1.9 and 2.1 times the white matter rCBV values demonstrated high sensitivity and specificity in differentiating lesions with more or less than 20% of malignant histological features. The DSC-pMRI is a promising tool for assigning percentages of high-grade malignant features in masses recurring after surgical and radiation treatment of high-grade brain neoplasms.

KEY WORDS: perfusion weighted images, magnetic resonance imaging, brain tumors
clinical follow up. All 45 cases in this study had surgical or
clinical follow up. Using patients with negative diagnoses,
the normal spectrum of DWIBS MRI signal in the head and
neck was established. Abnormal DWIBS signals were
defined by abnormal distribution or size beyond the expect-
ed signal morphology in the head and neck. By consensus
between a radiologist-in-training and an experienced neuro-
radiologist, all patients were reviewed for DWIBS signal
abnormalities which then were related to presence or
absence of malignancy or nonmalignant diagnoses.

RESULTS
The normal spectrum of DWIBS signal in the head and neck
was established in patients with negative clinical follow up,
which included the visualized brain parenchyma, spinal
cord, sinonasal mucosa, cervical lymph nodes less than 1
mm, and lymphoid tissues in Waldeyer's Ring. Abnormal
DWIBS signals were detected in 18 cases, of which 11 cases
had a malignancy (68% sensitivity). The malignancies
included squamous cell carcinoma (8), mucoepidermoid car-
cinoma with squamous differentiation (1), lymphoma (1),
and papillary thyroid cancer (1). The remaining seven
patients with DWIBS signal abnormalities had nonmalignant
cervical lymphadenopathy. Five patients without DWIBS
signal abnormalities had intraosseous residual adenocarcino-
ma (1) and adenoid cystic carcinoma (1), a small glottic
squamous cell carcinoma (1), Hurthle cell thyroid cancer (1),
and papillary thyroid cancer (1). Overall, this MRI technique
detected squamous cell carcinoma with about 88% sensitiv-
ity and had approximately 75% specificity for malignancy.
Intraosseous and nonthyroid head and neck malignancies
were detected with more than 90% sensitivity. Enlarged
lymph nodes constituting lymphadenopathy were detected
with 100% sensitivity.

CONCLUSION
In this study, the clinical efficacy of detecting head and neck
malignancies using the DWIBS MRI sequence was assessed.
The sensitivity of this MRI technique for detecting head and
neck malignancies including squamous cell carcinoma sug-
gests that it may have a role as a rapid noninvasive screen-
ing exam. Further studies of this technique in a large popu-
lation of patients with risk factors for head and neck cancer
will be necessary for validation. This technique also may be
a diagnostic tool in detailed MRI exams of the neck.

KEY WORDS: Diffusion-weighted imaging, head and neck
malignancy, DWIBS

Paper 19 Starting at 10:23 AM, Ending at 10:31 AM
Larynx CT Protocol with Breath Holding and Straw
Blowing for Staging of Laryngeal Cancer: Improved
Accuracy or Added Radiation Exposure?

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University of Washington
Seattle, WA

PURPOSE
Vocal cord mobility is one of the criteria of laryngeal cancer
staging. The purpose of this study is to compare the accura-
cy of the dedicated larynx CT with that of the standard neck
CT for assessment of laryngeal cancer staging.

MATERIALS & METHODS
Twenty-eight patients with laryngeal cancer underwent lar-
ynx CT protocol, which included both standard neck and lar-
ynx CT on Volume CT. The standard neck CT images are
reformatted to 2.5 mm axial images following intravenous
administration of 75 cc of contrast material from the skull
base to upper thorax. The dedicated larynx CT includes 1.25
mm axial images using 12 cm FOV, from the base of tongue
to the bottom of cricoid cartilage during bread holding and
straw blowing. Radiologists on site review the standard neck
CT and the angle of images is set parallel to true vocal cord
for the larynx CT. Additional 75 cc of contrast was adminis-
tered before the larynx CT. Coronal reformatted images of
the standard neck CT as well as dedicated larynx CT also
were provided. There were nine patients with glottic cancer,
17 patients with supraglottic cancer, and one patient with
subglottic and one with hypopharyngeal cancer. Two radiol-
ogists reviewed the standard neck CT only first, and assigned
T staging based on AJCC classification. Then more than 4
weeks later, they reviewed the dedicated larynx CT with
neck CT to assign T staging. Confidence level of CT staging
being accurate also was measured using 5 grading system.
The surgical and clinical staging was used as a standard of
reference.

RESULTS
The average accuracy (the correct rate between CT staging
and clinicopathologic staging) was 0.5 for the standard neck
CT, and 0.51 for larynx protocol (neck CT and larynx CT).
The confidence level was lower in the larynx protocol for
reader A (4.4 for neck CT, and 4.0 for larynx protocol), and
remained unchanged for reader B (3.8). Subgroup analysis
based on the primary site showed that larynx protocol lead to
correct staging in 33% of cases of glottic cancer. However,
the staging was less accurate on the larynx CT for supraglot-
tic laryngeal cancer by both readers (Table).

<table>
<thead>
<tr>
<th>Primary site</th>
<th>Neck CT staging correct</th>
<th>Larynx CT staging correct</th>
<th>Both correct</th>
<th>Both incorrect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glottic N=9</td>
<td>A</td>
<td>1</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>B</td>
<td>0</td>
<td>3</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>Supraglottic N=17</td>
<td>A</td>
<td>4</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>B</td>
<td>5</td>
<td>2</td>
<td>6</td>
<td>4</td>
</tr>
</tbody>
</table>

CONCLUSION
The larynx protocol did not improve overall staging accura-
cy or readers' confidence level in this preliminary study.
When the true vocal cords showed no abduction in breath
holding, it was unclear whether the cords were fixed or the
patient did not follow the instruction. Considering addition-
al exam time and radiation exposure and isotropic voxel size
on Volume CT, standard neck CT with multiplanar reformat-
ting and a simple mirror examination by otolaryngologist
may suffice the staging of laryngeal cancer.

KEY WORDS: Laryngeal cancer, CT, staging
Paper 20 Starting at 10:31 AM, Ending at 10:39 AM
Lymph Nodes of Patients with Regional Metastases from Head and Neck Squamous Cell Carcinoma Treated with High-Dose Radiation Therapy: Correlation between CT and Pathology Findings
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Medical University of South Carolina
Charleston, SC

PURPOSE
The goal of the study is to establish whether signs of nodal disease seen on computed tomography (CT) of the neck after radiation therapy (RT) or chemoradiation therapy can predict the probability of residual lymph node disease in patients with cervical metastatic disease from squamous cell carcinoma of the head and neck region.

MATERIALS & METHODS
We reviewed clinical records of patients with cervical metastasis from head and neck squamous cell carcinoma who underwent radical or modified neck dissection after high-dose RT for squamous cell carcinoma of the head and neck region. Twenty-two patients who had undergone a pre-RT CT scan, RT with curative intent and a post-RT CT scan, followed by neck dissection were included retrospectively in the study, for a total of 24 heminecks. Neck lymph nodes suspicious for metastatic involvement were identified based on the following criteria on the pre-RT CT: any nodal dimension larger than 15 mm, presence of necrosis, or extracapsular extension. Pre- and post-RT nodal volume, presence of necrosis and extracapsular extension, and nodal station were recorded for each abnormal lymph node. Percent volume changes of the lymph nodes between the pre- and post-RT CT were calculated (volume of lymph node on the pre-RT CT minus volume of the same lymph node on the post-RT CT percent). Surgical pathology reports also were reviewed for each hemineck. Student’s t-test and Pearson’s chi-square test were used for statistical analysis. Results were considered statistically significant when p < 0.05.

RESULTS
The results of the statistical analyses are listed in the Table. Fifty-nine abnormal lymph nodes were identified by imaging criteria. Average pre- vs post-RT volume change percentages (+/- standard error of the mean) were significantly different between the 15 nodes that were found to be positive at neck dissection (22.07% +/- 27.98%) and the 44 lymph nodes that were found free of disease (69.07% +/- 3.09%) (p = 0.007). Internal heterogeneities consistent with necrosis were seen on the post-RT CT in 80% of lymph nodes abnormal at pathologic evaluation and in only 25% of the benign lymph nodes (p < 0.001).

Comparison of CT findings and histology of neck lymph nodes

<table>
<thead>
<tr>
<th></th>
<th>Nodes positive at pathology (N=15)</th>
<th>Nodes negative at pathology (N=44)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-RT CT necrosis</td>
<td>10/15</td>
<td>21/44</td>
<td>0.243*</td>
</tr>
<tr>
<td>Pre-RT CT extra-capsular</td>
<td>6/15</td>
<td>13/44</td>
<td>0.528*</td>
</tr>
<tr>
<td>involvement</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Post-RT CT necrosis</td>
<td>12/15</td>
<td>11/44</td>
<td>&lt;0.001*</td>
</tr>
<tr>
<td>Post-RT CT extra-capsular involvement</td>
<td>4/15</td>
<td>10/44</td>
<td>0.504*</td>
</tr>
<tr>
<td>Pre- vs. post RT CT % nodal volume changes</td>
<td>22.07 +/- 27.98</td>
<td>69.07 +/- 3.09</td>
<td>0.007*</td>
</tr>
</tbody>
</table>

* Pearson’s chi square test  
* Student’s t test

CONCLUSION
Our data indicate that CT findings may be useful in predicting the likelihood of residual nodal disease in patients with squamous cell carcinoma of the head and neck treated with high-dose RT. This information combined with the clinical findings could contribute to determine the necessity for post-RT neck dissection.

KEY WORDS: Head and neck cancer, radiation treatment, regional metastasis

Paper 21 Starting at 10:39 AM, Ending at 10:47 AM
Multidetector CT in Obstructive Sleep Apnea Syndrome: Evaluation of the Upper Airway and CT Cephalometric Analysis: Work In Progress
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PURPOSE
Obstructive sleep apnea syndrome (OSAS) is a major public health problem affecting about 2-4% of the middle-aged population. Despite its high prevalence and major health implications, the pathogenesis is not well understood. The upper airway geometry in patients with OSAS differs from those in normal subjects which is amenable to cross-sectional imaging. • To prospectively assess the upper airway anatomy of OSAS patients by multi-detector row computed tomography (MDCT) and compare these findings with age- and sex-matched controls. • To assess the changes in the anatomical parameters in those OSAS patients (included in the initial study) who undergo surgery.

MATERIALS & METHODS
Subjects of either sex and more than 18 years of age with signs and symptoms suggestive of OSAS and a diagnostic sleep study with a respiratory distress index (RDI) > 5 are being enrolled in the study. We intend to include a total of 30 OSAS subjects. All the diagnosed subjects will be undergoing a detailed CT evaluation. Controls for the study are being chosen from among the patients presenting to our department for head/neck CT for an unrelated pathology. Presently we have evaluated eight OSAS subjects and an equal number of controls. CT is being performed on a Siemens Sensation 16 (Siemens Medical System, Foresheim,
Germany) helical CT scanner. After obtaining the topogram and base images of the region of interest, these are exported to the work station for further analysis. Sagittal and coronal reconstruction and volume rendering are done. Anatomical landmarks are identified and various parameters evaluated. The cephalometric parameters include linear bony measurements, angular bony measurements and soft tissue measurements. Additionally, the cross-sectional areas and AP and lateral dimensions and few other parameters at various levels of the airway also are measured. For those OSAS subjects who undergo a surgery within the period of the study, a repeat CT is proposed to evaluate the success of the surgery.

RESULTS
The preliminary analysis of the data reveals that the parameters which are likely to achieve significant differences between the two groups once the study is completed include the mandibular hyoid distance (mean 1.26 cm in control group, 1.60 cm in OSAS group), the tongue length (mean 6.89 cm in control group, 7.31 cm in OSAS group), soft palate length (mean 3.62 cm in control group, 4.10 cm in the OSAS group) retropalatal cross-sectional area (mean 1.99 sq cm in controls, 1.24 sq cm in cases), retropalatal antero-posterior and lateral dimensions.

CONCLUSION
By means of this study, we intend to provide a comprehensive CT data base which can add to our knowledge of the synchronous narrowings of the upper airway and demonstrate the “bottle-neck point”. This will go a long way in furthering the understanding of the mechanisms of OSAS. Besides, the study intends to give volumetric structural substrate to the surgeons before they embark upon surgery for OSAS.

KEY WORDS: Obstructive sleep apnea syndrome, multidetector CT, upper airway anatomy

Paper 22 Starting at 10:47 AM, Ending at 10:55 AM
Herniation of the Buccal Fat Pad into the Maxillary Antrum: Incidence of an Unusual Injury

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Jacobi Medical Center/Albert Einstein College of Medicine Bronx, NY

PURPOSE
CT findings in three cases of herniation of the buccal fat pad into the maxillary antrum have been reported recently (1), an unusual injury previously reported only once in the pre-CT era (2). This prompted us to review our experience with facial trauma to determine the incidence of this injury.

MATERIALS & METHODS
We retrospectively reviewed the CT scans performed for facial trauma at a busy urban level I trauma center in 2005. The scans were examined for presence or absence of fracture. Of the patients with fractures, the number of fractures involving the maxillary antrum and their locations were tabulated.

RESULTS
In 2005, 745 patients underwent CT scanning for facial trauma. There were 301 fractures (40% of the total), of which 125 (42% of the fractures) involved the maxillary antrum. Of the 125 maxillary antrum fractures, the antral roof/inferior orbital wall was involved in 108 (86%), the medial wall in 26 (21%), the anterior wall in 67 (54%), and the lateral wall in 56/125 (45%). Of the 56 fractures of the lateral antral wall, we found five instances (9%) in which the buccal fat pad herniated into the maxillary antrum.

CONCLUSION
Herniation of the buccal fat pad is an unusual injury, occurring in 5/745 (0.67%) of our patients scanned for facial trauma, 5/301 (1.7%) of the patients with any facial fractures, and 5/125 (4%) of patients with fractures of the maxillary antrum. Nonetheless, because of the high incidence of facial trauma due to motor vehicle accidents, assaults, and falls, busy metropolitan trauma centers can expect to see a steady stream of these injuries. A herniated buccal fat pad can undergo ischemic necrosis with consequent infection, as in a case of herniation into the oral cavity (3). Radiologists should therefore report this finding as clinicians determine whether or not to operatively reduce facial fractures.

REFERENCES

KEY WORDS: Buccal fat pad, maxillary antrum, trauma

Paper 23 Starting at 10:55 AM, Ending at 11:03 AM
Focal Opacification of the Olfactory Recess on Screening Sinus CT: Just an Incidental Finding?

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

PURPOSE
The olfactory recess is an area often overlooked during the interpretation of paranasal sinus CT because it is uncommonly affected by inflammatory sinus disease. Anecdotally in our practice, a small opacity within the olfactory recess on sinus CT culminated in the diagnosis of early stage esthesioneuroblastoma (Fig 1). We examined the prevalence of olfactory recess opacity (ORO) to clarify when such findings should raise suspicion for a small neoplasm or cephalocele.

MATERIALS & METHODS
Consecutively performed outpatient screening sinus CTs were evaluated for the presence of ORO, defined as soft tissue density abutting the cribiform plate. Evidence of prior surgery (ethmoidectomy/turbinectomy), distribution of inflammatory sinus disease, and presence of concha bullosae also were documented. A forward stepwise logistic regression model was developed to examine the association of ORO with these variables.

RESULTS
One thousand olfactory recesses were evaluated in 500 patients with a mean age of 46.9 years (range 18-89 years). ORO was identified in 59 patients (11.8%), bilateral in 27
cases (5.4%) and unilateral in 32 cases (6.4% with an equal distribution right versus left). Three hundred forty-three ethmoids were diseased and 66 (27.2%) of these also had ORO. In contrast, only 20 of 657 (3.0%) clear ethmoids had ipsilateral ORO (p < 0.0001). ORO was significantly (p = 0.013) more likely to be seen in the context of prior surgery (18 of 75; 24.0%) than without prior surgery (68 of 925; 7.4%). The presence of concha bullosa was not associated with ipsilateral ORO. Of the 32 patients with unilateral ORO (which would be most suspicious for incidental pathology), only five (15.6%) had no ethmoid opacification or prior surgery, and two of these cases had subtle cephaloceles accounting for the ORO (Fig 2). Finally, unilateral ORO was present in only one case (cephalocele) of the 122 patients with completely clear sinuses.

CONCLUSION
While olfactory recess opacification may be seen in the presence of adjacent ethmoid opacification or prior ethmoidectomy/turbinectomy, it is distinctly uncommon in the absence of these sources of inflammation. As such, isolated unilateral olfactory recess opacity should be viewed with suspicion and should direct the clinician to further evaluate this area.

KEY WORDS: Paranasal sinus, computed tomography, olfactory recess

Paper 24 Starting at 11:03 AM, Ending at 11:11 AM
Retrospective Review and Imaging Analysis of the Olfactory Bulbs and Apparatus in Patients with CHARGE Syndrome

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1University of California Los Angeles/Fondation Ophtalmologique A. de Rothschild, Los Angeles/Paris, FRANCE, 2David Geffen School of Medicine at University of California Los Angeles, Los Angeles, CA, 3Children’s Hospital Los Angeles, Los Angeles, CA, 4University of California Los Angeles/Armand Trousseau Hospital, Los Angeles/Paris, FRANCE

PURPOSE
Because olfaction is difficult to assess in infants and children, developmental anomalies of the rhinencephalon, olfactory tracts and bulbs in CHARGE syndrome (Coloboma, Heart anomalies, Choanal atresia, mental and growth Retardation, Genital and Ear anomalies), often are under evaluated. Recent studies of CHARGE patients revealed a high incidence of characteristic olfactory anomalies (1). The purpose of this paper is to describe the characteristic olfactory anomalies seen on both MR imaging (MRI) and CT in a retrospective review of nine patients with CHARGE syndrome, in order to make neuroradiologists aware of this important additional characteristic finding.

MATERIALS & METHODS
The imaging findings on MRI in a total of nine patients with CHARGE syndrome (n = 5 females, n = 4 males) were reviewed retrospectively from two institutions (David Geffen School of Medicine at UCLA and Children’s Hospital of Los Angeles) with attention to the olfactory bulbs, tracts and frontal lobes, by three certified neuroradiologists (J.B, C.K., A.P.)MRI was performed using a 1.5T unit, using T1- and T2-weighted spin-echo sequences, with attention to the coronal plane. Olfactory bulbs were evaluated as normal, hypoplastic, or aplastic. The olfactory sulcus was evaluated for being present, shallow or absent.

RESULTS
All nine patients demonstrated a degree of rhinencephalic malformation noted on MRI of the olfactory bulb region when compared to age-matched controls. These malformations included either bilateral or unilateral aplasia or hypoplasia of the olfactory bulbs, and tracts associated with either bilateral or unilateral shallow or absent olfactory sulcus. In patients with olfactory bulb agenesis there was always an ipsilateral agenesis of the olfactory sulcus with a characteristic narrow and triangular medial orbital frontal cortex (Fig 1).

Fig. 1 Coronal T2 MRI demonstrating bilateral olfactory bulb and olfactory sulcal aplasia.
Craniofacial fibrous dysplasia is a relatively common disease entity, occurring in approximately 20% of patients with the monostotic form of the disease. Its typical appearance is a ground-glass pattern of bony expansion centered within the medullary cavity. Although exuberant hyperostosis of the frontal bone has been reported in association with esthesioneuroblastoma, we are unaware of previous descriptions of a ground-glass appearance of bony involvement mimicking fibrous dysplasia. This case demonstrates that when these bony changes are seen adjacent to an esthesioneuroblastoma, while one may suspect coexisting fibrous dysplasia, bony invasion by the esthesioneuroblastoma should be suspected.

**Key Words:** Esthesioneuroblastoma, fibrous dysplasia, skullbase neoplasm

**Paper 26 Starting at 11:19 AM, Ending at 11:27 AM**

A Changing Course of the Carotid Artery

Phillips, K. · Strother, M. · Aulino, J.

Vanderbilt University
Nashville, TN

**Purpose**

The expected course of the cervical internal carotid artery is a direct pass from the carotid bifurcation to the skull base; yet variations from this pattern may be the norm. Tortuosity, kinking, and coiling have been described as the carotid assumes a more meandering course to the skull base. Some of these variations have proved deadly, when surgeons confront a pulsating submucosal mass in the parapharyngeal space. Theories regarding the etiology of the morphologic changes vary widely; ranging from congenital migration anomalies of the embryonic aortic arches to senescent changes affecting carotid elasticity and atherosclerosis.

**Materials & Methods**

We present an elderly patient whose carotid artery assumed an aberrant, parapharyngeal course following tonsillectomy. We present an elderly patient whose carotid artery assumed an aberrant, parapharyngeal course following tonsillectomy. Preoperatively, the carotid position was normal.

**Results**

The case is illustrative first as a lesson in anatomy. The surgical planes which must be violated to allow this change are discussed.

**Conclusion**

The case also adds to the discussion of the etiology of aberrant carotid courses; a discussion which should include iatrogenic sequela of prior tonsillectomy.

**Key Words:** Carotid, tonsillectomy, parapharyngeal

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**Conclusion**

This retrospective review of nine patients with CHARGE syndrome demonstrates characteristic abnormalities of the olfactory system, including aplasia or hypoplasia of the olfactory bulbs, tracts and sulcus, when compared to age-matched controls. It is important for the neuroradiologists to be aware of this important ancillary imaging finding, which may help ascertain the diagnosis of CHARGE in these patients, as clinically this finding is often overlooked and not assessed.

**References**


**Key Words:** Olfactory bulb, CHARGE syndrome, MR imaging

**Paper 25 Starting at 11:11 AM, Ending at 11:19 AM**

**Fibrous Dysplasia...Or Is It? A Case of Bone Invasion by an Esthesioneuroblastoma Mimicking Fibrous Dysplasia**

Schiro, B. J. · Escott, E. J. · McHugh, J. B. · Carrau, R. L.
University of Pittsburgh Medical Center
Pittsburgh, PA

**Purpose**

We report the unusual findings of a 56-year-old female with a superior nasal and intracranial esthesioneuroblastoma with invasion of the frontal bone mimicking the radiographic appearance of fibrous dysplasia.

**Materials & Methods**

We correlated the CT and MR appearance of the frontal bone with the surgical and pathologic findings.

**Results**

On the initial MR imaging, an enhancing mass extended from the nasal cavity, through the ethmoidal region, and intracranially into the frontal region. The frontal bone adjacent to lesion had decreased signal intensity on all pulse sequences, and little if any enhancement. This also involved portions of the bone not in direct contact with the mass, along with associated dural thickening and enhancement distant from the lesion. Thin enhancing tissue was seen along the subgaleal surface of the frontal bone. On CT imaging, the nasal, ethmoidal, and frontal mass again was seen with extent through the cribriform plate. The frontal bone had a ground-glass appearance, without associated erosion or hyperostosis. At surgical exploration, the frontal bone was soft, vascular, and infiltrated with tumor. The mass had transgressed the inner and outer tables and was invading the soft tissues of the scalp, including the pericranium and galea. Pathology results confirmed olfactory neuroblastoma with bone and soft tissue involvement and extensive vascular tissue proliferation. Tumor within the frontal bone was associated with extensively sclerotic fibrous connective tissue.

**Conclusion**

Esthesioneuroblastoma is a rare skullbase malignancy that characteristically arises in the upper nasal cavity from olfactory epithelium. It often erodes through the cribriform plate superiorly and invades the adjacent parenchyma of the brain.
**Purpose**

The identification of a retropharyngeal carotid artery (RPC) is crucial to avoid surgical misadventures when it presents as a retropharyngeal mass. The risk of this catastrophe is not established since the prevalence of RPC in the general population as well as its demographic associations are largely unknown. This study was designed to determine these features of RPC based on the Atherosclerosis Risk in Communities (ARIC) carotid MRI study.

**Materials & Methods**

We reviewed 1968 MR studies for the presence of RPC. Subjects were recruited based on a prior carotid ultrasound study (approximately 60% from top 15th percentile and 40% from <85th percentile intima-media-thickness of the thicker carotid bifurcation). MR scans were acquired on 1.5T MR scanners at four sites (3 General Electric, 1 Siemens) using a 4-channel phased-array carotid coil. The carotid bifurcation was localized using fast gradient-echo sequences, followed by a 3-dimensional time-of-flight MR angiogram (MRA). High-resolution T1-weighted fat-suppressed cardiac-gated black blood MR images (BBMRI) were acquired through the internal carotid artery (ICA)/bifurcation with the thicker wall. Eight slices were centered through the plaque or around the flow divider if no plaque was present (2 mm thickness, 0 gap). The BBMRI sequence was repeated with eight additional slices above and below, 5 minutes after intravenous gadolinium administration (0.01mmol/Kg). Results were weighted based on our recruitment strategy to reflect the general population. Rao-Scott Chi-Square tests were used to compare prevalence within categories.

**Results**

A total of 288 RPCs were identified. A weighted analysis to reflect the general population showed the prevalence of RPC was 14.1%, occurring more frequently in women than men (18% vs 8.8%), on the right than left (6.7% vs 3.2%), and more likely unilateral than bilateral (9.9% vs 4.2%). RPCs were more prevalent in ages 70-79 (16.4%) years than 60-69 (11.4%) years. There was no significant difference between the 70-79 year group and those > 80 years (16.9%). There was no significant difference in prevalence by race. We identified eight RPCs (2.7%) that transiently moved into or out of the retropharyngeal space during the exam (Fig 1).

**Conclusion**

RPCs are common in the general population and cannot be excluded by normal-appearing MR imaging or CT because the RPC might be transient. A higher index of suspicion is warranted in evaluating females or right-sided pharyngeal masses.

**Key Words:** Retropharyngeal carotid, mobile carotid, ARIC

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**Purpose**

The vertebral artery (VA) course anomalies with related important surgical parameters, that determine safe surgery at craniovertebral junction (CVJ) in CVJ anomalies is evaluated prospectively.

**Materials & Methods**

Fifty consecutive cases, 36 males and 14 females, ranging from 5 to 60 (average 27) years of age, having CVJ anomalies that included BI were evaluated preoperatively by CT angiography with 3D volume-rendered reconstruction and were subsequently treated surgically.

**Results**

The VA course was divided into three segments (V1-3) as per our previous published study. VA coursed above the posterior arch of atlas in 92% of cases of CVJ anomalies. Eight percent of cases had a unilateral ‘C2 segmental type’ of vertebral artery. In two cases with occiput-C1-C2-C3 fusion, VA traversed behind the fused pedicles of C1-C2-C3 up to the C1 posterior arch, after which it adopted a usual course. To
avoid intraoperative VA injury, the limit of safe surgical dissection along the posterior aspect of C1 arch was 23.5 mm and 21 mm from midline, in nonoccipitalized and occipitalized atlas cases respectively. It was 12.5 mm from midline over the superior aspect of C1 arch. Our results varied significantly from those of the safe surgical dissection limits published in the literature for the cases without anomalies. As per the best of our knowledge, there is no study in the literature which has described the safe surgical dissection limits at CVJ in CVJ anomalies. The decision regarding the feasibility of transarticular screw fixation and required screw thickness, as determined by the distance of V1 loop from the medial end of the atlantoaxial facet joint [ranged from 0 to 8 mm (averaged 4.7 and 3.6 mm on the right and left side respectively)], was affected greatly by the CT angiographic findings.

**Conclusion**

Knowledge of the course of the VA via the anatomy of CVJ is essential for surgical procedures at CVJ in CVJ anomalies. Ours being the first and the largest study of its kind in the literature, we recommend the preoperative evaluation of VA, and set the limits of safe surgical dissection and the parameters at CVJ, to avoid intraoperative VA injury in cases of CVJ anomalies.

**Key Words:** Vertebral artery, craniovertebral anomalies, surgical parameters

**Paper 29 Starting at 11:43 AM, Ending at 11:51 AM**

A Closer Look to Sphenoid Sinus with Magnetic Resonance Imaging

Hatipoglu, H. G. · Selvi, A. · Cetin, M. A. · Sakman, B. · Yuksel, E.

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Ankara, TURKEY

**Purpose**

Preoperative assessment of sphenoid sinus and neighboring neurovascular structures has gained importance after the introduction of new endoscopic techniques. Computerized tomography is the preferred imaging modality. Our purpose was to evaluate sphenoid sinus and parasphenoidal structures with magnetic resonance imaging.

**Materials & Methods**

A total of 111 patients who underwent cranial magnetic resonance imaging between May and July 2006 were included in the study. The radiologic anatomy of the sphenoid sinus and neighboring structures were evaluated on axial and coronal T2-weighted images.

**Results**

The study was conducted on 111 patients (M/F:41/70; mean age of M/F:43.7/41.5). We have grouped pneumatization of the sphenoid sinus into four according to the location as follows: occipitosphenoidal (0%), conchal (1.8%), presellar (18.91%), sellar (79.27%). There was protrusion of internal carotid artery in 14.41% of all cases bilaterally. It was 13.50% unilaterally. The protrusion was most commonly in the infrasellar location. There was no protrusion of internal carotid artery in 72.07% of all cases. The closest distance between internal carotid arteries in the parasphenoidal region varied between 9 and 24 mm. It was 16.46 mm (9.40-24 mm) for female and 15.21 mm (9-24 mm) for male.

**Conclusion**

Evaluation of sphenoid sinus and parasphenoidal structures with magnetic resonance imaging might provide useful information before endoscopic sinus surgery and neurosurgical procedures.

**Key Words:** Sphenoid Sinus, Magnetic Resonance Imaging, Internal Carotid Artery

**Monday Morning**

10:15 AM – 12:00 PM

Grand Ballroom A

(4c) ANATOMY & TECHNIQUES

(Scientific Papers 30 – 42)

See also Parallel Sessions

(4a) ADULT BRAIN: Neoplasms I

(4b) HEAD AND NECK: Pharynx, Larynx, Soft Tissue and Sinonasal

(4d) ADULT BRAIN: Degenerative/Demyelinating/ Metabolic Disease I

Moderators: David Rubinstein, MD

Michael A. Kraut, MD

**Paper 30 Starting at 10:15 AM, Ending at 10:23 AM**

Internal Architecture of the Thalamus: MR Microscopy of Formalin-Fixed Human Cadaver Specimens at 9.4T

Naidich, T. P. · Delman, B. N. · Byne, W. · Fatterpekar, G. M. · Hof, P. R. · Tang, C. Y.

1Mount Sinai Medical Center, New York, NY, 2Bronx Veterans Administration Medical Center, Bronx, NY

**Purpose**

MR microscopy (MRM) at 9.4T now achieves in-plane resolution of 30-50 microns. The purpose of this exhibit is to illustrate the nuclear and laminar structure of the human thalamus in, and perpendicular to, the anterior commissure-posterior commissure (AC-PC) plane of Talairach and Tournoux.

**Materials & Methods**

Seven formalin-fixed human adult cadaver thalami were oriented in the Talairach plane, embedded in Fomblin (perfluoropolyether), and scanned in a Bruker Avance 9.4T system using a 30 mm birdcage coil and intermediate-weighted pulse sequences to achieve a pixel resolution of 35 x 35 x 500 microns. Diffusion tensor images (DTI) of the same specimens were obtained to emphasize the orientations of
the internal and adjoining white matter tracts. These images then were correlated with standard anatomical texts, color coded for nuclear and lamellar anatomy, and placed into cine loops to display the thalamic anatomy in understandable “approachable” terms.

RESULTS
MRM of the thalamus at 9.4T resolves the individual nuclei of the anterior, medial, lateral, and posterior groups, displays the lamellae and the intralaminar nuclei of the thalamus, resolves the reticular nuclei along the lateral border of the thalamus, and demonstrates the relationships of the thalamus to adjoining structures. DTI can be performed readily in formalin-fixed tissue and successfully characterizes the orientations of the fiber tracts depicted. Choice of the Talairach-Tournoux plane simplifies identification of thalamic structures and provides data in a form that later proved useful for assisting stereotactic surgery in living patients.

CONCLUSION
MRM successfully demonstrates the internal anatomy of the thalamus. Knowledge gained from these studies will facilitate future interpretation of the high-field (4T - 7T) anatomical and susceptibility images now being developed for clinical use.

KEY WORDS: Thalamus, high-resolution, MR microscopy

Paper 31 Starting at 10:23 AM, Ending at 10:31 AM
Intrapontine Segments of Cranial Nerves V, VI, VII and VIII

Naidich, T. P. · Delman, B. N. · Fatterpekhar, G. M. · Hof, P. R. · Tang, C. Y.
Mount Sinai Medical Center
New York, NY

PURPOSE
MR microscopy (MRM) and diffusion tensor imaging (DTI) may be performed successfully on formalin-fixed human cadaveric specimens at 9.4T, achieving in-plane resolution of 30-50 microns. The purpose of this exhibit is to demonstrate the location, orientation and trajectories of the intrapontine segments of CN V, VI, VII and VIII, and to present these in a readily understandable format suitable for self-education.

MATERIALS & METHODS
Five formalin-fixed human adult cadaver brainstems were embedded in Fomblin (perfluoropolyether), and scanned in three orthogonal planes in a Bruker Avance 9.4T system using a 30 mm birdcage coil and intermediate-weighted pulse sequences to achieve a pixel resolution of 35 x 35 x 500 microns. Diffusion tensor images (DTI) of the same specimens were obtained to assess the orientations and trajectories of the intraaxial fascicles of these nerves, from their nuclei of origin to their entrance/exit sites at the surface of the pons. These images then were correlated with standard anatomical texts, color coded for nuclear and lamellar anatomy, and placed into cine loops to display their anatomy in an “approachable” format.

RESULTS
MRM and DTI of the cadaveric brainstem at 9.4T resolves the intraaxial fascicles of these cranial nerves, displays their relationships to adjacent structures, and characterizes their trajectories through the pons. Pseudocine loops of the serial brainstem images in each of the three orthogonal planes aids greatly in first appreciating and then learning the courses of these nerves within the stem.

CONCLUSION
MRM and DTI at 9.4T successfully demonstrate the intrapontine courses of cranial nerves V through VIII and display them in a format useful for learning this complex anatomy. Knowledge gained from these studies will facilitate future interpretation of the high-field (4T-7T) anatomical and susceptibility images now being developed for clinical use.

KEY WORDS: Cranial nerve, high-resolution, MR microscopy

Paper 32 Starting at 10:31 AM, Ending at 10:39 AM
Handedness and MR Imaging Asymmetry of the Hand Motor Cortex

Briganti, C. · Caulo, M. · Lanni, G. · Mattei, P. A. · Gaudino, S. · Storto, M. · Tartaro, A. · Colosimo, C.
1University of Chieti, Chieti, ITALY, 2University of Chieti, Rome, ITALY

PURPOSE
Hand preference is the most evident behavioral asymmetry in humans, but the neurobiologic correlate of handedness is still a matter of debate. This study aims to demonstrate anatomical interhemispherical asymmetries of the hand motor cortex (HMC) and to correlate anatomical asymmetry with different degree of dexterity in a right-handed population.

MATERIALS & METHODS
Structural brain MR imaging was obtained from 111 right-handed healthy subjects (61 men and 50 women; mean age 25.5 ± 3.8 years) via a Talairach’s space transformed three-dimensional (3D) magnetization-prepared rapid gradient-echo (MPRAGE) sequence. The HMC of the left and right hemisphere of each subject was localized by using Talairach coordinates. The morphology and the volume of the HMC of all the subjects were reported. As an estimator of the HMC volume, we calculated the area of the hand knob in five contiguous slices using a mouse-driven pointer and a software dedicated to image processing (Brain Voyager 4.9. Brain Innovation; The Netherlands). An asymmetry index (AI) was calculated for the left and right HMC volume for all the subjects. Between-hemisphere anatomical asymmetries were tested using the t-test (p < 0.001). The Edinburgh test was administered to all the subjects and a lateralization index (LI) for handedness was calculated.

RESULTS
The volume of the HMC was significantly greater in the left than in the right hemispheres. A positive correlation was found between the volume of the HMC and the different morphological variants of the hand motor area, with a significantly (p < 0.01) greater volume of the epsilon-shaped compared to the omega-shaped HMC. Subjects with a higher degree of AI towards the left hemisphere did not show a significant stronger degree of dexterity at the Edinburgh test.
CONCLUSION
In right handers the left HMC is significantly greater than the right. Only 25% of anatomical variance in the HMC of the right-handed population is explained by a different degree of dexterity and this is not significant.

KEY WORDS: Hand motor cortex, MR imaging, handedness

Paper 33 Starting at 10:39 AM, Ending at 10:47 AM
Oculomotor Cistern: Anatomy and High-Resolution Imaging

Everton, K. L. · Rassner, U. A. · Harnsberger, H. R. · Osborn, A. G.
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PURPOSE
The oculomotor cistern (OMC) is a small cerebrospinal fluid (CSF)-filled dural cuff that invaginates into the cavernous sinus and surrounds the intracavernous third cranial nerve. Long known to neurosurgeons who must mobilize the nerve during cavernous sinus surgery, the OMC has not been described in the imaging literature. Radiologists should be aware of its appearance and normal variants so that it is not mistaken for pathology. The OMC also may serve as a conduit for diseases that infiltrate the cavernous sinus. In this paper we describe the normal gross and imaging anatomy of the OMC. We present its imaging spectrum as delineated on 1.5T and 3T MR scans and demonstrate its involvement in cavernous sinus pathology.

MATERIALS & METHODS
This retrospective IRB-approved study examined all patients with screening studies of the internal auditory canals (IAC) for sensorineural hearing loss and temporal lobes for epilepsy performed over 1 year. 1.5T and 3.0T MR images were reviewed to identify the OMC. Diameter and cistern length were measured. Volunteers underwent dedicated noncontrast high-resolution MR imaging to determine optimum technique for OMC visualization.

RESULTS
One or both OMCs were visualized on 75% of IAC screening studies. The right cistern averaged 4.2 mm (SD 3.2) in length and 2.2 mm (SD 0.8) in diameter at its opening (porus). The maximum length observed was 13.1 mm. The left cistern averaged 3.0 mm (SD 1.7) in length and 2.1 mm (SD 1.0) in diameter at the porus, with a maximum length of 5.9 mm. The OMC can be visualized on 64% of routine axial T2-weighted brain scans.

CONCLUSION
The OMC is an important neuroradiologic and surgical landmark that can be identified routinely on high-resolution MR imaging. It also is seen routinely on standard brain MR studies.

KEY WORDS: Anatomy, oculomotor, cistern

Paper 34 Starting at 10:47 AM, Ending at 10:55 AM
The Multiple Insertions of the Temporalis Muscle: Anatomical, Radiographic and Clinical Considerations

Kirsch, C. F. E. · Wisco, J. J. · Sedlmayr, J. C.
David Geffen School of Medicine at University of California Los Angeles
Los Angeles, CA

PURPOSE
Gray’s anatomy classically describes the temporalis muscle as originating from the temporal lines of the parietal bone and only inserting on the coronoid process of the mandible. However, careful anatomical dissection and radiographic evaluation reveals that the temporalis muscle bifurcates and
has five additional insertions. The purpose of this research is to demonstrate the five additional insertions of the temporalis muscle identified on both cadaveric dissection and radiographic imaging and their clinical implications.

**Materials & Methods**
A total of 10 anatomical cadaveric dissections of the infratemporal fossa were performed during routine student anatomical dissections. Careful dissection of the bilateral temporalis muscles was performed with photographs taken to document each additional insertion. CT and MR imaging in 20 patients scanned through the temporalis regions were reviewed retrospectively. Ten patients had temporalis muscle pathology from infection (n = 1), trauma (n = 5) and tumor (n = 4). CT and MR images were matched for age and sex, with 10 normal control patients with no temporalis muscle pathology. Images assessed for insertions of the temporalis muscles bilaterally, and correlated with clinical findings in the 10 patients with known temporalis muscle pathology.

**Results**
In addition to the classical insertion of the temporalis muscle on the coronoid process, five additional insertions with true associated bony prominences were noted. These include: 1) Anterior medial zygomatic arch, near the suture of the zygoma and sphenoid bone, 2) Posterior medial zygomatic arch near the temporal bone, 3) Deep belly insertion from a vertically oriented crest on the zygoma within the infratemporal fossa, 4) Deep fibers inserting into the superior mylohyoid line posterior to the mandibular molar with fibers interdigitating with the buccinator muscle, the superior constrictor muscle and the buccopharyngeal fascia, and 5) A superficial belly inserting posteriorly along the ramus near the mandibular condyle. These five additional insertions are identifiable on careful anatomical dissection and both CT and MR examinations. Pathology involving temporalis areas of insertion affect the temporalis muscle’s ability to contract and retract the mandible, noted on clinical evaluation of the 10 affected patients.

**Conclusion**
Careful anatomical and radiographic evaluation of the temporalis muscle demonstrates five additional insertions associated with bony prominences, in addition to the classic single insertion of the coronoid process of the mandible. These five additional insertions include: 1) Anterior medial zygomatic arch, 2) Posterior medial zygomatic arch near the temporal bone, 3) Deep belly insertion from a vertically oriented crest on the zygoma within the infratemporal fossa, 4) Deep fibers inserting into the superior mylohyoid line posterior to the mandibular molar with fibers interdigitating with the buccinator muscle, the superior constrictor muscle and the buccopharyngeal fascia, and 5) Superficial belly inserting posteriorly along the ramus near the mandibular condyle. These additional insertions are apparent on both careful anatomical dissection and radiographic review and have clinical significance when impacted by infection, tumor or trauma.

**Key Words:** Temporalis muscle, insertion, MR imaging
tion. # From the CT data analysis in 35 patients; results for the analysis in 100 patients will be reported at the time of the meeting. There was no statistical difference in terms of noise and image quality between the three methods.

**CONCLUSION**
Systematic utilization of dose modulation techniques allows for significant reduction in the radiation dose associated with standard neuroradiology CT protocols, while maintaining a similar imaging quality.

**KEY WORDS:** Dose modulation, dose reduction, CT radiation dose

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**Paper 36 Starting at 11:03 AM, Ending at 11:11 AM**

**Clinical Implementation of Spin Tag Perfusion MR Imaging**

West, T. · Deibler, A. · Kraft, R. · Burdette, J. · Maldjian, J. A.

Wake Forest University
Winston-Salem, NC

**PURPOSE**
Clinical translation of research image acquisitions are hampered by the lack of availability of the final postprocessed images. This is due predominantly to the need for research personnel to handle image transfer, postprocessing and image display/review. Here we describe an automated method for clinical implementation of an MR spin-tag perfusion sequence that requires no manual intervention, and can be extended to any studies requiring offline processing.

**MATERIALS & METHODS**
Perfusion images were acquired using a modified version of the flow-sensitive alternating inversion recovery (FAIR) (1) sequence (120 volumes, 6 minutes 30 seconds). Briefly, a multislice FAIR sequence is modified to incorporate saturation pulses at time T₁ to allow quantitative imaging of perfusion using a single subtraction (QUIPSS II) (2). The QUIPSS II saturation pulses saturate a 10 cm slab inferior to the imaging slices with a 1 cm gap between the edge of the saturation slab and imaging slices. The inversion pulse of the FAIR sequence is a C-shaped frequency offset corrected inversion (FOCI) pulse (β = 1361, µ = 6) (3). The reconstructed control/label images are transferred in the background to an offline workstation for fully automated processing, including conversion to Analyze format, motion correction, computation of CBF maps, conversion back to DICOM (4), and transfer to the clinical PACS system for system-wide review. The quantitative CBF images contain pixels that represent the magnitude of perfusion (ml/100 gm tissue/min) for each voxel.

**RESULTS**
Figure 1 demonstrates an example of a CBF map using the automated processing pipeline. In this case, the patient presented with a history of left MCA stenosis. The CBF map demonstrates reduced perfusion in the left parietal lobe corresponding to the area of reduced flow.

**Conclusion**
Spin tag perfusion imaging is currently a powerful, predominantly research technique for obtaining perfusion information. Fully automated methods of implementation are necessary to make it clinically viable.

**REFERENCES**

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**Paper 37 Starting at 11:11 AM, Ending at 11:19 AM**

**Hybrid Reconstruction Kernel: Optimized Head and Neck CT**

Weiss, K. · Cornelius, R. · Greeley, A. · Sun, D.

University of Cincinnati
Cincinnati, OH

**PURPOSE**
Develop and test a hybrid CT algorithm to simultaneously optimize bone and soft tissue characterization, potentially halving the number of images that need to be stored, transmitted, and reviewed.

**MATERIALS & METHODS**
CT images generated with separate bone and soft tissue kernels were combined retrospectively so that soft tissue algorithm pixels less than -150 HU or greater than 150 HU are substituted with corresponding bone kernel reconstructed pixels. Hybrid images were generated in Matlab (MathWorks, Inc, Natick, MA) and subsequently reimported into eFilm Workstation 2.0 (Merge Technologies Inc., Milwaukee, WI) for viewing along with conventional images. Three neuroradiologists independently reviewed the first six hybrid head and neck cases generated, (2 orbits, 2 temporal bone, and 2 paranasal sinus scans) and compared them to both standard soft tissue and bone kernel reconstructed images for characterization of anatomy and pathology. For each case, corresponding image sections were simultaneously viewed in manufacturer preset settings for bone (window 2500, level 480), head and neck (window 350, level 90) and brain (window 80, level 40) as well as with independently adjusted window and level settings. The conspicuity of bone, soft tissue, and brain anatomy/pathology were separately scored for each CT reconstruction technique.
RESULTS
For the depiction of bone, in all six cases, the three neuroradiologists scored the hybrid images as being equivalent to bone kernel reconstructions but superior to the standard kernel. For depiction of extracranial soft tissues and brain, the hybrid kernel was rated equivalent to the standard kernel but superior to that of the bone kernel. Figure 1 illustrates the dual optimized bone and soft tissue depiction afforded by the hybrid kernel technique, displayed respectively at 2500/480 and 350/90 window/level settings.

CONCLUSION
Hybrid kernel reconstruction is a promising technique affording optimized bone and soft tissue evaluation while halving the number of images needed to be transmitted, stored, and reviewed.

KEY WORDS: Computed tomography

Paper 38 Starting at 11:19 AM, Ending at 11:27 AM
Quantitative Sodium MR Imaging of Brains in Humans at 9.4T
Thulborn, K. R. · Atkinson, I. · Damen, F. · Claiborne, T. · Boskamp, E.
1University of Illinois at Chicago, Chicago, IL, · GE Healthcare, Milwaukee, WI

Purpose
To demonstrate that sodium MR imaging can be performed in humans at 9.4T without problems from safety concerns.

MATERIALS & METHODS
Under an IDE protocol approved by the FDA and IRB, sodium imaging was performed on human volunteers (n = 10) in a human-sized, custom-designed 9.4T scanner (80 cm bore magnet with head gradient insert) together with measurement of vital signs (heart rate, respiratory rate, body temperature, EKG) before and after scanning. Sodium imaging was performed using a custom-designed birdcage RF coil and a modified three-dimensional twisted projection imaging sequence (TE < 0.3 ms, TR = 120 ms, radial fraction 0.2, 4mT/m). The SNR values of over 20 allowed a two-point quantification of the MR signal from calibration standards. A resolution of 3 mm³ can be obtained in an acquisition time of less than 6 minutes while a 5 mm³ resolution can be acquired in less than 3 minutes. The specific absorption rates (SAR), monitored in real time, did not reach 50% of the FDA guidelines for such MR scanning despite the rapid duty cycle. The subjects experienced no significant changes in vital signs or untoward effects when moved in supine position slowly (< 4 cm/minute) through the static magnetic field. The acoustical noise of scanning was below that of proton imaging on clinical scanners operating at 3T.

RESULTS
The first human sodium images at 9.4T are shown in Figure 1 in gray scale and after quantification into tissue sodium concentration, on a color scale.

Figure 1. Human sodium images from the 9.4T scanner.

CONCLUSION
Sodium MR imaging can be performed at 9.4T without adverse biological effects to achieve acceptable spatial resolution in a few minutes. The biological interpretation of such quantitative sodium imaging has the potential to provide a new metabolic dimension of imaging information for patient care.

KEY WORDS: Sodium, quantitative MR imaging, brain

Paper 39 Starting at 11:27 AM, Ending at 11:35 AM
Gadolinium Chelates as an Alternative Radiographic Contrast Agent for Use with Flat-Panel Detector Angiographic Units
Hui, F. K. · Tong, F. C. · Cawley, C. M. · Zhang, J. Y. · Dion, J. E.
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Atlanta, GA

PURPOSE
Gadolinium chelates can be utilized in radiographic examinations as an alternative to iodinated contrast when strong contraindications are present. The relatively low X-ray attenuation of “safe” doses of gadolinium limits its role in such studies. Gadolinium chelate-enhanced digital subtraction angiography (DSA) is particularly limited due to the KeV of DSA, at which gadolinium chelates are even more radiolucent. While gadolinium use in DSA typically results in poor conspicuity, we describe an improvement visibility when employing a flat-panel detector system, compared to conventional analog sodium-iodide detection systems.

MATERIALS & METHODS
Omnican 0.5 mmol/mL (Amersham Health system) was employed as a contrast agent and imaging was performed on a Philips flat-panel detector 3-dimensional angiographic system, the Allura Xper. The gadodiamide was injected at 0.5 mmol/mL. Comparison was made to the Philips Integris Analog system where Visipaque 270 was employed, at an 80:20 dilution. Postprocedure creatinine was measured over several weeks to monitor for nephrotoxic effects.
RESULTS
We demonstrate improved conspicuity for gadolinium chelates when utilizing a flat-panel detector system. The patients did not demonstrate nephrotoxic effects at the doses administered, calculated in mmol/kg.

CONCLUSION
Flat panel detectors (FPD) improve conspicuity of gadolinium chelates during DSA and can result in diagnostic quality examinations at doses that remain relatively nonnephrotoxic.

KEY WORDS: Gadolinium, flat panel detectors, toxicity

Paper 40 Starting at 11:35 AM, Ending at 11:43 AM
Detection of Acute Brain Hemorrhage Utilizing Amorphous Silicon Flat-Panel-Based CT

Albani, B. J. · Gonngunta, V. · Turner, R. · Kelly, M. · Woo, H. · Fiorella, D. · Rasmussen, P. · Johnson, L. · Masaryk, T.
1Cleveland Clinic Foundation, Cleveland, OH, 2Siemens Medical Systems, Malvern, PA

PURPOSE
Among the risks of intracranial endovascular procedures is confined space intracranial hemorrhage. Management often requires immediate assessment of extent, hydrocephalus and mass effect utilizing conventional CT scan. This may necessitate interruption or termination of the procedure and is time-consuming to the extent that it demands transfer from the angiography suite. The purpose of this study was to assess the ability of a TFT digital C-arm to provide diagnostic back-projection reconstructions of rotational images to assess degree/severity of a variety of intracranial hemorrhages.

MATERIALS & METHODS
IRB-sponsored informed consent was obtained in all cases. Eighteen patients with know intracranial hemorrhage were recruited for both conventional noncontrast CT (spiral acquisition, 120 K/v/380 mas, sl thk 5 mm, routine 20° angulation) and noncontrast rotational angiography (20 sec rotation collecting 543 1K DR images across 219° rotation utilizing 70 kv and 220 ma/exposure. Back-projected reconstructions generated 225 slices which were reformatted to comparable 512 X 512, 5 mm slices similarly angled.) Radiation exposure was comparable for the two studies. Studies were compared for location and extent of hemorrhage, mass effect (local or midline shift), presence and degree of hydrocephalus. Cases with subarachnoid hemorrhage were scored according to the Fisher grading scale. Those with purely parenchymal defects, the hematomas were measured in three orthogonal directions and compared.

RESULTS
Eighteen patients were recruited to the study with signed consent forms. In one patient malfunction of the C-arm prevented successful image acquisition; in three early attempts artifact due to poor patient preparation precluded meaningful comparison of the CT and C-arm-acquired studies. No studies were conducted following placement of radiopaque embolic devices. In the remaining 14 cases there were two cases of midline shift, three with local mass effect, and six with hydrocephalus - all confirmed by conventional CT. Five cases with pure parenchymal hemorrhage were detected and confirmed. One case of parenchymal and SAH was confirmed on both C-arm and conventional CT. There were eight cases of CT-documented pure SAH, of which rotational C-arm tomography detected only four which were of higher grade (Fisher 3, 4).

CONCLUSION
This small study suggests that Dyna CT is reliable in identifying intraparenchymal hemorrhages, midline shift, and local mass effect. It also appears that significant hydrocephalus can be identified. However, the ability to assess subtle subarachnoid hemorrhage along the inner table and below the suprasellar cistern, is presently limited by artifact. Radiopaque embolies and/or foreign objects may contribute additionally to artifact. These preliminary observations suggest value in the use of rotational C-arm CT in the expeditious management of neuroendovascular complications. Careful room setup and further technical refinements are necessary for routine use.

KEY WORDS: Hemorrhage, CT, flat panel detector

Paper 41 Starting at 11:43 AM, Ending at 11:51 AM
Detection of Smaller Aneurysms by 64-Slice Multidetector CT Angiography

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University of Minnesota and Hennepin County Medical Centers
 Minneapolis, MN

PURPOSE
Previous literature has demonstrated high accuracy of 4-slice multissection CT angiography (4MSCTA) in detection of aneurysms measuring 4mm or greater, but less accuracy regarding <4mm aneurysms (1). Our purpose was to determine the accuracy of 64-slice CTA (64MSCTA) in aneurysm detection, particularly those <4mm, in comparison to the combination of digital subtraction (DSA) and 3D rotational digital subtraction angiography (3D-RDSA).

MATERIALS & METHODS
Forty-five patients with clinical histories requesting acute 64MSCTA evaluation for aneurysm were included retrospectively. These included: subarachnoid hemorrhage (SAH) on CT (n=27), negative CT but positive lumbar puncture for hemorrhage (n=4), severe headache without hemorrhage but positive family history of aneurysm (n=2), suspected aneurysm on nonenhanced CT or MRI presenting with acute symptoms (n=8), or unexplained parenchymal (excluding basal ganglia) or subdural hematomas (n=4). Twenty-five underwent catheter DSA; all but two had 3D-RDSA. Two neuroradiologists independently reviewed each CTA (on 3D-workstation), DSA, and 3D-RDSA examination.

RESULTS
Thirty aneurysms were noted in 20 patients on 64MSCTA; 9 were <4mm (range 2-13mm). The average aneurysm size was slightly larger on DSA/3D-RDSA (5.2mm) than 64msCTA (5.1mm). Ultimately, 26 aneurysms were detected by catheter DSA/3D-RDSA in 17 of 25 patients who underwent catheter angiography. One 2.5mm MCA aneurysm on the opposite side of a larger bleeding aneurysm was initially
missed by both reviewers on 64-MSCT A and 3D-RDSA. Interestingly, the reviewers noted four 1-1.5mm sessile outpouchings only on 3D-RDSA, not noted on catheter DSA or 64MSCTA; each was additional to larger aneurysms, and was not considered to be the site of SAH. Two aneurysms were considered false-positive CTA evaluations, not confirmed by DSA or 3D-RDSA: one related to atherosclerotic ectasia, the other a prominent middle cerebral vein overlapping the artery. Sensitivity for detecting aneurysms <4mm, 4-10mm, and >10mm on a per-aneurysm basis was 100% for each, excluding the indeterminate 1-1.5mm sessile lesions that were not the hemorrhagic site, and excluding 4 cases of failed or suboptimal boluses.

CONCLUSION
64MSCTA has improved detection of small aneurysms <4mm compared to 4MSCTA. However, 3D-RDSA is currently the most sensitive technique to detect aneurysms prior to intervention, although it has limitations in interpretation after coiling. Additionally, 1-2mm “blister-like” sessile outpouchings are occasionally noted on 3D-RDSA but not on CTA or conventional catheter DSA; these are usually not the source of hemorrhage, and their significance is yet to be determined.

REFERENCES

KEY WORDS: Aneurysm, multidetector CT, CT angiography

Paper 42 Starting at 11:51 AM, Ending at 11:59 AM
Preliminary Study of In Vivo Hemodynamic Analysis of Intracranial Aneurysms with the Use of Time-Resolved Three-Dimensional Phase-Contrast MR Imaging and In-House Software

Isoda, H.1 · Ohkura, Y.2 · Kosugi, T.2 · Takeda, H.1 · Hirano, M.1 · Yamashita, S.1 · Inagawa, S.1 · Takehara, Y.1 · Alley, M. T.4 · Markl, M.5 · Pelc, N. J.6 · Sakahara, H.4

1Hamamatsu University School of Medicine, Hamamatsu, JAPAN, 2Renaissance of Technology Corporation, Hamamatsu, JAPAN, 3GE Yokogawa Medical Systems, Hino, JAPAN, 4Stanford University School of Medicine, Stanford, CA, 5University Hospital Freiburg, Freiburg, GERMANY

PURPOSE
Hemodynamics plays a very important role in the development, growth and rupture of intracranial aneurysms. We are now developing in-house software for blood flow visualization and analysis for 4-dimensional data sets obtained by time-resolved three-dimensional phase-contrast MR imaging (4D-Flow) (1), which provides us with 4-dimensional information of flow including space and time. This software can calculate wall shear stress (WSS) and generate streamlines in a few minutes based on the data of both 4D-Flow and MR angiography. The purpose of our study was to calculate in vivo WSS and generate streamlines of intracranial aneurysms and to analyze the relationships between hemodynamics and WSS of the aneurysms.

MATERIALS & METHODS
This study included 10 subjects (5 male and 5 females, 51 to 83 years old, 66.1 years old on average) with 11 aneurysms (2 anterior communicating artery aneurysms, 2 middle cerebral bifurcation aneurysms, 2 aneurysms originating from C2 to C3 segment of internal carotid artery, 2 internal carotid posterior communicating artery aneurysms, 2 basilar top aneurysms, and one basilar artery superior cerebellar artery aneurysm; their diameters ranged from 4 to 9 mm, 6.3 mm on average). 4D-Flow was performed by a 1.5T MR scanner with a head coil. Imaging parameters were as follows: TR/TE/NEX, 5.8/2.1/1; FA, 15; FOV, 160x160x32 mm; Matrix, 160x160x20; voxel size, 1x1x1.6 mm; reconstructed Matrix, 160x160x40; reconstructed voxel size, 1 x1x 0.8 mm; VENC, 60 cm/s; imaging time, 10 to 15 min; transaxial direction; gated with ECG, 20 phases. 3D TOF MR angiography was performed for geometric information. The software calculated the WSS based on the interpolated shear-velocity using the data set obtained by 4D-Flow near the wall and provided us with 3D streamlines.

RESULTS
3D streamlines and WSS distribution maps in arbitrary direction during the cardiac phase were obtained for all intracranial aneurysms. Seven aneurysms had one spiral flow each and four aneurysms had two spiral flows each. The WSS was lower at the apex of the spiral flow than that of the whole aneurysmal wall (P < 0.05).
CONCLUSION
In vivo hemodynamic analysis for intracranial aneurysms based on 4D-Flow data sets with the use of the software is feasible for clinical practice. Each intracranial aneurysm in this study had at least one spiral flow. The WSS was lower at the apex of the spiral flow than that of the whole aneurysmal wall.

REFERENCES

KEY WORDS: Intracranial aneurysms, hemodynamics, cine phase contrast MR imaging

Monday Morning
10:15 AM – 12:00 PM
Grand Ballroom B

(4d) ADULT BRAIN:
Degenerative/Demyelinating/Metabolic Disease I
(Scientific Papers 43 – 54)

See also Parallel Sessions
(4a) ADULT BRAIN: Neoplasms I
(4b) HEAD AND NECK: Pharynx, Larynx, Soft Tissue and Sinonasal
(4c) ANATOMY & TECHNIQUES

Moderators: Orest Boyko, MD
Peter Kalina, MD

Paper 43 Starting at 10:15 AM, Ending at 10:23 AM
Comparison of 3T and 1.5T T2 Lesion Load in Multiple Sclerosis and Clinically Isolated Syndrome Patients: Clinical Implications

Jewells, V. L. · Chin, B. · Sayad, C. · Markovic-Plese, S. · Smrta, J. · Lin, W.
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PURPOSE
Current diagnosis as multiple sclerosis (MS) in a patient is based upon clinical findings using the McDonald and Barkhof Criteria with MRI serving as an ancillary tool. With the increased availability of 3T magnets, the question of increased demonstration of lesion loads needs to be addressed.

MATERIALS & METHODS
A retrospective comparative intraindividual study was performed over 2 years of T2 lesion loads in nine (2M, 7F) clinically isolated syndrome (CIS) patients mean age of 40+/−14 years with 1.5T and 3T imaging after obtaining written informed consent. CIS or MS status was determined by a board-certified neurologist specializing in MS as defined by the International Panel on MS diagnostic criteria. Patients were scanned initially at 1.5T with subsequent 3T imaging (mean 15 days later). No new symptoms occurred between the two scans. All 3T imaging was performed with a Siemens Allegra head only scanner with the following protocol 3 mm Axial T1 pre contrast, Axial T2, and Axial and Sagittal FLAIR as well as postcontrast T1 images in Axial, Coronal, and Sagittal planes with an appropriate head coil. All 1.5T imaging was performed utilizing the same protocol and appropriate head coil. Two radiologists recorded T1, T2, T1+C, and FLAIR lesions 3 mm in size or greater which were classified as periventricular (PV), subcortical (SC), or infratentorial (IT). The McDonald Criteria and Barkhof Criteria then were applied to determine diagnosis as MS or CIS.

RESULTS
Two additional patients (18%) were reclassified as MS from CIS when they were imaged at 3T compared to 1.5T imaging based upon T2 lesion numbers and location. Patient #1 had visualization of one additional IT and PV lesions on the same day of scanning. Patient #6 demonstrated one additional PV lesion and three additional SC lesions at 3T 6 days later. Thirty-four additional Flair lesions (26 SC, 6 PV, and 2 IT), 41 additional T2 lesions (22 SC, 9 PV, and 2 IT), and 63 additional T1 lesions (36 SC, 20 PV, and 7 IT) were seen with 3T imaging.

CONCLUSION
The visualization of increased numbers of T2 lesions at 3T changed the status of 18% of our patients from CIS to MS, hence 3T increased the sensitivity for lesion detection. The greatest gains in increased lesion conspicuity were for T1 subcortical lesions due to the improved SN ratio available with 3T maging. A change in status using the Barkhof and McDonald criteria has significant implications since early diagnosis can prevent the residual deficits of 0.5-28% or change > 1.0 Expanded Disability Status Score (EDSS) that occur with each MS exacerbation in 42% of patients. The
increased visualization of T1 lesions or black holes is also important since their presence is consistent with poorer prognosis. However, neurologists may be hesitant to accept 3T lesion numbers for diagnosis due to the possibility of increased false positives. However, both of our patients who demonstrated greater lesion numbers with 3T imaging have now converted to MS based upon clinical dissemination in time of symptoms.

**Key Words:** Multiple sclerosis, 3T, clinically isolated syndrome

**Paper 44 Starting at 10:23 AM, Ending at 10:31 AM**

**How Early Can the Diagnosis of Multiple Sclerosis Be Ascertained with a Single MR Scan?**


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**Purpose**

According to the criteria proposed by McDonald et al, the diagnosis of multiple sclerosis (MS) in patients who present for the first time with a clinically isolated syndrome (CIS) requires clinical or MR imaging (MRI) demonstration of demyelinating lesions disseminated in space and time. These criteria can be achieved with a single brain MRI if obtained at least 3 months after the onset of the clinical event. Although a diagnostic brain MRI commonly is obtained earlier in many instances with the purpose of freeing patients from uncertainty on diagnosis, there is not enough data to recommend a diagnosis based solely on this early MR scan. The purpose of this study is to investigate the diagnostic performance of MRI obtained before the 3-month interval in a large cohort of CIS patients from four different European centers (Barcelona, London, Milan, Amsterdam).

**Materials & Methods**

Patients who presented for the first time with a monophasic neurologic syndrome of the type seen in MS have been studied, if fulfilling the following inclusion criteria: 1) a CIS suggestive of CNS demyelination involving the optic nerve, brainstem, spinal cord, or other topography, not attributable to other disease; 2) age between 14 and 50 years; 3) onset of symptoms within 3 months of clinical examinations; 4) Availability of two comparable brain MR examinations, the first within 3 months, and the second between 3 and 12 months after CIS onset; 5) clinical follow up of at least 24 months after CIS onset. In both MR scans the presence and number of T2 lesions, the number of gadolinium-enhancing lesions, and the number of fulfilled Barkhof criteria were assessed. We compared the diagnostic properties of the two exams as regards the conversion to clinically definite MS (CDMS) according to the Poser criteria.

**Results**

Two-hundred thirty-four patients were included in this study (mean age: 31.4 years; 159 females). The first MR exam was obtained at a median interval of 35.0 days (range 3 to 89 days) and the second at a median of 140 days (range 92 to 363 days). Sixty-two patients (26.5%) presented a relapse during the first 2 years after symptom onset, therefore fulfilling the diagnostic criteria for CDMS. According to the McDonald criteria, a diagnosis of MS was established in 51 patients (21.8%) as both criteria of dissemination in space (at least 3 Barkhof criteria) and time (at least one gadolinium-enhancing lesion) were fulfilled in the scan obtained after 3 months from CIS onset. The same MRI criteria applied in the first scan also were fulfilled by 51 patients (21.8%). The comparison between the diagnostic properties of the first and second MRI for identifying patients with conversion to CDMS showed very similar results in sensitivity (46.8% vs 43.5%), specificity (87.2% vs 86.0%) and accuracy (76.5% vs 74.8%).

**Conclusion**

Our findings suggest that a single brain MRI may suffice to identify CIS patients with a high risk of developing CDMS even when it is performed within the first 3 months after the onset of symptoms.

**Key Words:** Multiple sclerosis, diagnosis, MR imaging

**Paper 45 Starting at 10:31 AM, Ending at 10:39 AM**

**Localizing White Matter Lesions Underlying Cognitive Impairment in Multiple Sclerosis**

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**Purpose**

This study investigates the impact of location-specific white matter injury on cognitive dysfunction in multiple sclerosis (MS). Using diffusion tensor imaging (DTI) and a novel statistical mapping technique we aimed to identify regions where reduced fractional anisotropy (FA) predicts impaired performance in cognitive testing.

**Materials & Methods**

Nineteen MS patients in remission (mean age 44 years; Expanded Disability Status Scale (EDSS) range 1.5-6; 17 relapsing remitting, 2 secondary-progressive) underwent 3T MRI (Philips Achieva) including DTI (2.5mm isotropic, 15 directions). MS patients underwent the Paced Auditory Serial Addition Test (PASAT), a test of processing speed and working memory. Analysis was performed using fMRI Software Laboratory (FSL) tools (1). Following eddy current correction and brain extraction, FA maps were derived. FA maps were aligned and mapped onto a mean skeleton prior to voxelwise statistical analysis using Tract-Based Spatial Statistics (TBSS) (2). We regressed FA (voxelwise, across subjects) with PASAT score as covariate of interest while controlling for age, sex and overall disability (EDSS score). Results were thresholded at voxel t=2 level and subsequently permutation-based inference on cluster size (P<0.05) was used to correct for multiple comparisons.

**Results**

Statistical mapping revealed significant regression between reduced FA and lower PASAT score in the posterior corpus callosum and its radiations bilaterally (Fig1a, tract skeleton with locations in dark gray where reduced FA regresses with
PASAT performance), the posterior left cingulum, the left arcuate fasciculus (Fig1b) and posterior left optic radiations.

CONCLUSION
This study demonstrates the utility of tract-based statistical mapping to identify loci of abnormality predicting cognitive impairment. Reduced FA in the posterior corpus callosum, left arcuate fasciculus, posterior left cingulum, and posterior left optic radiations predicted poor performance in PASAT independent of overall disability. fMRI in cognitively-intact MS patients (3) has shown compensatory activity in the left parietal lobe during PASAT; our results demonstrate underlying white-matter abnormality which may thus disrupt connectivity to this region during PASAT. Localized injury to specific white-matter tracts may therefore underly cognitive impairment in MS.

REFERENCES

KEY WORDS: Multiple sclerosis, diffusion tensor imaging, cognitive function

MATERIALS & METHODS
Nine patients with clinically definite MS and four healthy volunteers were scanned on a 7T MR scanner (GE Healthcare, Waukesha, WI) with a volume excite coil (Nova Medical, Wilmington, MA), and an in-house developed 8-channel phased-array receive coil. A gradient-echo sequence was used to acquire T2*-weighted images with an in-plane resolution of 195 x 260 µm (TE/TR = 15/250 ms, 20 cm FOV, 1024 x 768 matrix, 20° flip, BW = 31.25, 2 mm thick, 1.5 mm skip, 3 NEX, acquisition time = 9.38min). Two patient and three volunteer scans also included a diffusion-weighted single-shot EPI acquisition with ASSET parallel imaging and a custom-designed high bandwidth fat saturation pulse to collect images with 1 mm in-plane resolution (25.6 cm FOV, 256 x 256 matrix, 2 mm slices with no gap, \(b = 1000 \text{s/mm}^2\), ASSET R = 2, acquisition time = 3min.).

RESULTS
Figure 1 depicts typical imaging results at 7T using the developed technologies. The optimized 7T acquisitions resulted in higher resolution anatomical and DT images. White matter lesions were detected easily and delineated better from adjacent structures compared to lower field strengths. With these improvements in resolution, it was possible to differentiate between juxtacortical white matter lesions and cortical lesions (Fig A). High-resolution DTI demonstrated excellent SNR even with small voxel sizes of 2 mm³ and use of parallel imaging minimized EPI distortions. MS lesions were clearly visualized based on abnormal diffusivity (Fig B). The hyperintensity of the lesions on the ADC map correspond to previous findings that diffusion increases in MS lesions.

Figure 1. A) T2*-weighted GRE. Blue arrow indicates gray matter lesion, green arrow juxtacortical. B) ADC map with ROIs indicating MS lesions.

CONCLUSION
7T MR imaging of MS patients provides higher resolution anatomical and diffusion images allowing for improved visualization of structural abnormalities. These initial results suggest that scanning MS patients at 7T is feasible and can detect lesions that are not well visualized at lower fields.

KEY WORDS: Multiple sclerosis, 7T, diffusion tensor imaging

PAPER 46 Starting at 10:39 AM, Ending at 10:47 AM

Initial Applications of 7T MR Imaging to Multiple Sclerosis

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PURPOSE
The availability of 7T human MR research systems opens new possibilities for characterizing alterations in tissue structure and function in multiple sclerosis (MS) lesions and brain parenchyma. Improved sensitivity is provided by high field strength combined with advances in RF coil technology. This study evaluates the performance of these technologies in normal volunteers and MS patients.

KEY WORDS: Multiple sclerosis, 7T, diffusion tensor imaging

Research support was provided by UC Discovery Program and GE Healthcare grant number itl-tio04 and NIH R01 NS40117.
Serial Monthly Triple-Dose Gadolinium in Patients with Early Forms of Multiple Sclerosis: Laboratory Data from the BECOME Trial

Wolansky, L. · Balandandapani, P. · Bhagat, N. · Phatak, T. · Gwal, K. · Haghighi, M. · Vidgop, Y. · Skurnick, J. · Cook, S. · Joseph, G. · Cadavid, D.

New Jersey Medical School/University of Medicine & Dentistry of New Jersey
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PURPOSE
The “BECOME” study [Phase IV, rater-blinded, randomized clinical trial, comparing the effects of 250 mcg of Betaseron® with 20 mg of Copaxone® in patients with the relapsing-remitting or clinically isolated forms of multiple sclerosis (MS) using 3T MR imaging with triple-dose gadolinium (Gd)] is now underway at our institution. Because of its proved efficacy in evaluating MS by increasing conspicuity of contrast enhancement (1), triple-dose Gd (0.3 mmol/kg) Gadopentetate Dimeglumine (Magnevist®, Berlex, Montville, NJ) is being used monthly on up to 24 occasions per subject. No prior study has employed monthly triple dosing on so many occasions in such a large cohort (75 subjects). The clinical adverse event profile previously has been shown to be satisfactory. This communication reports on subject biochemical profiles observed in the course of the study.

MATERIALS & METHODS
To monitor safety, all subjects enrolled in the BECOME study underwent blood and urine examination on a monthly basis prior to each MR imaging (MRI) and received clinical monitoring for any side effects at the time of MRI and clinical (every 3-4 months) visits. The following laboratory tests were examined: comprehensive blood chemistry panel including uric acid, cholesterol, CPK, electrolyte screen, liver function tests, complete blood count with differential (RBCs, Protein, Glucose, Ketones, Occult Blood, Bilirubin, Urobilinogen, Nitrates, Bacteria, Crystal, Epithelial, and Cast.). The percentage of abnormal laboratory values while undergoing monthly triple-dose Gd was compared to the pretriple-dose Gd percentage. To control for biochemical abnormalities caused by Betaseron and Copaxone, the results were stratified by treatment group. At the time of this writing, 1015 monthly triple doses of gadopentetate dimeglumine had been administered on at least two consecutive occasions in 75 subjects.

RESULTS
The vast majority of 47 tests did not show any greater frequency of abnormalities after starting triple dosing than at baseline. Two abnormalities were observed significantly more frequently on monthly triple dose, with no significant difference between anti-MS treatment groups. These were low phosphate in blood (from 3% in screening to 15%, p<0.05), and increased phosphatemia on at least one visit. Ten patients had moderate (1-2 mg/dL) hypophosphatemia on at least one visit. One of these patients was found to have hyperparathyroidism and was referred to an endocrinologist. Among the other nine patients, six had only one episode of moderate hypophosphatemia with normal urine phosphorus levels at subsequent visits. There were no incidents of severe (<1mg/dL) hypophosphatemia and none of the subjects appeared to have related clinical symptoms.

CONCLUSION
Upon completion of over 1,000 monthly MR images with triple-dose Gd in the BECOME study, the laboratory analysis has revealed only two abnormalities that significantly increased while undergoing triple-dose Gd: hypophosphatemia and increased urinary specific gravity > 1.030. While the cause of these abnormalities remains to be determined, there were no apparent symptoms associated.

REFERENCES

KEY WORDS: Gadolinium, multiple sclerosis
adverse outcome associated with gadolinium administration, in order to determine the frequency of such events.

**KEY WORDS:** Gadolinium, neurotoxicity, renal failure

**Paper 49 Starting at 11:03 AM, Ending at 11:11 AM**

**Temporal Lobe White Matter Lesions: Can These Help Differentiate Multiple Sclerosis from Nonspecific White Matter Changes?**

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**PURPOSE**
To prove that temporal lobe white matter lesions are specific to multiple sclerosis.

**MATERIALS & METHODS**
Two experienced neuroradiologists retrospectively analyzed axial and sagittal FLAIR and T2-weighted axial images in 52 consecutive clinically proved multiple sclerosis (MS) patients. This group also fulfilled McDonald’s MR imaging criteria for MS. Control group comprised of 52 consecutive patients, 70 years and above in age, with an impression of “nonspecific white matter changes or microangiopathic changes” on their brain MR reports. Patients with history of prior strokes, surgery, trauma, radiation and hemorrhage were excluded. Only those lesions, which were anterior to an imaginary plane along the anterior limit of the trigone of the lateral ventricles and inferior to the sylvian fissure, were classified as temporal lobe lesions. Presence, location, and number of T2 hyperintense lesions were recorded in the MS and the non-MS control groups. Confluent periventricular lesions and a count of more than three lesions were designated as multiple lesions. The data were analyzed using $\chi^2$-square test.

**RESULTS**
Forty-five patients (87%) with MS had temporal lobe lesions, while as eight patients in the control group had lesions in temporal lobe (chi-square = 52.67, $P < 0.0001$). Patients with MS were 35 times more likely to have temporal lobe lesions compared to the patients in the control group (odds ratio= 35.4; 95%, confidence interval = 11.8 to 105.8). Forty-three of 45 patients in MS group with temporal lesions had periventricular or deep white matter distribution. In two patients, lesions were subcortical. There was no predilection for right or left side. Only two of the eight non-MS patients with temporal lobe lesions had periventricular distribution. The rest had cortical or juxtacortical lesions. All the patients in the non-MS control group with temporal lobe lesions had extensive white matter lesions elsewhere in the brain.

**CONCLUSION**
Temporal lobe white matter lesions are important radiologic markers in the diagnosis of multiple sclerosis.

**KEY WORDS:** Multiple sclerosis, white matter

**Paper 50 Starting at 11:11 AM, Ending at 11:19 AM**

**Diffusion Tensor Study of Tumefactive Demyelinating Lesions**

Liu, X. · Tian, W. · Wang, H.
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**PURPOSE**
Tumefactive demyelinating lesions (TDLs) sometimes are difficult to be diagnosed as they can simulate intracranial tumors on conventional MR images. As there are limitations of MR perfusion-weighted imaging and MR spectroscopy in the differential diagnosis, our study is to evaluated if the diffusion tensor imaging (DTI) could be used to differentiate TDLs and high-grade gliomas.

**MATERIALS & METHODS**
There are seven cases with tumefactive demyelinating diseases diagnosed by combination of laboratory tests, clinical improvement and follow-up imaging retrospectively reviewed. And nine patients with pathology-confirmed high-grade gliomas were used for comparison. DTI examinations (EPI sequence TR/TE = 10000/85, b value 1000 s/mm$^2$, 25 directions) were performed in GE Signa 1.5T scanners. Trace apparent diffusion coefficient (trace ADC), fractional anisotropy (FA) in regions of enhanced and unenhanced TDLs and enhanced tumors were calculated. Differences were analyzed by nonparameter Mann-Whitney test.

**RESULTS**
The mean FA value of the enhanced TDLs is 0.193 ± 0.07; mean FA value of the unenhanced TDLs is 0.214 ± 0.04; while mean FA value of the enhanced high-grade gliomas is 0.131 ± 0.03. There are significant differences between the mean FA value of the enhanced high-grade gliomas and mean FA value of the enhanced TDLs ($P = 0.005$), and mean FA value of the unenhanced TDLs ($P = 0.000$). The mean trace ADC value of the enhanced TDLs is 1.048 ± 0.17; mean trace ADC value of the unenhanced TDLs is 1.042 ± 0.22; while mean trace ADC value of the enhanced high-grade gliomas is 1.12 ± 0.23. There are no significant differences among those lesions.

**CONCLUSION**
FA of DTI is useful in assisting differential diagnosis between the TDL and high-grade gliomas.

**KEY WORDS:** Diffusion tensor imaging, tumefactive demyelinating lesions
**Brain Diffusion-Weighted MR Imaging over 60 Years: Interest of the Analysis of the Apparent Diffusion Coefficient Values for the Quantification of Leukoaraiosis**

Bracard, S. R. · Schmitt, E. · Foscolo, S. · Felblinger, J. · Kearney-Schwartz, A. · Zannad, F.

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**PURPOSE**
The majority of the studies on brain aging are based on a visual quantification (CT or T2-weighted MR imaging) of leukoaraiosis. This implies that they are operator-dependent, not easily reproducible and that they do not take into account the infravisual anomalies of the white matter. The results are thus sometimes contradictory. The goal of this work is to appreciate the interest of the analysis of the apparent diffusion coefficient (ADC) values for the quantification of the leukoaraiosis and its correlation with the cognitive disorders.

**MATERIALS & METHODS**
Two hundred fifty-four hypertensive patients aged over 60 years, without dementia (MMS > 22) or depression were explored on a Signa 1.5T MR unit (GEMS), with diffusion weighted SE EPI sequence (b = 0 and 1000 s/mm²). For each patient, all of the supratentorial voxels were computed and distributed to four categories according to the ADC values: - class 1: normal values; ADC < 0.8. 10⁻³ mm²/s; - class 2: subnormal values; 0.8 < ADC < 1.2. 10⁻³ mm²/s; - class 3: abnormal values; 1.2 < ADC < 2. 10⁻³ mm²/s with two subgroups: - 3.1: 1.2 < ADC < 1.6 10⁻³ mm²/s; - 3.2: 1.6 < ADC < 2. 10⁻³ mm²/s; - class 4: LCS values; ADC > 2. 10⁻³ mm²/s.

**RESULTS**
The distribution of the pixels in each class is statistically correlated at the age which is a positive correlation between age and categories 3 and 4 (p < 0.0001) and a negative with categories 1 and 2. The distribution of the pixels in each class is statistically correlated with the cognitive status evaluated by the Grober and Buschke test and the Mini Mental test. The distribution of the pixels is well correlated with the Fazekas’ score, with a negative correlation for class 1 (p < .0001), and a positive correlation for class 3 (p < .0001) and class 4 (p < 0.004).

**CONCLUSION**
Diffusion seems a simple and significant technique to reach the modifications of the cerebral parenchyma occurring within the framework of normal cerebral aging. In addition, the use of the quantified values of the ADC makes it possible to reach objective and reproducible results facilitating a possible follow up in time.

**KEY WORDS:** Brain diffusion, leukoaraiosis

**Effect of Intravenous Gadolinium-DTPA on Diffusion-Weighted Imaging**

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Malatya, TURKEY

**PURPOSE**
Diffusion-weighted imaging (DWI) usually is performed before the intravenous paramagnetic contrast injection. Occasionally, it may be necessary to perform or to repeat DWI after such administration. Our purpose was to evaluate the effect of intravenous gadolinium-DTPA on DWI.

**MATERIALS & METHODS**
DWI was performed on 88 brain lesions right before, immediately after and at 5 to 10 min following the end of 0.1 mmol/kg gadodiamide dimeglumine (Gd-DTPA-BMA) administration. Signal to noise (SNR) and contrast to noise ratios (CNR) of the above-mentioned lesions and SNR of normal brain tissue were calculated on b: 0 s/mm² and on b: 1000 s/mm² DWIs. Apparent diffusion coefficient (ADC) values of the lesions were measured on ADC maps. Paired t-test was used to determine the significant differences between precontrast and postcontrast values.

**RESULTS**
The lesion group consisted of 23 intraaxial and 11 extra axial masses, 19 ischemic strokes, 15 intracranial hemorrhages and 20 demyelinating lesions. Precontrast and postcontrast images were not statistically different regarding SNR and CNR in DWIs. This statement was also true for strongly enhanced lesions. However, ADC values significantly decreased after contrast injection on the early postcontrast DWI in normal brain tissue (1%, p < 0.049) and (3%, p < 0.008) in lesions. On late images, on the other hand, ADC values were normalized.

**CONCLUSION**
Contrast media injection has significant but time-dependent effects on ADC values. Therefore, only precontrast and late DWI images should be used in quantitative ADC studies.

**KEY WORDS:** Brain, gadolinium-DTPA, diffusion-weighted images

**Quantitative Magnetization Transfer, Diffusion Tensor, and Diffusion Spectrum Imaging in a Myelin Mutant at 3T**

Wu, Y. · Samsonov, A. · Alexander, A. L. · Duncan, I. D. · Field, A. S.

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**PURPOSE**
Imaging markers having both sensitivity and specificity for the complex pathologic changes found in multiple sclerosis (inflammation, demyelination, axonal loss, et al.) remain elusive. Even such quantitative methods as diffusion tensor
(DT) and magnetization transfer (MT) imaging have failed, thus far, to yield sufficiently sensitive and specific markers to guide experimental therapies aimed at neuroprotection and myelin repair. We are striving for greater sensitivity and specificity by studying more sophisticated models of diffusion and magnetization transfer phenomena in a relatively simple animal model, the *shaking (sh)* pup, a myelin mutant characterized by profound dysmyelination without the confounding effects of inflammation or axonal loss.

**Materials & Methods**
In this preliminary study, a 3-month-old *sh* pup and an age-matched control dog underwent hybrid diffusion imaging (HYDI) [i.e., combined DTI and diffusion spectrum imaging (DSI)], as well as quantitative MT (qMT) imaging on a 3T GE SIGNA scanner using a quadrature extremity coil. The HYDI diffusion sampling scheme consisted of four icosahedral shells with a total of 129 encoding directions, with the second shell used for DSI processing and the entire dataset for DSI, yielding maps of fractional anisotropy (FA), mean diffusivity (MD), axial (*D*<sub>ax</sub>) and radial (*D*<sub>rad</sub>) diffusivity, and zero-displacement probability (*P*<sub>0</sub>). The qMT protocol included collection of MT- and nonMT-weighted 3D TOF SPGR images with multiple offset frequencies and flip angles, as well as multishot SE EPI images for B1 mapping, allowing calculation of T1, bound pool fraction (*f*), cross-relaxation rate constant (*k*), and T2 of the bound pool fraction. Parametric images were gray-white segmented; volume-normalized white matter (WM) histograms then were compared between *sh* pup and control.

**Results**
Given the profound paucity of myelin in the *sh* pup, the FA histogram in the *sh* pup demonstrated surprisingly little difference from control, presumably reflecting the axonal preservation characteristic of the *sh* pup at this young age. While *D*<sub>ax</sub> and *D*<sub>rad</sub> were both increased in the *sh* pup, *P*<sub>0</sub> showed greater sensitivity to the absence of myelin than any of the tensor-based parameters. Bound pool fraction also showed greater sensitivity to the absence of myelin than the traditional MT ratio, which is calculated from a more simplistic model. T1 relaxation showed the greatest myelin specificity, with T1 histograms for *sh* pup and control being completely nonoverlapped.

**Conclusion**
The quest for noninvasive imaging markers with greater sensitivity and specificity for the complex changes found in MS and other white matter diseases will require more sophisticated modeling of diffusion, magnetization transfer, relaxation, and likely other phenomena. Ultimately, a multivariate approach likely will be needed to exploit whatever complementary information is available from several quantitative MR parameters.

**Key Words:** White matter, MR imaging, quantitative

**Purpose**
An abnormal iron deposition in the deep gray matter can promote oxidative injury to neuronal cells and has been thought to contribute to neurodegenerative disease process. In multiple sclerosis (MS), the iron-induced T2-shortening has been reported in the prior imaging studies; however, few studies have been conducted to yield a more specific and quantitative estimation of iron content on MRI. This study evaluated the excess iron accumulation in the deep gray matter in patients with MS using a newly developed quantitative MR technique - magnetic field correlation (MFC) imaging.

**Materials & Methods**
Seventeen patients with relapsing-remitting MS and fourteen age-matched normal controls were studied with a 3T MR system. The mean disease duration of the disease at time MRI was performed was 5.5 years (range 1.3-13.8). After the routine conventional T2- and T1-weighted imaging, MFC imaging was acquired using an asymmetric single-shot echo echo-planar imaging sequence (TR/TE: 2800/59ms; refocusing pulse shifts: 0ms, -4ms, -8ms, -12ms, -16ms; 2.0 mm slice thickness; matrix: 128x128; FOV: 256x256). MFC was determined by fitting signal intensities with a range of asymmetry shifts after a motion correction between images. The scanning time for MFC is 3 minutes 35 seconds with a total of 40 slices obtained. Regions of interest (ROIs) were selected in both deep gray matter and white matter regions, and the mean MFC values were compared between patients and controls. We also correlated the MFC data with lesion load and neuropsychological tests in patients.

**Results**
MFC measured in the deep gray matter in patients with MS was significantly higher than that in normal controls (*p* ≤ 0.03) with an average increase of 24% in globus pallidus, 39.5% in putamen, and 30.6% in thalamus. The increased iron deposition measured with MFC in deep gray matter in patients was positively correlated with the total number of brain lesions (for thalamus: *r* =0.61, *p* =0.01; for globus pallidus: *r* =0.52, *p* =0.02), indicating that a larger number of distal white matter lesions was associated with higher MFC in the deep ferruginated neurons. A moderate but significant correlation between the MFC value in the deep gray matter and several neuropsychological tests (Rey Complex Figure test, California Verbal Learning test, and Digit Span Backward test) was also found. There was no statistical difference of MFC in measured white matter regions including frontal white matter and corpus callosum between patients and controls.

**Conclusion**
Quantitative measurement of iron content with MFC provides a more objective and specific method for abnormal iron deposition. Our measurements of iron content with MFC demonstrate increased iron accumulation in the deep...
gray matter in MS, which may be associated with the disrupted iron outflow pathway by lesions. Such abnormal iron accumulation may contribute to neuropsychological impairment and have implication for designing new therapeutic strategies that can halt neurodegenerative process in MS.

**Key Words:** Brain iron, sclerosis, Magnetic resonance Imaging

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**Monday Morning**

10:15 AM – 11:45 AM

Columbus G

(5) ELC Workshop A: Introduction to PowerPoint

— David S. Martin, MD

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**Monday Afternoon**

1:15 PM – 2:45 PM

Columbus I-L

(6) Brain Tumors (ASFNR)

(56) Molecular Mechanisms of Brain Tumor Angiogenesis

— Mark W. Dewhirst, DVM, PhD

(57) Brain Tumor Therapy: New Lights on the Horizon

— David A. Reardon, MD

(58) Advanced Imaging in Therapeutic Monitoring of Brain Tumors

— Daniel P. Barboriak, MD

Moderator: Daniel P. Barboriak, MD

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**Molecular Mechanisms of Brain Tumor Angiogenesis**

*Mark W. Dewhirst, DVM, PhD*

**Learning Objectives**

Upon completion of this presentation, participants will be able to:

1) Describe the mechanism of action and factors that control the hypoxia inducible transcription factor, HIF-1.
2) Predict the downstream effects of HIF-1 activation on tumor cells.
3) Predict the downstream effects of HIF-1 activation on tumor vascular endothelium.

**Presentation Summary**

Hypoxia inducible factor-1 (HIF-1) is a transcription factor that stimulates expression of > 60 genes important in hypoxia adaptation, including promotion of angiogenesis and inhibition of endothelial cell apoptosis. Evidence from our laboratory has shown radiation activates HIF-1 via reoxygenation. Free radical mediated stabilization of HIF-1 and depolymerization of HIF-1 stress granules formed under hypoxic conditions are responsible. We have shown further that HIF-1 stabilization influences endothelial cell and tumor cell survival after radiation treatment and that blockade of HIF-1 activation can sensitize tumors to treatment. More recently, we have investigated whether cytotoxic chemotherapy can induce these same types of effects. Although the kinetics of the events are different, HIF-1 stabilization still occurs. These observations strongly suggest that HIF-1 or its downstream targets are legitimate therapeutic targets when combined with other cytotoxic brain tumor therapies.

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**Brain Tumor Therapy: New Lights on the Horizon**

*David A. Reardon, MD*

Dr. Reardon currently Associate Professor, Department of Surgery; Associate Professor, Department of Pediatrics; and Associate Deputy Director, The Preston Robert Tisch Brain Tumor Center at Duke completed his residency at Johns Hopkins Hospital in Baltimore, MD, and his fellowship at the University of Michigan in Ann Arbor, MI. Dr. Reardon works with the team to design and implement clinical trials using innovative therapeutic agents to improve the cure rates of patients with brain and spinal tumors. In addition to trials implementing new chemotherapy regimens, he oversees the use of radiolabeled monoclonal antibody trials for patients with high-grade gliomas.

**Learning Objectives**

Upon completion of this presentation, participants will be able to:

1) Review current treatment strategies involving anti-angiogenic agents for patients with malignant glioma.
2) Describe the basis and application of imaging techniques to evaluate promising new therapeutic strategies including anti-angiogenic agents, in the treatment of patients with malignant glioma.
3) Discuss the possible mechanisms underlying the clinical activity of anti-angiogenic agents among malignant glioma patients.
Advanced Imaging in Therapeutic Monitoring of Brain Tumors

Daniel P. Barbioriak, MD

LEARNING OBJECTIVES

Upon completion of this presentation, participants will be able to:

1) Discuss the shortcomings of traditional methods of quantifying therapeutic response of brain tumors on MR imaging, and the need for better methods to assess response.

2) Describe how dynamic MR imaging methods can be used to measure changes in neoangiogenesis, and compare the disadvantages and advantages of the techniques.

3) Explain the difference between a biomarker and a surrogate endpoint, and summarize the steps needed to validate an imaging method for clinical purposes.

PRESENTATION SUMMARY

Despite advances in standard therapy, including surgical resection followed by radiation and chemotherapy, the prognosis for patients with glioblastoma multiforme (GBM), the most common primary CNS tumor in adults, remains poor with the vast majority of patients dying within 1-2 years of diagnosis. Historically, the role of chemotherapy for this disease has been controversial. However, a recent study established the role of chemotherapy and defined a new standard of care for newly diagnosed patients afflicted with this disease. Specifically, patients treated with the DNA methlyating agent temozolomide, achieved a statistically better overall survival compared to patients randomized to receive only radiation therapy. However, the median progression-free survival and overall survival achieved with this approach were only 6.9 and 14.6 months, respectively. Clearly, more effective therapies are needed. In addition, given that progression following this regimen is essentially universal, effective salvage regimens remain desperately needed. One promising area of therapeutic intervention for malignant glioma patients includes anti-angiogenic agents. Malignant gliomas are among the most angiogenic of tumors. Vascular endothelial growth factor (VEGF) is a key mediator of glioma angiogenesis. Bevacizumab, a humanized monoclonal antibody against VEGF, is FDA-approved for use in both colorectal cancer and lung cancer based on its ability to significantly enhance the anti-tumor activity of chemotherapy. Vredenburgh and colleagues at the Preston Robert Tisch Brain Tumor Center at Duke have recently completed phase 2 studies evaluating the combination of bevacizumab plus the topoisomerase-1 inhibitor irinotecan for patients with recurrent malignant glioma. Specifically, a 63% radiographic response rate was observed following treatment with this regimen every other week, and the median progression-free survival was 23 weeks. Based on these highly encouraging results, several additional studies incorporating bevacizumab or other VEGF/VEGF-receptor targeting agents are planned or underway for malignant glioma patients. One postulated mechanism underlying this regimen’s anti-tumor activity is normalization of tumor vasculature achieved by bevacizumab leading to markedly enhanced chemotherapy delivery. A recent study employing MRI gradient echo, spin echo and contrast enhancement to measure blood volume, relative vessel size and vascular permeability among GBM patients undergoing treatment with a receptor tyrosine kinase inhibitor targeting VEGF. These results support the normalization theory underlying the clinical activity of antiangiogenic agents among malignant glioma patients. An update of these studies and ongoing work will be presented.

REFERENCES


LEARNING OBJECTIVES
Upon completion of this presentation, participants will be able to:
1) Define the normal anatomy of the nasal cavity and paranasal sinuses.
2) Define important and/or common variants as they may pertain to sinus surgery.
3) Describe typical patterns of sinonasal inflammatory disease and the surgical implications.

PRESENTATION SUMMARY
With the widespread use of functional endoscopic sinus surgery (FESS), and the ability to reach almost anywhere intranasally, it is important that we are able to readily understand the anatomical and functional relationships of the paranasal sinuses and effectively communicate with our surgeons. While the simple concept of sinus anatomy as four paired groups and their draining ostia is correct there is extraordinary anatomical variation within the paranasal sinuses. The ethmoid air cells alone have such variability in their septal and lamellar arrangements that they function as unique “fingerprints” in each person. Multidetector CT scanners with multiplanar reconstruction capabilities permit a more complete paranasal sinus imaging evaluation with improved 2D (and 3D) depiction of the sinuses and their drainage pathways. As neuroradiologists our knowledge of paranasal sinus anatomy should extend beyond the basic contour and arrangement of four sinus groups and their ostia, to an appreciation of the subtleties and complexities of the sinuses. This allows us to better understand the functional relationships of the sinuses, and more fully report the normal anatomical contours and surgically important anatomical variations.

REFERENCES

Sinonasal anatomy and inflammatory disease
Christine M. Glastonbury, MBBS, FRANZCR

Sinonasal Tumors - Imaging and Staging
Michelle A. Michel, MD

LEARNING OBJECTIVES
Upon completion of this presentation, participants will be able to:
1) Review the epidemiology, etiologies, and classification, and current treatment of sinonasal malignancies.
2) Compare the roles of CT, MR, and PET imaging in the evaluation of sinonasal malignancy.
3) Recognize the characteristic imaging features of a variety of sinonasal neoplasms and be able to describe involvement of adjacent anatomic structures by these lesions.
4) Identify contemporary staging of squamous cell carcinoma of the maxillary sinus and ethmoid sinuses.

PRESENTATION SUMMARY
Although sinonasal malignancies are rare and they account for less than 1% of cancer deaths in western countries, these tumors arise in a complex anatomical location and are histologically diverse. In addition to new histologic and clinical classifications, the last decade has brought new insights into the etiological risk factors, tumor biology, and therapeutic options of these lesions. Sinonasal malignancies have a rela-
tively poor prognosis and many present at an advance stage due to delay in diagnosis. Diagnosis may be delayed because the presenting symptoms often mimic those of chronic rhinosinusitis, they generally present with little pain, and there is space for tumor growth within the sinus lumen. Epithelial tumors account for the majority of sinonasal malignancies and squamous cell carcinoma is the most common. Additional epithelial neoplasms include cylindrical cell carcinomas, adenocarcinomas, and adenoid cystic carcinomas. Soft tissue tumors of the nasal cavity and paranasal sinuses are uncommon and include rhabdomyosarcoma, hemangiopericytoma, and other very rare forms. Malignancies of bone and cartilage include osteosarcoma, chondrosarcoma, malignant giant cell tumor, and Ewing sarcoma. Additional neoplasms such as esthesioneuroblastoma, mucosal melanoma, and lymphomas are uncommon, but may have characteristic features that help to distinguish them from other lesions. CT and MR imaging are the modalities of choice for imaging neoplasms of the sinonasal cavities and their roles are often complementary. CT demonstrates bony remodeling or destruction, identifies intratumoral calcification, demonstrates the matrix of cartilaginous and osseous neoplasms, and delineates obstruction of sinus drainage pathways. MR imaging is superior for distinguishing tumor margins from obstructed secretions; for delineating extension of tumor into the infratemporal fossa, orbit, and intracranial cavities; for detecting perineural tumor spread; and for demonstrating the vascularity of neoplasms. PET imaging may be useful in guiding endoscopic biopsies, in evaluating for tumor recurrence and nodal involvement, and in distinguishing residual or recurrent tumor from postsurgical or radiation changes. Paranasal sinus cancers are staged using the American Joint Committee on Cancer (AJCC) TNM system. This staging applies to lesions originating in the maxillary and ethmoid sinuses and there is no accepted staging system for malignancies of the frontal and sphenoid sinuses. Treatment options vary depending upon several factors including tumor histology, tumor extent and involvement of critical anatomical structures, presence of distant metastases, and the patient’s general condition. Surgical resection and radiation therapy are the most common treatment options with chemotherapy having a role in certain settings. Overall, the 5-year survival for all histologic types is 55-60% for stage I lesions and 30% for stage IV lesions.

**KEY REFERENCES**

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**Imaging Evaluation of the Sinonasal Cavity after Therapy**

*C. Douglas Phillips, MD, FACR*

**LEARNING OBJECTIVES**
Upon completion of this presentation, participants will be able to:
1) Demonstrate the variety of FESS procedures.
2) Identify frontal sinus obliteratorive procedures.
3) Describe postoperative appearances of standard sinus surgery.
4) Describe the lesions treated by craniofacial resection and explain the postoperative appearance.

**PRESENTATION SUMMARY**
Imaging the Postoperative Sinus. There is widespread acceptance of modern endoscopic surgery as not only the surgical method of choice for inflammatory sinus disease, but also in a growing number of benign and even malignant diseases of the nasal cavity and paranasal sinuses. It is important for the neuroradiologist to recognize the routine appearance of the paranasal sinuses following all functional endoscopic procedures, as well as the older and still utilized Caldwell-Luc procedure, osteoplastic flap procedures, and more extensive craniofacial and sinus surgeries, such as a maxillectomy and craniofacial resection.

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**Monday Afternoon**

1:15 PM – 2:45 PM

**Columbus G**

(8) ELC Workshop B: Introduction to PowerPoint

— John L. Go, MD
— Barton F. Branstetter IV, MD

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**Introduction to PowerPoint**

*John L. Go, MD*

**LEARNING OBJECTIVES**
Upon completion of this presentation, participants will be able to:
1) Review through the initial steps of preparing a PowerPoint presentation.
2) Plan for future PowerPoint presentations by creating templates.
3) Locate basic functions in the PowerPoint interface.
4) Create sample PowerPoint presentations.
Microsoft PowerPoint has become a standard format for creating and submitting scientific material to national meetings, and for creating lectures in academic settings. This workshop is designed to provide basic skills for creating and editing PowerPoint presentations. No prior experience with the software is required. Several tricks and hints for improved authoring efficiency are provided.

**Monday Afternoon**

1:15 PM – 2:45 PM
Columbus EF

(9) ASNR Business Center Programming: Part I

(64) Effective Leadership Skills
— Norman J. Beauchamp, Jr, MD, MHS

(65) Advanced Leadership: Solving Wicked Problems
— Gregory L. Katzman, MD, MBA

(10) ASNR Business Center Programming: Part II

(66) Manage Your Turf: An Academic Medical Center Perspective
— Norman J. Beauchamp, Jr., MD, MHS

(67) Strategic Planning in Academia
— David M. Yousem, MD, MBA

**Effective Leadership Skills**

*Norman J. Beauchamp, Jr, MD, MHS*

**Advanced Leadership: Solving Wicked Problems**

*Gregory L. Katzman, MD, MBA*
Internal Auditory Canal Hemangiomas

Quigley, E. P. · Harnsberger, R. H. · Salzman, K. L. · Warren, F. · Wiggins, R. H. · Davidson, H. C.
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PURPOSE
Hemangiomas are rare lesions of the internal auditory canal (IAC) that should be differentiated from other more common lesions in this location in order to improve preoperative planning. This study reviews the pathology and nomenclature of IAC hemangiomas, describes their varied clinical presentations, evaluates their key imaging findings on CT and MR, and discusses clinical management. The major clinical and imaging features of IAC hemangiomas are differentiated from other common lesions of the IAC.

MATERIALS & METHODS
Eleven pathologically proved IAC hemangioma cases were reviewed at our institution by three CAQ neuroradiologists. The following data were obtained and reviewed: demographics, clinical presentation, CT and MR imaging characteristics, pathology, treatment, and clinical outcome.

RESULTS
Eight of 11 cases had complete clinical data. There were five male and three female patients with an age range from 46 to 83 years. Sensorineural hearing loss was the most common presenting feature, seen in half of the cases. Other presenting features included: hemifacial spasm, facial weakness, vertigo, and tinnitus. Of the 11 cases reviewed, two had only CT, four had only MR imaging, and five had both CT and MR study available for review. Four of the lesions (36%) were solely within the IAC. All lesions, 11/11 had a diffusely enlarged IAC. Five out of seven cases (71%) demonstrated honeycomb calcification on CT. Nine of nine (100%) demonstrated contrast enhancement on MR imaging. Two out of nine (22%) demonstrated focal low T1 signal intensity on MR imaging, consistent with internal calcifications. Other MR imaging features included irregular, aggressive margins in three of nine (33%).

CONCLUSION
Hemangiomas are classified as capillary, cavernous, arteriovenous, or mixed type. IAC hemangiomas are histologically predominantly cavernous. Classically, temporal bone hemangiomas along the course of the facial nerve, intratemporal, are described as ossifying hemangiomas. A “honeycomb” matrix or intratumoral bone spicules are a hallmark of ossifying hemangioma. IAC hemangiomas may be ossifying or nonossifying. This series demonstrates variable calcification and ossification. IAC hemangiomas are a rare lesion which should be considered in the differential of relatively a common lesion, the vestibular schwannoma. Both CT and MR provide distinguishing features which allow early detection and treatment. Given histologic and imaging similarities of IAC hemangioma and intratemporal hemangioma, we propose that IAC hemangioma and intratemporal hemangioma are different expressions of the same process.

KEY WORDS: Hemangioma, internal auditory canal, IAC
MR Imaging of the Levator Veli Palatini Muscle in Patients with Velopharyngeal Dysfunction

Petropoulou, K. A. · Losee, J. E. · Jiang, S. · Smith, D. M. · Fitz, C. R.
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PURPOSE

Velopharyngeal dysfunction (VPD) is an important cause of speech pathology in children. Its underlying pathology determines the optimal course of treatment, yet elucidating this anatomy remains a diagnostic dilemma: while many of these patients have primary pharyngeal dysfunction and should be treated with pharyngoplasty, a subset have occult palatal anomalies (such as submucous cleft palate) and should be treated by palatoplasty. We employed MR imaging to assess the levator veli palatini muscle and thus identify the underlying cause of palatal dysfunction.

MATERIALS & METHODS

Eleven patients with suspected palatal pathology were evaluated and compared to four normal controls. The morphology of the levator palatini muscles was evaluated in terms of muscle sling configuration and completeness, muscle insertion site and distance from the posterior edge of the hard palate. Five cases have been surgically confirmed. All MR studies were performed on 1.5T magnets utilizing head coil. High-resolution axial T1-weighted, axial and oblique coronal PD sequences were employed to visualize the levator veli palatini muscle.

RESULTS

The levator veli palatini muscles were identified readily in all normal controls as well as in patients with pathology. In the normal controls the muscles followed a parabolic configuration and formed a complete sling in the soft palate at least 1cm from the posterior edge of the hard palate. In patients with VPD the muscles demonstrated either sinusoidal (7) or near-parabolic (4) configuration. The former inserted directly to the posterior edge of the hard palate while the latter inserted in the soft palate at an average of 0.6 cm from the posterior edge of the hard palate. All patients had an incomplete sling in the center.

CONCLUSION

Levator veli palatini, pathology, an important component of VPD, can be assessed by MR imaging. This strategy may represent a useful means of identifying the most efficacious surgical procedure to treat patients with VPD and avoiding unnecessary and ineffective pharyngoplasty in patients with primary palatal pathology.

KEY WORDS: Levator veli palatini muscle, velopharyngeal dysfunction, MR imaging

Using High-Resolution 3T 3D FLAIR to Detect Altered Signal in Labyrinthine Fluid in Patients with Vestibular Schwannoma

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1Mayo Clinic, Rochester, MN, 2Siemens Medical Solutions, Malvern, PA

PURPOSE

It has long been known that intracanalicular (IAC) vestibular schwannomas cause elevation of the protein content of labyrinthine fluid. This can result in decreased T2 signal which can be subtle and difficult to recognize without intensity measurements. We have developed a 3D SPACE FLAIR (fluid attenuated inversion recovery) technique to increase the conspicuity of these signal changes.

MATERIALS & METHODS

The study population consisted of 15 patients with sensorineural hearing loss, five patients of whom were scanned as follow-up imaging for presumed vestibular schwannomas. FLAIR images of the IAC were acquired on a 1.5T MR scanner (Magnetom Avanto, Siemens Medical Solutions, Erlangen, Germany). A 4-channel surface coil array (Machnet B.V. Eelde, The Netherlands) was positioned over the external auditory canals bilaterally and used to acquire 3D SPACE FLAIR images in the transverse plane through both IACs simultaneously. The field of view was 130 mm at 192 x 192 matrix with 1.5 mm section thickness. The SPACE technique accelerates the acquisition of a high-resolution 3D image set by sculpting the TSE flip angle evolution to obtain the desired contrast while enabling larger turbo factors (TF). For this acquisition, the apparent TE was 119 ms TR was 6 sec with a TF of 233 at an echo spacing of 3.76 ms, yielding a total imaging time of 6 min 38 sec.

RESULTS

All ten patients without IAC tumors were noted to have labyrinthine fluid that was isointense with CSF on 3D FLAIR. Three of five patients with known vestibular schwannomas had abnormal labyrinthine fluid that was hyperintense to CSF on 3D FLAIR.

Fig 1. Left: 3T 3D SPACE FLAIR demonstrates increased signal in membranous labyrinth ipsilateral to vestibular schwannoma. Normal nulled signal on unaffected side. Right: 3T 3D FSE T2-weighted imaging shows normal signal following CSF in membranous labyrinth bilaterally.
CONCLUSION
Alterations in labyrinthine fluid signal intensity induced by IAC vestibular schwannomas can be detected using this 3D FLAIR technique. Further study with audiometric correlation is warranted to determine if these signal changes have any prognostic significance.

KEY WORDS: 3D Flair MR imaging, temporal bone, vestibular schwannoma

Paper 71 Starting at 3:39 PM, Ending at 3:47 PM
MR Imaging of the Membranous Labyrinth at 3T

Morris, J. M. 1 · Lane, J. I. 1 · Johnson, K. J. 2 · Bolster, B. 2 · Horger, W. 2 · Witte, R. J. 1
1 Mayo Clinic, Rochester, MN, 2 Siemens Medical Solutions, Malvern, PA

PURPOSE
Clinical MR imaging of the inner ear has been limited to demonstrating fluid signal intensity within the bony labyrinth on T2-weighted sequences. However, recent advances in image acquisition techniques and hardware are capable of generating resolution and contrast sufficient to differentiate tissue in these structures in scan times that are clinically feasible. We describe our efforts to directly visualize the membranous labyrinth at 3T.

MATERIALS & METHODS
Six volunteers were imaged on a 3T MR unit (Magnetom Tim Trio, Siemens Medical Solutions, Erlangen, Germany). Either 7 cm loop coils or 4 ch flex coils were centered over the external auditory canal and used to acquire 3D T2 SPACE in the axial plane through the IAC with a 10 cm FOV, 294 x 320 matrix and 0.3 mm partitions, yielding 0.3 mm isotropic resolution. Reference was made to an ex vivo temporal bone demonstrates low signal macula (arrow). Right, 9.4T T2-weighted image of cadaver temporal bone demonstrates low signal macula (arrow).

CONCLUSION
To our knowledge, this is the first report of visualization of the membranous labyrinth on MR imaging. Further study is warranted to improve spatial resolution and to evaluate the clinical utility in the assessment of cochleo-vestibular disease.

KEY WORDS: Membranous labyrinth, 3T MR imaging, temporal bone

Paper 72 Starting at 3:47 PM, Ending at 3:55 PM
Superior Canal Dehiscence: Multidetector-Row CT Evaluation

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PURPOSE
To present a series of 26 patients, with clinical findings suggestive of superior canal dehiscence syndrome, who presented to a single otologic practice and to describe the clinical workup, common findings, surgical and conservative treatment of these patients.

MATERIALS & METHODS
Retrospective chart review of 26 patients with unilateral otologic symptoms such as perilymph fistula, otosclerosis, otosclerosis, hydrops or eustachian tube dysfunction. Patients with superior canal dehiscence syndrome may not present with the classic Tullio phenomenon and symptomatology. Few patients with symptomatic superior canal dehiscence elect surgical treatment. Making the correct diagnosis with the combination of clinical history, audiologic evaluation, VEMP, properly formatted CT scans and high clinical suspicion can save patients from unnecessary and potentially harmful treatments such as stapedectomy or perilymph fistula repair.

KEY WORDS: Sparacia


Paper 73 Starting at 3:55 PM, Ending at 4:03 PM

New Imaging of Old Nerves: Multidetector CT Evaluation of Temporal Bone Anatomy

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1Oregon Health & Science University, Portland, OR, 2University of Utah, Salt Lake City, UT

PURPOSE

Advances in multidetector CT technology which have yielded improved spatial resolution can be exploited for small structure detection such as anatomical detail in the temporal bone. The ability to perform submillimeter section thickness permits better evaluation of small anatomical structures in the temporal bone, and also allows near isovoxel multiplanar reconstructions. Several tiny nerve canals not previously seen with standard CT technology are now seen routinely with multidetector CT. The aim of this study is to evaluate the frequency with which these canals are seen, and review anatomical variations since there may be important surgical implications.

MATERIALS & METHODS

A total of 44 scans obtained consecutively during a 2-month time interval on our Philips 64 slice CT scanner were reviewed for this study. Our temporal bone protocol utilizes an unenhanced scan with effective slice thickness of 0.625 mm through the temporal bones. Image acquisition is nonhelical and performed in the axial and coronal planes. For the purposes of this study, axial images were reviewed specifically for the structures of interest. Eighteen of 44 scans were excluded from review because of technical difficulties from excessive motion and surgical changes precluding evaluation of the anatomy of interest. This yielded a total of 26 scans and 52 ears which were appropriate for evaluation. Images were evaluated for the following anatomical structures: chorda tympani nerve canal, canal for the nerves of Jacobson and Arnold, and the singular canal. Multiplanar reconstructions were performed in planes of interest for better anatomical demonstration using off-line using commercially available software or directly on our Agfa PACS system.

RESULTS

A total of 44 scans obtained consecutively during a 2-month time interval from 8/7/06 to 9/27/06 on our Philips 64 slice CT scanner were reviewed for this study. Eighteen of 44 scans were excluded from analysis because of technical difficulties such as excessive motion and surgical changes which precluded evaluation of the anatomy of interest. This yielded a total of 52 ears which were appropriate for evaluation. Images were evaluated for the following anatomical structures: chorda tympani nerve canal, canal for the nerves of Jacobson and Arnold, and the singular canal. Multiplanar reconstructions were performed in planes of interest for better anatomical demonstration using off-line using commercially available software or directly on our Agfa PACS system.

CONCLUSION

High-resolution CT of the temporal bones now routinely depicts small nerve branches including the chorda tympani nerve, singular canal, and canals for Arnold’s and Jacobson’s nerve. Knowledge of these normal anatomical structures and variants is important since there are potentially important diagnostic and treatment planning implications.

KEY WORDS: Temporal bone, anatomy, multidetector CT

Paper 74 Starting at 4:03 PM, Ending at 4:11 PM

Temporomandibular Chondroblastoma

Dougherty, D. A. · Bhatia, R. · Arnold, D. · Civantos, F. · Gomez-Fernandez, C.
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PURPOSE

The current work highlights the unusual presentation of an uncommon bone tumor with regard to radiographic features, pathology, treatment and prognosis.

MATERIALS & METHODS

The study design is case review detailing multiple pathologically proved cases of chondroblastoma arising in the temporomandibular region. Imaging findings and differential diagnoses, treatment and pathology are discussed with regard to a total of four cases of this unusual entity.

RESULTS

In two recent cases, the patient presented with a mass in the temporomandibular region. Given the destructive and expansile characteristics of each, the imaging features were nonspecific and suggested several diagnoses. Two additional cases are discussed with regard to long term follow up. Patient MG is a 54-year-old woman who presented with an 8-month history of headache and left-sided hearing loss. CT demonstrated an expansile, destructive lesion involving the left temporal bone with intracranial extradural extension. There was destruction of the head of the mandible with involvement of the neck, ramus and condyle. The mass involved the zygomatic arch and extended into the soft tissues of the infratemporal fossa with medial displacement of the temporal lobe. Patient SK is a 70-year-old male with a large mass appearing centered in the right masticator space. There was extension to the right parotid, middle cranial fossa and parapharyngeal space. Prominent bony destruction was evident on CT, including that of the temporal bone, temporoparietal junction, and greater wing. MR imaging demonstrated each lesion to be well circumscribed and of mixed signal intensity. The signal characteristics were mainly low with focal areas of high T2. A heterogeneous pattern of moderate contrast enhancement was present. Patients MG and SK underwent a combined temporal and infratemporal approach resection. Pathology revealed a neoplastic proliferation of mononuclear cells with osteoclast-type giant cells. Several preliminary diagnoses were considered including PVNS, giant cell tumor and chondroid tumors including the final diagnosis of chondroblastoma as these were positive for immunostain S-100.
CONCLUSION
Chondroblastoma is a rare neoplasm most often occurring in the epiphyses of long bones and accounts for only 1% of primary osseous neoplasms. Local pain is often a presenting symptom with extremity chondroblastoma and prognosis is based upon invasion of the articular cartilage, the metaphysis or local soft tissue. The occurrence of chondroblastoma in the temporal bone or in the mandible is exceedingly rare. Total excision using a combined otolaryngologic and neurosurgical approach offers the best chance of disease-free survival. Using this approach, two additional patients at our institution (AA and AL) have had disease-free follow up for 9 and 10 years respectively. Total excision is imperative due to a high incidence of local recurrence and the occurrence of benign metastasis, particularly to the lung. In summary, chondroblastoma of the temporomandibular region is not commonly seen, but does occur with some frequency. Early diagnosis will affect complete surgical resection and thus patient outcome.

KEY WORDS: Chondroblastoma, temporomandibular

Paper 75 Starting at 4:11 PM, Ending at 4:19 PM

Melorheostosis of the Skull Base

Branstetter, B. F. · Seethala, R.
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PURPOSE
Melorheostosis is a rare bone disease that most frequently affects the appendicular skeleton. The classic radiographic appearance is that of hyperostotic, flowing cortical bone, mimicking melted wax. Craniofacial melorheostosis is exceedingly rare, and the radiographic appearance is less well defined. We present a case of sinonasal melorheostosis with an unusual radiographic appearance.

MATERIALS & METHODS
We report the case of a 52-year-old female who presented with nasal fullness and difficulty breathing. On examination, she had a mass in her nasal septum. CT of the paranasal sinus revealed a heterogeneous mass with irregular areas of cortical density, intermediate density, and relative lucency (Fig). The mass infiltrated into surrounding bones of the face and skull base. The lesion was presumed to be fibrous dysplasia based on the radiographic appearance.

RESULTS
Excisional biopsy demonstrated hypertrophied cortical bone indicative of melorheostosis.

CONCLUSION
In this presentation, we report the radiographic findings of sinonasal melorheostosis, which may be mistaken easily for fibrous dysplasia.

KEY WORDS: Skull base, osseous lesions

Paper 76 Starting at 4:19 PM, Ending at 4:27 PM

Increased Cochlear Signal on FLAIR Images in Patients with Acoustic Neuroma: A Manifestation of High Protein Levels in Perilymph

Bhadelia, R. · Tedesco, K. · Hwang, S. · Erbay, S. · Lee, P. · Heilman, C.
Tufts New England Medical Center and Beth Israel Deaconess Medical Center
Boston, MA

PURPOSE
Elevated protein levels have been reported in perilymph of patients with acoustic neuroma (1). High protein content is known to increase signal intensity of fluids on fluid attenuation inversion recovery (FLAIR) images. The purpose of this study was to investigate if cochlear signal intensity on the affected side in patients with acoustic neuroma is increased compared to the unaffected side, and compared to normal control subjects.

MATERIALS & METHODS
We retrospectively evaluated 15 patients with unilateral acoustic neuroma, and 25 age-matched control subjects (patients having MR imaging for headache or memory loss). All patients and control subjects had routine 5 mm FLAIR images of the brain. In patients and control subjects, signal intensity of both cochleae on FLAIR images was determined by placing a small region of interest (ROI). Signal intensity of brainstem also was determined at the same level by placing a second ROI. A ratio of cochlear signal intensity to brainstem signal intensity (CIBI ratio) was obtained. T-test was used to compare CIBI ratios of the affected sides in patients to the CIBI ratios of the unaffected sides, and control subjects.
RESULTS
The average tumor size was 17 mm (range: 4-41 mm). The CIBI ratio of the affected sides in patients was 0.88 ± 0.18 (average ± standard deviation). The CIBI ratio of the unaffected side in patients was 0.57 ± 0.12. The CIBI ratio of control subjects was 0.51 ± 0.07. The CIBI ratio of the affected sides in patients was significantly higher compared to the unaffected side (p < 0.001), and compared to control subjects (p < 0.001).

CONCLUSION
Patients with acoustic neuroma have increased cochlear signal intensity on the affected side on FLAIR images compared to the unaffected side, and compared to normal subjects. This may be due to increased protein content of cochlear fluid on the affected side.

REFERENCES

KEY WORDS: Acoustic neuroma, MR imaging

Vascular Road Mapping for CT-Guided Minimally Invasive Procedures for Head and Neck Pathology

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1University of Maryland and Baltimore Veterans’ Administration, Maryland, MD, 2University of Maryland, Maryland, MD

PURPOSE
Computed tomography (CT)-guided minimally invasive procedures for evaluation/treatment in head and neck pathology are well established. However, some of these procedures, such as selective spinal nerve block (SSNB) and biopsy of deep lesions, are still considered high-risk procedures, mainly because of the potential for iatrogenic injury to surrounding structures including vital vessels (e.g., vertebral arteries, carotid arteries, internal jugular veins). To avoid these complications and identify the position of the vessels in relationship to the planned needle pass, contrast-enhanced CT of the neck usually is performed prior to procedures. However, by the time of needle placement, contrast is washed out and less helpful for guidance. Therefore, we propose using CT-guided vascular “roadmapping” as a feasible method to enhance conspicuity of adjacent vasculature during needle placement and potentially avoid vascular complications.

MATERIALS & METHODS
To date in our prospective study, five patients have undergone CT-guided neurointerventional procedures (3 SSNBs and 2 biopsies for deep-neck lesions). CT imaging with the administration of nonionic intravenous contrast was performed on all five patients prior to the procedures. All procedures were performed using a 16-slice multidetector CT scanner (slice thickness = 0.75 mm). The preprocedural scan was registered with the intraprocedural scans. Image registration and fusion were performed using software developed by our group. To minimize the effect of patient motion during the procedure, automatic rigid (translation + rotation) image registration was performed using normalized mutual information (NMI) as a measure of image similarity. Direct fusion (no image registration) was compared with fusion after rigid image registration.

RESULTS
Direct fusion was compromised by misaligned structures as a result of patient motion since acquisition of the preprocedural scan. This misalignment was minimized with the use of image registration. With the use of our postimage-processing algorithm, a roadmap of the vasculature could be seen superimposed on noncontrast CT images during needle placement, demonstrating the 3-dimensional location of the inserted needle (Fig 1). The roadmap allows rapid identification of vascular structures and their relationships to the needle, avoiding nonintentional vascular damage.

CONCLUSION
Vascular roadmapping is a technologically feasible method that improves visualization of vascular structures and increases safety in CT-guided high-risk neurointerventional procedures. However, the efficacy of this technique is compromised by patient motion. We developed and performed initial testing using a postimage-processing technology and are working on introducing approaches for real-time vascular roadmapping to increase the accuracy and safety of CT-guided procedures.

KEY WORDS: CT-guided procedures, vascular road mapping, image registration

Standardized Methods for Quantificational Evaluating Standardized Uptake Value and Metabolically Active Tumor Volume of Neck Tumors in F18-FDG PET/CT

Zhang, J. · Hall, N. C. · Shah, Z. · Jia, G. · Knopp, M. V.
The Ohio State University Columbus, OH

PURPOSE
To propose standardized methods for evaluating the accura-
cy and reproducibility of standardized uptake value (SUV) and metabolically active tumor volumes (MATV) as biomarkers for the neck tumor assessment in F18-FDG PET/CT.

**Materials & Methods**

Whole-body PET/CT imaging data from 30 human neck tumors before and after therapy were acquired 60–90 minutes post 450–550 MBq FDG injection on a Siemens HI-REZ PET/CT. 3D spherical VOIs were placed in neck tumors, neighboring normal tissues (a) as well as the high, middle and low third of the aorta (b) with well away from the edge. Taking (a) and (b) as the background, the maximum SUV (SUVmax), averages of top 10 SUVs (SUVtop10) as well as average SUV (SUAVg) were calculated for each tumor and setup to estimate each MATV at 50% cutoffs of the isosurface, with and without background subtraction. We compared SUVs differences, lesion-to-background ratios (LBRs) as well as the PET MATVs with lesion sizes from CT by region-growing techniques.

**Results**

Significant differences were found in both SUVs between SUVmax and SUVtop10 (p<0.02) as well as MATVs with and without background subtraction (p<0.01), while no pronounced variance can be found for each of the SUVs as well as leaded MATVs calculated from the high, middle and low third of the aorta for all these neck oncology studies. Comparing to the CT volume of tumors, the 50% cutoffs of SUVmax without background subtraction always results in increased MATVs especially for small lesions with lower LBRs as well as decreased MATVs for large lesions with higher LBRs; while the SUVtop10 based MATV determination with aorta background subtraction shows more accurate and robust results for small lesions (less than 2 ml) as well as the SUAVg based neighboring tissue subtraction leads to better results for large lesions. For neck lesions with both small size and high LBRs (greater than 8), there is no significant difference between MATVs determined by 50% cutoffs of SUVmax or SUVtop10 no matter with or without background subtraction. When monitor the tumor response before and after therapy, MATVs with background subtraction held the same trend as SUVs, while this was not true for most of the neck lesions if MATVs were determined without background subtraction.

**Conclusion**

Neck lesions vary with varying sizes from small to large as well as lesion-to-background ratios from low to very high. Determining SUV based on single maximum pixel gives an overestimation of the true maximum SUV value and the alternative SUVtop10 method is more reproducible. Using the isosurface at 50% maximum SUV also yields an overestimation or underestimation of lesion volumes for small or large lesions under certain LBRs. The proposed threshold cutoffs approach after background subtraction provide a reproducible standard way for contouring metabolically active tumor volumes which leads to more accurate MATVs for neck lesions (p<0.05) and holds the same trend as SUV changes. These methods may be useful for the quantifiable biomarkers assessment in radiation therapy planning and monitoring response to therapy of neck oncology studies.

**Key Words:** Standardized biomarker, neck tumor, metabolic volume
images, segmented total brain volume was determined, and then normalized by intracranial volume as a measure of brain atrophy. A neurologist determined Tinetti scores of gait and balance, and determined whether there was a history of stroke. Simple and partial correlations were used to determine the relationships between FAGCC and FASCC values, and gait and balance scores without and with adjustment for age, gender, arthritis, neuropathy, stroke, and brain atrophy.

RESULTS
The mean age of subjects was 74 years (range: 60-91 years). Seventy-three of the 92 subjects were female. A significant correlation was observed between FAGCC and gait scores ($r = 0.35; p = 0.001$). A significant correlation also was observed between FAGCC and balance scores ($r = 0.21; p = 0.04$). However, after adjustments for age, gender, arthritis, neuropathy, stroke, and brain atrophy, only gait scores remained significantly correlated to FAGCC ($r = 0.31; p = 0.005$). There was no relationship observed between FASCC and balance or gait scores.

CONCLUSION
In elderly individuals, FA in the genu of corpus callosum is associated with quantitative measures of gait and balance. The association between FA in the genu of corpus callosum and gait is independent of age and other factors affecting gait in the elderly.

KEY WORDS: Diffusion tensor imaging, gait, elderly

Paper 80 Starting at 3:23 PM, Ending at 3:31 PM
Bilateral Symmetry of Amyloid Deposition in Alzheimer Disease and Mild Cognitive Impairment Determined with Pittsburgh Compound B

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PURPOSE
The radioligand Pittsburgh Compound B (PiB) is selectively retained in brain regions with high amyloid beta deposition in Alzheimer disease (AD) brain and subsequently can be visualized on PET. To date, no known studies have been done examining extent of amyloid symmetry in AD. Our objective was to evaluate and compare PiB retention between left and right brain regions of interest (ROIs) and correlation with Mini-Mental State Exam scores (MMSEs) in control, MCI, and AD subjects.

MATERIALS & METHODS
Data from 30 subjects [10 controls (MMSE 29.6 ± 0.7); 10 MCI (MMSE 27.3 ± 2.2); 10 mild AD (MMSE of 24.6 ± 2.7)] were utilized. All subjects underwent dynamic PET/PiB imaging studies over a 90 min period. Standardized uptake values reference region (SUVRs) of the cerebellum were calculated from the left and right brain ROIs.

RESULTS
No statistically significant asymmetries in PiB retention were found between left and right ROIs in these MCI and AD subjects. There was a trend toward higher cortical PiB SUVRs on the left (< 5%) that did not reach statistical significance. Most cortical areas had a significant negative correlation between PiB retention and MMSE scores whether or not the controls were included in the analysis. No significant correlation was observed in white matter areas. This correlation did not differ between right and left ROIs. PiB retention was highest in frontal cortex and posterior cingulate/precuneus areas and lowest in cerebellum and mesial temporal lobe.

CONCLUSION
We conclude that amyloid deposition, as assessed by PiB, is a bilaterally symmetric phenomenon, that correlates negatively with cognitive function in this small sample of MCI and mild AD subjects.

KEY WORDS: Pittsburgh Compound B (PiB), Alzheimer, amyloid imaging

Paper 81 Starting at 3:31 PM, Ending at 3:39 PM
Regional Demyelination in Early Alzheimer Disease Revealed by Magnetization Transfer Transfer at 3T

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PURPOSE
Alzheimer disease (AD) is a neurodegenerative disorder manifested by progressive cognitive deterioration. Since higher cognitive functions are based on distributed neural networks, AD-associated cognitive impairment is expected to result from compromised cortical connectivity. Recently, the breakdown of myelination has been suggested to be an essential factor in AD development (Bartzokis 2004). The aim of this study is to estimate regional myelination in newly diagnosed AD patients.

MATERIALS & METHODS
Ten patients (mean age 68.8 years, CDR: 0.5-1, FAST: 3-4) and nine age-matched controls were scanned successfully on a 3T Philips scanner. The protocol included a sagittal T1-weighted 3D gradient-echo sequence (MPRAGE, 160 slices, 1mm isotropic voxels) and a gradient-echo MTI (FA 30, TE 15, matrix size 256*256, pixel size 1*1 mm, 36 slices, 3mm thick, MT pulse duration: 7.68 ms, FA 500, Frequency offset 1.5kHz). MT images were coregistered to the T1 acquisition. The MTR for every intracranial voxel was calculated as follows: MTR = (M0 - Ms)/M0 * 100% where Ms represents the intensity of voxels with saturation, and M0 that without sat-
uration. Subsequently, T1 images were segmented, producing probability maps for gray matter (GM), white matter (WM), and CSF for each subject in its native space. A mask was defined by thresholding the WM probability map at p>0.95. In order to exclude the contribution of GM and CSF, the mask was applied to the MTR coregistered images. Only voxels with MTR>10% were included in the following calculations. We chose mean regional MTR values as an estimator of myelination. For parcellation of the entire brain, the MNI template and Brodmann Atlas were used. Each ROI was denormalized according to the subject’s morphology and applied separately to the individual MTR maps.

RESULTS
We found a decrease (t-test, p<0.05) in the mean regional MTR values in the frontal and temporal lobes of the left hemisphere (Fig 1a) and a tendency for similar changes in the symmetrical lobes of the right hemisphere (p<0.07), as well as in occipital lobes (p<0.07). No region revealed the opposite trend. To test the fine-scale performance of MT-MRI, we selected Brodmann’s areas 22, 44-45, and 46, where cortical damage has been reported early in AD (Bozzali 2006). We found significant area-specific demyelination (Fig 1b) in the left hemisphere.

CONCLUSION
The preliminary data confirm that the MT-MRI protocol is sufficiently sensitive both for a meso-scale and for a fine-scale quantification even when applied to a small sample of AD patients.

KEY WORDS: Magnetization transfer imaging, Alzheimer disease

Paper 82 Starting at 3:39 PM, Ending at 3:47 PM
Evaluation of Diffusivity and Diffusion Anisotropy by Using Tract-Based Analysis of Limbic Circuits in Alzheimer Disease Cases

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PURPOSE
Our purpose for this study is to access the feasibility of tract-based diffusion tensor analysis of limbic circuits as an indicator of severity of Alzheimer disease (AD). For this purpose, we evaluated apparent diffusion coefficient (ADC) and fractional anisotropy (FA) along the tracts which are included in limbic circuit for patients with AD.

MATERIALS & METHODS
The subjects were 40 AD cases and 15 normal controls. AD cases included 18 mild cases (MMSE score: 20 to 22), 16 moderate cases (MMSE: 10-19) and 6 severe cases (MMSE: less than 10). We measured FA and ADC using echo-planar-based diffusion tensor imaging. We selected uncinate fascicles, anterior cingrum and posterior cingrum as a tract included in limbic circuit. We also selected pyramidal tract as an internal control. Diffusion tensor analyzing software developed by Masutani (University of Tokyo, diffusion tensor visualizer ver. 2, available at http://www.ut-radiology.umin.jp/people/masutani/dTV.htm) was used for tract-based measurement of FA and ADC. We evaluated statistical difference of the FA and ADC values for the tracts above using ANOVA. We also accessed the statistical difference of FA and ADC values between mild AD cases and control groups by Student’s t-test.

RESULTS
Mean ADC values (x 10⁻³ sec/mm²) of uncinate fascicles in severe, moderate, mild cases and control group were 0.48, 0.45, 0.44, 0.42 respectively and the four groups showed statistically significant differences (p < 0.001). While, mean ADC values of anterior cingrum were 0.47, 0.42, 0.42, 0.40 respectively, and that of posterior cingrum were 0.45, 0.42, 0.42, 0.40. The four groups showed statistically significant difference (p < 0.001) for both fascicles. ADC values showed statistically significant differences (p < 0.001) between mild cases and control groups for all three fascicles within limbic circuits. Mean FA values of uncinate fascicles in severe, moderate, mild cases and control group were 0.33, 0.34, 0.35, 0.37 respectively and the four groups showed statistically significant differences (p < 0.001). While, mean FA values of anterior cingrum were 0.34, 0.40, 0.41, 0.41 respectively, and that of posterior cingrum were 0.37, 0.40, 0.41, 0.42. The four groups showed statistically significant difference (p < 0.001) for both fascicles. FA values showed statistically significant differences (p < 0.001) between mild cases and control groups only for uncinate fascicles. For pyramidal tracts, both ADC and FA values showed no significant differences in four groups.

CONCLUSION
Increased diffusivity and decreased diffusion anisotropy in limbic circuits correlated to the severity of AD. Degeneration of white matter fiber tracts secondary to neuronal loss in the associative cortex may be one of the reasons of these AD-associated changes in limbic circuits. Especially ADC showed statistically significant difference between mild AD cases and controls in all the fascicles of limbic circuits we evaluated. These increased ADC may be feasible as a marker for early diagnosis of AD.

KEY WORDS: Alzheimer disease, diffusion tensor, tract-based analysis
Correlation between the Diffusion Tensor Imaging Findings and Clinical Manifestation in Patients with Familial Creutzfeldt-Jakob Disease

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PURPOSE
Diffusion tensor imaging (DTI) was found superior in detecting cortical involvement in patients with Creutzfeldt-Jakob disease (CJD). Our aim was to evaluate the correlation between the unique DTI findings and the clinical manifestations.

MATERIALS & METHODS
As part of a large prospective clinical study 11 patients were diagnosed clinically and genetically as familial CJD. All patients were scanned with a protocol, which included FSE T2 FLAIR, DWI and DTI. The radiologic interpretation was done by neuroradiologist blinded to the clinical manifestations. The patients underwent a detailed neurologic examination by a trained neurologist blinded to the radiologic findings and the results of MR imaging were correlated with the clinical signs.

RESULTS
The DTI revealed abnormal findings in 10/11 patients in the basal ganglia, 8/11 in different cortical areas and 6/11 in the thalami. No signs of involvement of the brain stem and cerebellum were seen. When correlated with the clinical findings it was found that the DTI was positive for the frontal cortex in 8/9, for the motor cortex in 7/9, (while 1 was found positive after a follow-up scan after 3 months). In the basal ganglia the DTI was positive in 10 patients, but clinical findings were found only in 8. Eleven of 11 and 7/11 patients had clinical cerebellar and brainstem respectively but neither had positive DTI nor other MRI sequence findings.

CONCLUSION
In patients with CJD, DTI was sensitive to cortical and deep gray matter involvement but not to cerebellar or brainstem involvement. It was well correlated with the clinical findings in these patients.

KEY WORDS: Creutzfeldt-Jakob disease, diffusion tensor imaging, cortical involvement

Neuroimaging in Suspected Normal Pressure Hydrocephalus: Is Imaging Predictive?

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PURPOSE
The purpose of this study was to determine if neuroimaging with CT and MR can reliably predict a subset of patients proved to have normal pressure hydrocephalus (NPH) based on clinical assessment

MATERIALS & METHODS
We retrospectively assessed a cohort of patients referred to a cognitive geriatric neurologist for evaluation of NPH. Clinical workup included a MMSE, clock-drawing, neuropsychologic assessment, and videotaped gait analysis pre and postlumbar drainage of 30 cc of cerebrospinal fluid (CSF). Improvement of cadence post-CSF drainage was suggestive of true NPH. Neuroimaging studies were assessed by a neuroradiologist; blinded to clinical outcome. Images were assessed for degree of atrophy, degree of leukoaerosis, Evan’s index, and overall impression.

RESULTS
A total of 26 patients with a mean age of 71.4 years (49.6-83.8) were referred for evaluation of NPH. All 26 patients had gait disturbance as a primary complaint. In addition, 25 had cognitive deficit and 22 had urinary incontinence. Videotaped gait analysis pre- and post-CSF tap test was positive for NPH in five patients, equivocal in two and the remainder were negative. All five positives were referred for a shunt procedure. All had CT, or MR imaging or both. Of the five with proved NPH, none had moderate or severe atrophy, and none had severe leukoaerosis. The radiographic impression was suggestive of NPH in three of five. Mean change in cadence was 8.8% in those with NPH vs -2.7 in those without NPH. The mean Evan’s index was 0.43 in those with clinically proved NPH and 0.45 in those without NPH. In the subset who did not have proved NPH, there was moderate or severe leukoaerosis in 7/19, and 8/19 had moderate or severe atrophy. The radiographic impression was falsely suggestive of NPH in eight of 19.

CONCLUSION
Overall, imaging with CT and MR is not accurate in suggesting a diagnosis of NPH. Patients with moderate or severe leukoaerosis and/or atrophy were unlikely to respond positively to a CSF tap test and we suggest that the combination of these imaging findings make the diagnosis of NPH unlikely. The Evan’s index was not predictive of NPH.

KEY WORDS: NPH, dementia, normal pressure hydrocephalus
Comparison of Diffusion Tensor Imaging in Systemic Lupus Erythematosus with and without Neuropsychiatric Symptoms: A Prospective Study of Apparent Diffusion Coefficient and Fractional Anisotropy Values in Different Regions of the Brain

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PURPOSE
To determine if significant differences in apparent diffusion coefficient (ADC) and fractional anisotropy (FA) values in different gray and white matter regions of the brain exist in patients with neuropsychiatric systemic lupus erythematosus (NPSLE) when compared to patients with systemic lupus erythematosus (SLE) without neuropsychiatric symptoms.

MATERIALS & METHODS
Eight patients (aged 23-55 years, mean 44.8) with symptomatic NPSLE and 15 patients with SLE without neuropsychiatric symptoms (aged 27-59 years, mean 44.1) were evaluated. All subjects underwent routine brain MR imaging. Diffusion tensor imaging also was obtained using a single-shot spin-echo EPI technique along nine different directions with a b-value of 1000 s/mm$^2$. 50 mm$^2$ volumes of interest were placed in standardized normal-appearing gray and white matter regions within both hemispheres. ADC and FA maps were generated, and ADC and FA values and standard deviations were calculated. A two-sample t-test was used for statistical analysis.

RESULTS
Statistically significant differences ($p < 0.005$) were found in both ADC and FA values when comparing the NPSLE patients to the nonneuropsychiatric SLE patients in the internal capsule. Significant differences in FA values in the insular cortex, orbitofrontal cortex, thalamus, and cingulate cortex and significant differences in ADC values in periaqueductal gray matter also were noted when comparing the two populations.

CONCLUSION
DTI can distinguish significant differences in FA and ADC values in several normal-appearing regions of the brain in NPSLE patients when compared to SLE patients without neuropsychiatric symptoms. These alterations may be based on loss of tissue integrity and in part due to demyelination. Furthermore, these findings may in the future assist in the diagnosis of NPSLE, help distinguish between acute and chronic disease, play a role in monitoring disease progression, and possibly help to further elucidate the pathogenesis of NPSLE.

KEY WORDS: Lupus, neuropsychiatric, diffusion tensor imaging
encephalitis (HSE) and Japanese encephalitis (JE) and to correlate the apparent diffusion coefficient (ADC) values with duration of illness and histopathological changes in necrotising encephalitis (HSE) and non necrotising encephalitis (JE).

**MATERIALS & METHODS**

Between January 2004 and December 2005 forty-five confirmed cases of encephalitis (38 patients with JE and 7 patients with HSE) referred for MR imaging. IgM MAC ELISA and PCR tests were performed to confirm the diagnosis of JE and HSE respectively. The imaging was performed on 1.5T MR scanner (GE Medical System, Signa, Milwaukee) with T2 fast spin echo (T2-FSE), T1, fluid attenuated inversion recovery (FLAIR) and diffusion weighted imaging (DWI) (b value 0 & 1000). MRI findings were recorded in terms of site of involvement, extent of lesions, visibility of each lesion on T2, DWI and FLAIR sequences and ADC calculations. ADC map was generated on GE signa advantage workstation, version 4.0. ADC value in lesions were calculated at multiple places (ROIs) and obtained repeatedly for consistency and reliability of the measurements. Mean of the ADC value in each patient was noted and subjected for statistical analysis.

**RESULTS**

In patients with JE, most frequently involved areas were thalamus (94.7%), mid brain (86.8%), basal ganglia (63.3%) and adjacent medial temporal lobe (49.8%). Temporal and frontal cortex was most commonly involved site in patients with HSE. Basal ganglia was not infrequently involved in HSE. To see the changes in ADC with time, patients with JE and HSE were regrouped on the basis of time since clinical presentation viz. group 1 (3-5 days), group 2 (6-10 days), group 3 (11-14 days), group 4 (14-30 days) and group 5 (31-100 days). There was no restricted diffusion seen on DWI in JE in any stage of disease rather a minimal increase in average ADC value observed in acute and subacute stages of JE. Significant increase in ADC value was noted only after 4 weeks of illness in JE. Restricted diffusion was observed in HSE patients in acute and sub acute stage suggestive of cytotoxic oedema and necrosis early in the pathogenesis of HSE. There was a significant increase in average ADC value (p<0.05) observed after 10 days.

**CONCLUSION**

In our study the ADC values were different in the acute stage of HSE and JE reflecting the difference in the degree of diffusability of water molecule. There is abundance of cytotoxic oedema in HSE and vasogenic oedema in JE early in the disease course. The DWI and ADC evaluation may help in characterising and differentiating necrotising encephalitis (HSE) from non-necrotising encephalitis (JE) in acute stage.

**KEY WORDS:** Apparent Diffusion Coefficient, Encephalitis, Diffusion-Weighted Imaging

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**Paper 88 Starting at 4:27 PM, Ending at 4:35 PM**

**Cerebrovascular Oxygenation Changes during Respiratory Challenges**

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**PURPOSE**

Cerebrovascular oxygenation changes during respiratory challenges have clinically important implication of brain function including cerebral autoregulation and the rate of brain metabolism. Susceptibility-weighted imaging (SWI) can potentially produce high-resolution venography by exploiting the magnetic susceptibility of deoxygenated blood. The aim of this study was to assess cerebral venous blood oxygenation changes during simple voluntary breath-holding (apnea) and hyperventilation using SWI at 3.0T.

**MATERIALS & METHODS**

Five healthy volunteers (3 men and 2 women) with a mean age of 30.8 ± 6.5 years participated in this study. All data were acquired on a 3T with imaging parameters as follows: TR/TE=29/20 ms, flip angle = 15°, pixel size=0.4x0.4mm², and slice thickness = 1.2mm. The acquisition time is 1min 28sec. The baseline SWI scan with normal breathing was acquired followed by the same scan but with 30–45 seconds breath-holding starting just before the scan. This is followed by a recovery period with normal breathing about 5 min. Then the same SWI scan was performed after 2 mins of hyperventilation, which continued during the scan. Two volunteers were asked to repeat the scan on different days.

**RESULTS**

SWI showed excellent image contrast of the venous vasculature that is usually not visible on conventional imaging. The change in oxygenation level, indicated by the signal change due to alteration of the concentration of deoxyhemoglobin in the veins, can be clearly seen on SWI in all volunteers. As shown in Figure 1, compared to the baseline scan with normal breathing, the venous architecture slightly attenuated during breath-holding, but more prominent changes were seen during hyperventilation on the SWI mIP venogram. The repeat scans in the two volunteers demonstrated the same findings.

**CONCLUSION**

Our data reveal the oxygenation level is much lower during voluntary hyperventilation than during breath-holding. This is because voluntary hyperventilation can rapidly and strongly reduce cerebral blood flow (CBF) due to a large decrease of blood CO₂. This produces oxygen delivery...
reduction but does not decrease cerebral oxygen consumption in healthy persons, leading to increased concentration of deoxyhemoglobin in the veins. However, during breath-holding (except for extreme cases), a blood flow increases significantly with a range of 59–71% in both arteries and veins to compensate decreased oxygen saturation without increase of oxygen consumption. This study emphasizes that venous blood oxygenation is strongly influenced by CBF changes due to the modulation of blood CO₂ during respiratory challenge, which can be directly visualized on SWI.

**Key Words:** Oxygen saturation, hyperventilation, susceptibility-weighted imaging

**Paper 89 Starting at 4:35 PM, Ending at 4:43 PM**

**Quantitative Oxygen Partial Pressure MR Imaging of Cerebrospinal Fluid and Brain**

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**Purpose**

Quantitative, noninvasive imaging of oxygen partial pressure (pO₂) would be useful for understanding basic physiology, alterations in the setting of disease, and changes due to treatment. Dissolved oxygen is paramagnetic and acts as a weak MR relaxation agent. Recently, we have measured CSF pO₂ using flow-insensitive R1 (=1/T1) maps and found reasonable agreement compared with invasive methods (1, 2). This abstract reports pO₂ levels of different cerebrospinal fluid (CSF) regions and an SNR estimate. Also, data acquired using a new, rapid R1 mapping technique (3) demonstrate changes during functional activation that likely represent pO₂ alterations within the brain parenchyma itself.

**Materials & Methods**

All measurements were performed at 1.5T. pO₂ of different CSF regions (lateral ventricles, cisterna magna, and cortical subarachnoid space) in normal, young human volunteers breathing room air was measured using either nonequilibrium 3D inversion recovery (1) or 2D saturation recovery sequences (2), with imaging times on the order of 2-10 min. In four subjects, individual 15 s measurements were repeated 90 times to estimate the 95% confidence level of individual measurements. Finally, a rapid R1 mapping sequence utilizing transient-state magnetization with 1.5 s temporal resolution (3) was performed in conjunction with a finger-tapping/checking functional MR imaging (fMRI) block paradigm in three volunteers.

**Results**

Figure 1 shows typical pO₂ images of the CSF around the brain (blue=0 mmHg, red=190 mmHg). pO₂ (mean±SD) in various brain CSF regions was measured as follows: lateral ventricles, n=23, 57±19 mmHg; cisterna magna, n=15, 68±28 mmHg; cortical subarachnoid space, n=19, 132±38 mmHg. The 95% confidence interval for the individual pO₂ measurement (15 s) normalized to a 1 cc volume in the lateral ventricles was 5 mmHg (min-max 3-9 mmHg). The mean ΔR₁ change in activated voxels during fMRI was 15.8 x 10⁻³ s⁻¹. After subtracting the expected ΔR₁ change due to increased CBF (4.7 x 10⁻³ s⁻¹), we estimate a parenchymal pO₂ increase of 47 mmHg.

**Conclusion**

R1-based pO₂ mapping in the CSF can be performed at 1.5T with reasonable imaging times in normal human subjects. SNR is adequate to detect changes on the order of 5 mmHg, far smaller than normally seen during 100% oxygen challenge (about 100 mmHg). Preliminary fMRI studies suggest that quantitative pO₂ changes can be measured in brain parenchyma during activation.

**References**

1. Zaharchuk et al. *MRM* 2005;54:113

**Key Words:** Oxygen, MR imaging, T1 mapping
Cervical CT Angiography Using a Reduced Dose of Contrast Material at a High Iodine Concentration in Combination with a Saline Flush

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PURPOSE
We assessed the feasibility of reduced dose (75 mL) and higher concentration (350 mgI/mL) of contrast material in combination with a saline flush in cervical CT angiography (CTA) using a 16-detector row system.

MATERIALS & METHODS
Our study group comprised 30 consecutive patients. They were assigned to one of three protocols: group A: 75 mL of 350 mgI/mL with a saline flush (40 mL); group B: 75 mL of 350 mgI/mL without a saline flush; and group C: 100 mL of 300 mgI/mL without a saline flush. CTA was performed with the following parameters: pitch, 15; collimation, 0.5 mm; and reconstruction interval, 0.3 mm. We started scanning when the attenuation of a region of interest (ROI) placed in the aortic arch reached 130 HU. On source images, we placed a ROI in the common carotid artery (CCA) and the internal jugular vein (IJV) on both sides just below the carotid bifurcation and measured the absorption values of the ROIs. In addition, on final images, we visually evaluated the degree of demonstration of the IJV, which is unfavorable for cervical CTA, using a four-point grading system (worst, 0-best, 3).

RESULTS
Significantly higher attenuation was noted in groups A and B than in group C for the CCA (p = 0.006 and 0.039, respectively). For the IJV, the attenuation of group B was higher than that of groups A and C only on the right side (p = 0.046 and 0.005, respectively) and no difference was noted between group A and group C. Visual assessment showed no difference between the three groups.

CONCLUSION
Injection of 75 mL of 350 mgI/mL can achieve higher attenuation of the CCA irrespectively of using a saline flush. The IJV may show unfavorably high attenuation but it can be avoided by using a saline flush. Therefore, by using 75 mL of 350 mgI/mL with a saline flush, cervical CT angiograms equal to or better than those using standard dose and concentration (100 mL/300 mgI/mL) can be obtained.

KEY WORDS: CT angiography, cervical artery, contrast material

Optimal Display of Cervical Arterial CTA Data: Rotational Curved Reformatted Images versus Volume Rendering

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PURPOSE
To identify current optimal display protocols for cervical carotid and vertebral artery CTA display. Current CTA acquisitions and image display options can produce thousands of images for each study. Accurate assessment of arterial narrowing, distinction of vessel lumen from adjacent bone or wall calcification, and depiction of vascular anatomy can require more than a single display option. In this study we sought a reduced set of images required for complete analysis of cervical arterial CTA.

MATERIALS & METHODS
Cervical carotid and vertebral CTA studies of 20 consecutive patients (80 vessels total), were acquired with 0.625 mm axial sections during rapid infusion of contrast. Three sets of images were reviewed independently by two neuroradiologists: 1) acquired axial images presented as 1.25 mm images, 2) volume-rendered images of each vessel, with bone or calcification removed as necessary, and 3) rotational curved reformatted images at 3 degree intervals. Each reader evaluated each set of images independently of the others, and rated the images for artifacts, vessel anatomy, clarity of display of stenoses, and separation of bone or calcification from vessel lumen. We recorded the time required for interpretation of each image set. The patients did not undergo catheter arteriography, so no gold standard was available for comparison.

RESULTS
Both reviewers found the rotational curved reformatted images to be superior to the volume-rendered images for artifacts, stenoses and bone/vessel separation. These two were equivalent for vessel anatomy. The rotational curved reformatted images were superior to the acquired axial images for artifacts and vessel anatomy. Axial images and
rotational curved reformats were equivalent for stenoses and bone/vessel separation. Review of the axial images was the most time consuming, volume rendered and curved reformatted were equivalent.

**CONCLUSION**
Rotational curved reformatted images are superior overall to acquired axial images or volume-rendered images for display of cervical carotid and vertebral artery CTA, and less time consuming to review than the axial images. In this limited set of cases, no findings were missed on the rotational curved reformatted images that were seen on others. With further experience, the rotational curved reformatted display may be the only images required for analysis of CTA data.

**KEY WORDS:** CT arteriography

**Paper 92 Starting at 3:31 PM, Ending at 3:39 PM**

**Gender-Specific Quantification of Carotid Stenosis on CT Angiography**

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**PURPOSE**
Previous studies describing the linear relationship between millimeter carotid stenosis and derived percent stenosis by CT angiography have not accounted for the potential variability gender may create concerning carotid artery size (1). Other studies have cited at least a 10% difference in carotid size between genders (2). A rigorous reanalysis of our original data, with additional new cases to improve power, was performed to evaluate the effect of gender.

**MATERIALS & METHODS**
Two neuroradiologists separately reviewed CT angiograms of 120 carotids, blinded to other information. The narrowest portion of carotid stenosis was measured in millimeters. Distal internal carotid (ICA) was measured well beyond the carotid bulb. NASCET-style ratio was calculated for each ICA, excluding occluded and suspected near-occlusion cases. These cases were combined with previously published data, collected in the same manner, for a total of 256 carotids meeting inclusion criteria. Gender-specific ROC curves were utilized to determine the millimeter stenosis value equivalent to severe and moderate stenosis (70% and 50%, respectively), according to NASCET guidelines.

**RESULTS**
There was no change in the severe and moderate stenosis millimeter cutoff values for the male population, 1.3 mm for severe stenosis, and 2.2 mm for moderate stenosis. The ideal cutoff values for women were different. The female severe stenosis cutoff value was 1.2 mm, and the moderate stenosis cutoff value was 2.1 mm.

**CONCLUSION**
There is a minimal difference in the gender-specific cutoff values for moderate and severe carotid stenosis. At 0.1 of a millimeter, this difference is very subtle and is within the range of acceptable measurement error for any given carotid.

**REFERENCES**
2. Tartaglino LM, Hollander MD, Needleman L. CT angiography of carotid stenosis: should the NASCET criteria be different for men and women? Radiology 1997;205(P):231-232

**KEY WORDS:** Carotid stenosis, CT angiography, gender

**Paper 93 Starting at 3:39 PM, Ending at 3:47 PM**

**CT Angiography as the Only Method of Angiography in Patients with Both Clinical and Imaging Criteria of Perimesencephalic Subarachnoid Hemorrhage**

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**Purpose**
To determine if CT angiography (CTA) can be used reliably as the only method of angiography in patients presenting with classical clinical and CT imaging criteria of perimesencephalic hemorrhage to exclude underlying aneurysms.

**MATERIALS & METHODS**
A retrospective search of all CT reports referencing prepon- tine or perimesencephalic hemorrhage from June 2002 through November 2006 was performed at our institution. Images from the patients’ initial CT head exams were reviewed to confirm those patients with perimesencephalic hemorrhage by imaging criteria. For these patients, chart review was done to determine the presenting GCS and Hunt-Hess score. Finally, CTA (performed using multislice technique) and digital subtraction angiography (DSA) exams were reviewed in all patients by two neuroradiologists and one neuroradiology fellow.

**RESULTS**
Twenty-three patients were found with classic imaging find- ings of perimesencephalic hemorrhage (14 males; 9 females) on an initial CT head exam at time of presentation. The average age was 51.8 years (range 31-75 years). All patients were classified as Hunt-Hess I or II and all patients had a GCS at presentation of 15 except for one patient with a GCS of 14 (this patient had a GCS of 15 within 10 hours of presenta- tion). All CTA exams were done on the day of presentation and all initial DSA exams were done within 24 hours of the CTA. All 23 patients’ initial CTA and initial DSA were negative for aneurysms. Eleven patients received a second DSA (mean time from first DSA= 6 days) with all being negative for aneurysms as well. Eleven patients received a third imaging exam (CTA, DSA or MRA) with all being negative for aneurysm except for one DSA exam demonstrating an incidental small carotid cave aneurysm not felt to be the etiology of the patient’s initial hemorrhage.
CONCLUSION
With the appropriate clinical setting and imaging findings of perimesencephalic hemorrhage, we feel CTA can be used as the only method of angiography to exclude underlying aneurysms in this select group of patients eliminating risks of DSA as well as health care costs associated with DSA and in many cases numerous follow-up imaging exams.

KEY WORDS: Perimesencephalic, CT angiography

Paper 94 Starting at 3:47 PM, Ending at 3:55 PM
Evaluation of Cerebral Aneurysms with 16-slice Multi-detector CT: The Role of 3D MIPS

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PURPOSE
Although CT angiography (CTA) has replaced digital subtraction angiography (DSA) as the primary imaging modality for detection of cerebral aneurysms at many institutions, DSA is routinely performed at our institution, in part due to neurosurgeon preference and for better assessment of vascular anatomy. The purpose of this study is to evaluate the diagnostic accuracy of 16-slice multi-detector CT in detecting cerebral aneurysms, particularly those 3 mm or less in size, and to elucidate the role of 3D thin slab MIP (maximum intensity projections) reconstructions in improving aneurysm detection.

MATERIALS & METHODS
The investigator selected 30 patients from a database of patients who underwent evaluation for non-traumatic subarachnoid hemorrhage with both CTA and DSA, with particular focus on aneurysms less than or equal to 3 mm in size. CTA studies were reviewed by two blinded neuroradiologists who interpreted the axial source images alone, followed by axial source images plus thin-slab MIPs in the axial, coronal, and sagittal planes. The location, dome width, neck width, parent vessel involvement, and presence of vessels close to or originating from the aneurysm sac were recorded for each aneurysm. Similar data was recorded by a blinded neuroradiologist who interpreted the axial source images alone, followed by axial source images plus MIPs. On a per patient basis, sensitivity and specificity were 86% and 89% for both source images alone and source axial images plus MIPs. There was no significant difference in overall sensitivity and specificity with the addition of MIPs. Missed aneurysms ranged from 1.5-3 mm in size, with average dome size of 2.1 mm.

CONCLUSION
The sensitivity of CTA for aneurysm detection is less than that for DSA, particularly for aneurysms less than or equal to 3 mm in size. In this study, the addition of 3D thin slab MIP reconstructions did not significantly change the ability of CTA to detect smaller aneurysms, perhaps due to the limited study size and small nature of the aneurysms.

KEY WORDS: aneurysm, CTA, DSA

Paper 95 Starting at 3:55 PM, Ending at 4:03 PM
Neuroradiologic Manifestations of Loeys-Dietz Syndrome

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PURPOSE
Loeys-Dietz syndrome (LDS) is a recently described clinical syndrome characterized by the triad of arterial tortuosity and aneurysms, hypertelorism and bifid uvula or cleft palate and is caused by heterozygous mutations in the genes encoding transforming growth factor B receptor 1 and 2 (TGFBR1 and TGFBR2 respectively). We describe the various neurologic manifestations including intracranial and extracranial arterial dissections, arterial tortuosity, aneurysms, spinal scoliosis, Chiari malformations, spinal instability and the various craniofacial anomalies.

MATERIALS & METHODS
We retrospectively reviewed 26 patients ranging from 4 years to 49 years of age, 23 of whom had positive genetic testing, the remaining three patients had strong clinical features and were being worked up for LDS. The study was approved by the Institutional Review Board. The craniofacial severity index was used to determine the severity of symptoms of LDS. Scores ranged from 0 to 11 based on the severity of hypertelorism, bifid uvula, cleft palate and craniosynostosis. We also reviewed the CTA, MR imaging and plain films in these patients to look for various neurologic manifestations.

RESULTS
Of the 26 patients, 20 had hypertelorism (10 marked and 10 subtle), 18 had an abnormal uvula (11 bifid, 3 with midline raphe and 4 broad), seven had a cleft palate, 11 had blue sclera, 10 had micrognathia, 11 had retroglothonia, 14 had malar hypoplasia, one exotropia, five developmental delay, six headaches, four lefthguy, 18 high-arched palate none had ectopia lentis, which is typically associated with Marfan’s syndrome. Craniofacial severity index ranged from 0 (3 patients) to 11 (1 patient). All patients had extreme arterial tortuosity which is characteristic of this syndrome, five had dissections with pseudoaneurysms, five had intracranial aneurysms, one patient had a middle cerebral artery territory
infarct as a complication of dissection. Twelve patients had scoliosis, three patients had a Chiari malformation, three had spinal instability and three had craniosynostosis.

**CONCLUSION**

There were widespread neurologic manifestations in patients with LDS, all of whom had arterial tortuosity and five each had dissections and intracranial aneurysms. Most of the patients in this series were young and therefore required serial CTA monitoring for development of intra and extracranial dissections and aneurysms. Twelve patients had scoliosis and three each had craniosynostosis, a Chiari malformation and spinal instability. The risks of vascular dissections or aneurysms increased as the age of the patient increased.

**KEY WORDS:** Loeys-Dietz syndrome, dissections, pseudoaneurysm

**Paper 96 Starting at 4:03 PM, Ending at 4:11 PM**

**Condylar Jugular Diverticulum**

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**PURPOSE**

We present three cases of jugular bulb diverticula extending into the occipital condyle, a previously unreported variant.

**MATERIALS & METHODS**

This vascular variant was detected as an incidental imaging finding in three patients who were scanned for unrelated reasons. CT was performed in all three cases and time of flight MR venography was performed in two of three cases. One patient had a cine phase-contrast MR venogram.

**RESULTS**

Head CT demonstrated a well defined corticated defect in the occipital condyle that was contiguous with the jugular bulb on CT and MR venography showed vascular flow within the diverticulum. One patient underwent a phase-contrast MR venogram which showed pulsatile turbulent flow in the diverticulum. The diverticulum was unilateral in all three cases, and was on the side of a dominant transverse-sigmoid sinus in two of the three cases.

**CONCLUSION**

Despite an extensive search of the English language literature, we were unable to find a previous report describing this anatomical variation. Recognition of this variant will help to avoid potential confusion with pathologic lesions in the occipital condyle.
REFERENCES

KEY WORDS: Jugular, diverticulum, condyle

Paper 97 Starting at 4:11 PM, Ending at 4:19 PM
Flow Quantification of the Carotid and Vertebral Arteries in a Symptomatic Cohort: Initial Results at 3T
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PURPOSE
To assess the feasibility and accuracy of carotid and vertebral artery phase contrast flow quantification in symptomatic patients at 3T MR angiography (MRA).

MATERIALS & METHODS
Forty adult patients (22 females and 18 males, mean age = 62.6 years, age range = 31-81) with clinically suspected supra-aortic vascular stenosis and referred for contrast-enhanced MRA were prospectively enrolled in this study and scanned using a 3T MR system (Magnetom Trio, Siemens Medical Solutions). Flow quantitative analysis was performed at two preassigned levels in each patient, with interrogation of the common carotid and vertebral arteries 2 cm below the carotid bifurcation, and of the internal carotid and basilar arteries at the petrous level. All acquired data then were analyzed by a single experienced researcher using Argus flow analysis software (Siemens Medical Solution). Average velocity (cm/sec), peak velocity (cm/sec), average flow (ml/sec) and average flow per minute (L/min) were calculated at each level in each subject, yielding a total number of 280 quantitatively assessed segments. Data thus acquired were analyzed by a single experienced researcher using Argus flow analysis software (Siemens Medical Solution). Average velocity (cm/sec), peak velocity (cm/sec), average flow (ml/sec) and average flow per minute (L/min) were calculated at each level in each subject, yielding a total number of 280 quantitatively assessed segments. Data thus acquired were potentially valuable tool in the assessment of cerebral blood flow and determination of the significance of focal vascular stenoses, when detected at CE MRA.

RESULTS
Mean common carotid velocity in this patient population was determined to be 13.79 ± 5.03 cm/sec, vertebral arterial velocity 7.06 ± 4.37 cm/sec, internal carotid velocity 12.74 ± 5.93, and basilar artery 11.77 ± 10.07. Mean peak velocities at the same levels were 64.76 ± 18.89, 42.39 ± 22.75, 62.39 ± 17.80, and 56.25 ± 17.85 respectively. Mean flow and flow per minute calculations were 7.11 ± 1.64, 1.96 ± 1.06, 4.81 ± 1.78, 3.22 ± 1.31 and 0.43 ± 0.12, 0.14 ± 0.16, 0.27 ± 0.11, 0.27 ± 0.45 respectively. Of the population included in this study, five patients were found to have significant supra-aortic branch vessel stenosis/occlusion. Corresponding flow quantitative measurements in these patients were observed to closely reflect the significance of luminal stenosis in the affected vessels. These individual instances of significant variation of velocity and flow measurements from the means are discussed, with provision of correlating CE MRA images and relevant explanations for these findings, where available.

CONCLUSION
Phase-contrast flow quantification of the supra-aortic arterial vasculature at 3T represents a potentially valuable tool in the assessment of cerebral blood flow and determination of the significance of focal vascular stenoses, when detected at CE MRA.

KEY WORDS: Flow quantification, Cerebral blood flow, MRA imaging

Paper 98 Starting at 4:19 PM, Ending at 4:37 PM
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PURPOSE
Time-resolved (TR) MRA of the carotid arteries has been described utilizing parallel imaging or view-sharing techniques. It is a noninvasive technique that offers the combined advantage of anatomical and hemodynamic flow information of the cervical vessels. The purpose of this study is to evaluate TR MRA of the extracranial carotid and vertebral vessels with a combination of parallel imaging (GRAPPA) and TWIST, a new view-sharing technique that undersamples the periphery k-space depending on radial distance from the center of k-space (Siemens, Germany). The TWIST sequence is compared to currently used 3D contrast-enhanced bolus chase (BC) MRA and 3D time of flight (TOF) MRA.

MATERIALS & METHODS
Prior to contrast administration, 3D time of flight images of the extracranial carotid arteries was performed (TR=25, TE=7.2, SL=0.9 mm, 448x320 matrix, FOV=230x230, temporal resolution=167s). This was followed by 3D TR MRA using TWIST performed with an acceleration factor of 2 on a 1.5T system (TR=3.3, TE=1.3, SL=1.2 mm, 320x256 matrix, FOV=375x294, temporal resolution=3.9s) (Avanto, Siemens Medical Solutions). A bolus of 6 ml of Gd-DTPA was administered at 2 ml/s followed by a 15 ml saline flush, with nine sequential acquisitions, using the first acquisition as a mask. Lastly, 3D BC MRA was performed with a bolus of 14 ml of Gd-DTPA at 2 ml/s followed by a 20 ml saline flush, with 3 acquisitions, a mask, an arterial and a venous phase image (TR=3.6, TE=1.4, SL=1 mm, 512x320, FOV=375x294, temporal resolution=18s). Six subjects (12 sets of carotid arteries) with different pathologies underwent the protocol: stroke/TIA (n=3), demyelinating disease (n=1), ascending aortic aneurysm (n=1), and a normal subject. Two observers rated the images for confidence in interpretation on a 3-point scale, pathology, particularly ICA stenosis at the carotid bulb, plaque morphology, and artifacts. The reference standard for ICA stenosis was a consensus reading of all three sequences, and angiographic correlation, where available.
able. The TR sequence was also assessed for the number of frames in which contrast was present at the carotid bifurcation before venous opacification. A single observer performed SNR and CNR estimates.

**RESULTS**

TR MRA yielded isotropic data sets with distinct arterial and venous phases. Two severe (70-99%) and one mild (1-29%) cervical ICA stenoses, and one vertebral artery stenosis were demonstrated using the reference standard, all of which were diagnosed at TR MRA. TOF MRA had highest SNR and CNR, followed by BC MRA, and then TR MRA, although this did not affect diagnostic confidence of TR MRA, which was rated satisfactory to excellent in all cases. TOF MRA was subject to greatest artifact (wrap, n=3; motion, n=2; flow artifact, n=2).

**CONCLUSION**

TR MRA using the TWIST sequence and parallel imaging is feasible at 1.5T, and provides sufficient temporal resolution to assess anatomy and flow characteristics of the extracranial carotid circulation, complementing traditional TOF and BC techniques. With the increased signal to noise ratio offered at 3T and with newer gadolinium-based contrast agents, further improvements in temporal and spatial resolution are possible in the future.

**KEY WORDS:** Carotid, MR angiography, time-resolved

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**RESULTS**

Intracranial 3D TOF MRA obtained at 7T demonstrated improved image quality compared with 3T in most regions, except at the skull base where susceptibility artifacts were stronger at the higher field. Small caliber cortical arteries (e.g., M4 branches) and deep perforators (e.g., lenticulostriate arteries) were visualized more reliably at 7T than at 3T. Luminal contour was subjectively smoother at 7T than 3T, and arteries could be traced more distally along their course. Moreover, TOF angiography at 7T resulted in an average 83% increase of CNR throughout the intracranial vasculature compared to 3T (range: +33% to +134%).

**CONCLUSION**

Intracranial 3D TOF MRA at 7T is feasible and offers an average 83% increase in CNR over 3T, as well as subjectively better delineation of small arteries. This may improve the noninvasive diagnostic evaluation of cerebrovascular disorders such as vasculitis, atherosclerosis, vasospasm, and small aneurysms.

**KEY WORDS:** MR angiography, 7T

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**PAPER 99 Starting at 4:27 PM, Ending at 4:35 PM**

**7T Intracranial 3D Time-of-Flight MR Angiography: Improved Contrast-to-Noise Ratio and Vessel Delineation Compared to 3T**

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**PURPOSE**

Increases in main 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, and help account for the superiority of 3T MRA over that of 1.5T. The goal of this study was to demonstrate the feasibility of intracranial 3D TOF MRA at 7T and to investigate performance improvements in CNR compared to 3T.

**MATERIALS & METHODS**

Five healthy adult volunteers were scanned using identical acquisition parameters at both field strengths, taken from a standard clinical protocol for intracranial 3T TOF MRA at our institution (matrix 384 x 224 x 120, FOV = 24 cm x 16 cm x 12 cm, TE = 2.5 ms, TR = 20 ms, flip = 15 degrees, readout BW = 32kHz, acquisition time 7 minutes). The acquisition was divided into five slabs of 24 1.0 mm thick partitions each (6 overlapping partitions for consecutive slabs), employing the multiple overlapping thin slab acquisition (MOTSA) technique. In addition, CNR measurements for major arterial segments were obtained directly from the source images.

**Fig. Representative 7T (top) and 3T (bottom) TOF MRA MIPs at level of basal ganglia from healthy young adult volunteer. Note that (1) lenticulostriates are visualized readily (small arrows), (2) small caliber cortical branches have higher signal (large arrows), and (3) better suppression of background tissue with 7T acquisition.**
Developmental venous anomalies (DVA) can be associated with adjacent brain parenchymal alterations detected by MR imaging including cavernous malformations (CM) and signal abnormalities. The association of DVA and CM has been well documented; however, the occurrence of brain parenchymal signal changes adjacent to DVA in the absence of CM has been incompletely assessed. We performed this study to evaluate the prevalence of brain parenchymal MR signal abnormalities adjacent to DVA, correlating with DVA morphology and location.

Materials & Methods
Between July 2005 and July 2006, brain MR imaging with contrast reports were searched for the terms “developmental venous anomaly” or “venous angioma.” This resulted in 214 cases of interest for defining prognosis and stratifying patients to specific treatment regimens. Prior studies have reported that noninvasive methods for evaluating the subtype of low-grade gliomas (OD) and astrocytomas (AC) are of interest for defining prognosis and stratifying patients to specific treatment regimens. Prior studies have reported that an apparent diffusion coefficient (ADC) histogram analysis may aid in this process. The goal of this study was to retrospectively analyze the ADC and fractional anisotropy (FA) for oligodendrogliomas and astrocytomas.

Results
One hundred seventy-four DVA were identified in 162 patients. Twenty-seven DVA were identified with associated signal abnormality in the DVA drainage territory. Six of 27 DVA had associated signal abnormality. No statistically significant correlation with drainage type, location, or size of draining vein was noted (p > 0.05), although associated signal was more common with DVA with deep periventricular location and drainage pattern. In 6/174 DVA (3.4%) there was an associated CM, two of which also had abnormal adjacent signal. In two DVA cases there was associated parenchymal enhancement without abnormal signal, both with associated CM. Only one patient without a CM had abnormal susceptibility effects on GRE imaging adjacent to the DVA.

Conclusion
Signal changes in the drainage territory of DVA are not uncommon, occurring in 12.5% of our consecutive series.
included postgadolinium T1-weighted images, T2-weighted images, and a three or six directional diffusion-imaging sequence (b = 1000). Diffusion-weighted images were analyzed using in-house software to calculate the ADC and the FA (for data acquired with 6 directional encoding). The maps were normalized by values from normal-appearing white matter (NAWM) to generate maps of nADC and nFA. The T2 hyperintense region (T2All) was defined from the T2-weighted image. A Mann-Whitney rank-sum test was performed on the median ADC, nADC, FA and nFA values for oligodendroglioma and astrocytoma subpopulations.

**RESULTS**

Three and six directional data sets were analyzed together with respect to the ADC data, since a Wilcoxon signed-rank test showed no significant difference for the median values. The median ADC and FA values for NAWM and T2ALL regions are shown in Table 1.

<table>
<thead>
<tr>
<th>Low Grade Subtype</th>
<th>ADC</th>
<th>nADC</th>
<th>FA</th>
<th>nFA</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>NAWM</td>
<td>T2ALL</td>
<td>NAWM</td>
<td>T2ALL</td>
</tr>
<tr>
<td>Oligodendroglioma</td>
<td>760±147</td>
<td>1181±265</td>
<td>1.57±0.34</td>
<td>436±136</td>
</tr>
<tr>
<td>Astrocytoma</td>
<td>767±122</td>
<td>1476±281</td>
<td>1.97±0.36</td>
<td>369±128</td>
</tr>
</tbody>
</table>

p-value 0.0523 0.00004* 0.00003* 0.751 0.0165** 0.004*<br>

The median nADC was significantly smaller and the median nFA was larger for patients with oligodendrogliomas compared to the median nADC and nFA for astrocytomas (Table 1). Plotting nFA vs nADC for the two populations shows a more distinct separation than considering nADC or nFA separately (Fig 1).

**CONCLUSION**

A previous study suggested a trend towards significant differences in ADC histogram analysis for newly diagnosed low-grade oligodendroglioma and astrocytoma subtypes. Our study suggests a significant difference not only in nADC, but also in nFA values. A combination of nADC and nFA values that are obtained from diffusion tensor images may be valuable for defining a noninvasive biomarker that can be used to predict the histologic subtype of low-grade gliomas.

**KEY WORDS:** Low-grade brain tumors, apparent diffusion coefficient, fractional anisotropy
Mild traumatic brain injury (TBI) is an important public health issue. Despite the relatively low mechanical impact of injury and lack of clinical deficits at the time of injury, 15%-30% of patients will develop long-term cognitive impairment. Conventional CT or MR imaging, if performed at all, is commonly normal. Diffusion tensor imaging (DTI) is a sensitive means of assessing white matter integrity, with studies demonstrating multifocal decreased FA in white matter, predominantly in moderate to severe TBI. A previous report from our laboratory demonstrated that DTI could identify subjects with chronic cognitive impairment following mild TBI. The pattern of white matter injury was similar to that seen in diffuse axonal injury (DAI). The present study aims to determine if DTI can detect white matter abnormalities at the time of injury, before cognitive impairment develops.

**Materials & Methods**

As part of an ongoing study, eight patients were recruited from the emergency department and studied within 2 weeks of very mild head trauma. Inclusion criteria included documented head injury with no loss of consciousness or neurologic deficit and normal CT scan of the brain. Patients with history of neurologic or psychiatric disorders, substance abuse or prior head injury were excluded. Eight age- and gender-matched controls were recruited for comparison. DTI was performed at 3.0T using 25 diffusion sensitizing directions and $b=1000$. GRE and T2-weighted TSE images were also acquired. FA and ADC images were registered to the MNI template using a multistep procedure. Voxel-wise partial correlation analysis was performed. Clusters with $p < 0.001$ and size $> 100$ contiguous voxels were considered significant.

**Results**

No evidence of hemorrhage or signal abnormality was present on GRE and TSE images. Multiple areas of decreased FA are present in the head injury group involving subcortical white matter of the cerebral hemispheres. No regions of elevated FA or decreased ADC were found in the subject group.

**Conclusion**

Multifocal decreased FA is present in the subcortical white matter following very mild head injury. These findings support the presence of structural white matter injury due to very mild trauma. Prospective evaluation of the relationship between the white matter abnormalities and development of cognitive disability is underway.

**Key Words:** Diffusion tensor imaging, traumatic brain injury

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**Paper 104 Starting at 3:39 PM, Ending at 3:47 PM**

**Diffusion Tensor and High Angular Resolution Diffusion Imaging of the Brain**


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**Purpose**

Diffusion tensor imaging (DTI) is widely used for depicting white matter connectivity of the human brain in scientific and clinical applications. Newer high angular resolution diffusion imaging (HARDI) techniques, such as $q$-ball imaging (QBI), enable better visualization of complex white matter architecture. However, these advanced diffusion imaging methods are SNR-limited and could benefit from the greater signal available at higher magnetic field strengths. In this project, we demonstrate the feasibility of in vivo 7T DTI and QBI of the human brain and show improved signal-to-noise ratio (SNR) compared to 3T.

**Materials & Methods**

Three normal adult volunteers and six brain tumor patient volunteers were imaged using a 7T GE MR scanner (GE Healthcare, Waukesha, WI) equipped with a 30cm volume excite coil and 8-channel phased array receiver (Nova Medical, Wilmington, MA). Brain tumor patients and two volunteers also had a 3T clinical MR exam on the same day.
Single-shot spin-echo echo-planar (EPI) axial diffusion-weighted images were acquired over the supratentorial brain with 2mm voxels (25.6cm FOV, 128x128 matrix, 2mm slices with no gap) using 6 directions for DTI and 131 directions for HARDI, b-values 1000 for DTI and 3000 s/mm² for HARDI, and ASSET parallel imaging with reduction factor of 2. Higher order shimming was performed prior to the acquisition (1). Tensor analysis was performed in DTI_Studio (2) and the q-ball orientation distribution function (ODF) was reconstructed at each voxel using spherical harmonic basis functions (3).

RESULTS
The SNR at 7T was 70-80% greater than 3T at b=3000 s/mm² in the right centrum semiovale of two volunteers. The reformatted coronal color FA image from 7T DTI (Fig. bottom) shows minimal distortion with excellent depiction of the major fiber bundles. The ODF voxel array (Fig. top) from the yellow-boxed inset of the color FA image demonstrates multiple fiber crossings of association (SLF), projection (CS), and commissural (CC) white matter pathways. The background grayscale intensity in each voxel portrays generalized fractional anisotropy (GFA).

CONCLUSION
In this study, we have successfully demonstrated DTI and QBI in vivo at 7T using a specialized sequence. The 70-80% greater SNR available at 7T over 3T can be utilized for finer spatial resolution and/or higher angular resolution with stronger diffusion-weighting factors.

REFERENCES
1. Hammond K et al. ISMRM 2006;p2352

KEY WORDS: Diffusion tensor imaging, high angular resolution diffusion imaging, 7T

Acknowledgment: NIH RO1NS40117, LSIT01-10107 and ITL-BIO04-10148.

Paper 105 Starting at 3:47 PM, Ending at 3:55 PM
Optimization of Fractional Anisotropy and Seed Voxel Size for Diffusion Tensor Tractography of the Corticospinal Tract
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University of Pennsylvania Philadelphia, PA

PURPOSE
In order to optimize the visualization of the corticospinal tract (CST) with diffusion tensor tractography, we set out to find the fractional anisotropy (FA) threshold to maximize both relative fiber density and lines drawn through the CST. Additionally, we also set out to determine the optimal seed region of interest (ROI) voxel size for the CST in the cerebral peduncle to maximize lines drawn through both seed and target ROIs (true CST) while minimizing extraneous fibers.

MATERIALS & METHODS
Thirteen patients with brain tumors and one patient without tumors were studied; only nonaffected sides in patients without mass effect or compression were studied. We performed 3D diffusion tensor tractography (3D DTT) of the CST with diffusion tensor MR imaging. The CST was reconstructed using Volume-one software. We used a 2 ROI method to map the CST (seed in the cerebral peduncle; target in the precentral gyrus). In the first study, the seed size was fixed at 70 voxels and the target was fixed at 600 voxels; the FA value was systematically varied at 0.05 increments from 0.05 to 0.40 and the relative fiber density, measured as lines drawn/lines tracked, and lines drawn through both seed and target were measured. In the second study, the target voxel size within the precentral gyrus was fixed at 600 and FA value fixed at 0.25; the seed voxel size was systematically varied in increments of 10 from voxel size 20 to 70. The lines drawn through both the seed and target (true CST fibers) were measured and normalized by seed voxel size; additionally, the lines drawn through the seed but not through the target (extraneous fibers) also were measured and normalized by seed voxel size.

RESULTS
In the first analysis, 3D DTT allowed us to systematically vary the FA and measure lines drawn and relative fiber density of the CST at each value. For the measure of lines drawn, an FA value of 0.2 provided the highest average result of 189.1. For the measure of relative fiber density, and FA value of 0.25 provided the highest average result of 0.35. In the second analysis, the “true CST fibers” per seed voxel increased greatly from 2.9 at 70 voxels to 3.8 at a smaller seed size of 30 voxels and held relatively constant at 20 voxels. “Extraneous fibers” per seed voxel decreased dramatically from 4.4 at 70 voxels to 3.7 at 40 voxels (and remained relatively constant at 30 and 20 voxels).

CONCLUSION
An FA value of 0.2 to 0.25 is the optimal value for CST 3D DTT fiber tracking. A seed size of 30 voxels in the cerebral peduncle maximizes the “true CST fiber” values while minimizing “extraneous fiber” values.

KEY WORDS: Tractography, fractional anisotropy, seed voxel size, optimization
**Diffusion Tensor Imaging of Meyer’s Loop**

White, M. L. · Zhang, Y. · Hahn, F. J.
University of Nebraska
Omaha, NE

**Purpose**
The surgical approaches to the anterior temporal lobe may result in visual field defects due to the potential damage to the anterior bundle of the optic radiations - Meyer’s loop. The virtual dissection of the Meyer’s loop by preoperative diffusion tensor imaging (DTI) should be useful in minimizing the risk. However, it has been reported that DTI is limited in its ability to depict the most anterior portion of Meyer’s loop. To reconfirm the clinical applicability of DTI, we visualized Meyer’s loop by using DTI at 3T and quantitatively compared our results with published anatomical fiber dissection studies.

**Materials & Methods**
Ten healthy subjects without any history of neurologic disorders were included in this study. The images all were obtained with a HDx GE 3.0T MRI unit. Twenty-five directions of water-motion encoding were acquired in the axial plane. A single-shot echo-planar technique was used with TR = 6000-10000 ms, TE = minimum (79-98 ms), B-value = 1000, 128 x 128 or 256 x 256 matrix, 22 x 22 cm field of view, 3 mm slice thickness, 0 or 0.5 mm slice gap, acceleration factor = 2. The GE Functool ADW 3.1.23 workstation was utilized to process the DTI data.

**Results**
The Meyer’s loops were depicted clearly in all 10 subjects. The distance between anterior tip of the temporal lobe to Meyer’s loop was 27.1 to 32.8 mm (average ± SD, 29.1 ± 1.9). The anterior edge of the loop could be anterior or posterior to the tip of the temporal horn. The distance between Meyer’s loop and the tip of the temporal horn was -2.9 to 4 mm (average ± SD, 1.38 ± 1.9). Different from previously reported DTI data of Meyer’s loop, all measurements in this study were in good agreement with published data derived from Klingler’s fiber-dissection technique.

**Conclusion**
DTI fiber tracking at 3T appears to be a promising technique for the virtual dissection of Meyer’s loop with findings consistent with anatomical fiber dissection studies. DTI analysis of Meyer’s loop may be useful for evaluating visual field defects or preoperative planning.

**Key Words:** Meyer’s loop, diffusion tensor imaging

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**Evaluation of White Matter Abnormalities in Alzheimer Disease Using Diffusion Tensor Imaging: Analysis with Statistical Parametric Mapping**

Jeong, K. · Kim, S. · Choi, C. · Kim, N. · Lee, J.
Asan Medical Center
Seoul, REPUBLIC OF KOREA

**Purpose**
Voxel-based morphometry (VBM) has been used for morphologic comparison in several neurodegenerative diseases. However, there are few studies applying VBM in the evaluation of white matter changes in Alzheimer disease (AD). Our purpose is to evaluate white matter abnormality on diffusion tensor MR imaging in AD using statistical parametric mapping (SPM).

**Materials & Methods**
Diffusion tensor imaging was performed in 24 patients (mean age: 71 years, range: 58-85 years, M:F = 5:19) of clinically diagnosed AD and in 10 normal age-matched volunteers for comparison. Patients with large area of infarction were excluded. Fractional anisotropy (FA) maps were generated using house-developed software and were processed with SPM2 to make voxel-based comparison of anisotropy between the AD and control groups. For validation of the results from voxel-based analysis, fractional anisotropic value was measured on the FA map of each patient by placing region-of-interest in multiple areas of the brain in both groups and evaluated the differences between the two groups in each area.

**Results**
Significant reduction in fractional anisotropy was identified in the genu and splenium of the corpus callosum, cingulum and both medial temporal lobes in AD group on voxel-based analysis. There were scattered foci of decreased anisotropy in both frontal and temporal lobes. The results of ROI measurement of anisotropy showed significant difference in the above areas between the AD and control groups.

**Conclusion**
Voxel-based comparison of FA value revealed multifocal areas of white matter lesions in AD compared to the control group. Voxel-based analysis appears to be useful to identify white matter lesions in AD patients.

**Key Words:** Alzheimer disease, diffusion tensor imaging, voxel-based morphometry

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**Correlation between Maximal Relative Cerebral Blood Volume Ratio and Ki-67 Labeling Index in Primary High-Grade Gliomas of the Brain**

Kathuria, S. · Mangla, R. · Ekholm, S. · Westesson, P.
University of Rochester Medical Center
Rochester, NY

**Purpose**
The clinical relevance of MR perfusion needs further clarification as to its usefulness and limitations. The purpose of
this study is to investigate correlation between tumor cerebral blood volume, as measured by semiquantitative method using dynamic susceptibility contrast (DSC) MR perfusion technique, and Ki-67 labeling index in gliomas.

**MATERIALS & METHODS**

Twenty-five consecutive patients with histopathologic diagnosis of WHO grade III and IV primary gliomas with preoperative perfusion scan at our institution were included in the preliminary study. All MR imaging in these cases was performed with a 1.5 T GE Sigma MR system (General Electric Medical Systems, Milwaukie, WI). A series of 60 T2*-weighted gradient-echo echo-planar images were obtained during the first pass of a bolus of gadolinium-based contrast at a dose of 0.2 mmol per kilogram of body weight. Twelve axial section levels were chosen for imaging, based on lesion extent as determined by the precontrast FLAIR images. Raw perfusion-weighted MR data were processed offline on LUPE: the Lund perfusion program. Arterial input function (AIF) was chosen on the ipsilateral MCA artery among the various AIF suggested by the software. Implementation of a correction algorithm for T1 effects from blood-brain barrier leakage as described in Haselhorst et al. was applied in all the cases. The relative cerebral blood volume (rCBV) measurements were obtained from the perfusion-weighted MR data. Maximal rCBV (region of interest placement) measurements were obtained by identifying regions of maximal perfusion from color maps. The measurements were related to the rCBV of normal-appearing white matter and tumor/white matter ratios were calculated.

**RESULTS**

We have found a good linear correlation between the maximal rCBV ratios in primary brain astrocytomas and the Ki-67 labeling index of these tumors (r = .64). The maximal rCBV ratios in these tumors range from 0.54 to 5.88, with Ki-67 values ranging from 2% to 55%. We are in process of analyzing more cases and would like to present the final results during the meeting.

**CONCLUSION**

The maximal rCBV ratio measured using dynamic susceptibility contrast (DSC) MR perfusion technique in high-grade brain gliomas is a reliable predictor of proliferative activity of these tumors and thus can be useful in predicting tumor prognosis.

**KEY WORDS:** Perfusion MR imaging, neoplasm, Ki-67

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**Paper 109 Starting at 4:19 PM, Ending at 4:27 PM**

**MR Perfusion Techniques in the Evaluation of Fibromyalgia Patients: A Prospective Study**

Foerster, B. R. · Petrou, M. · Clauw, D. J. · Chenevert, T. L. · Hoeffner, E. G. · Sundgren, P. C.

University of Michigan
Ann Arbor, MI

**PURPOSE**

Fibromyalgia (FM) is a chronic pain condition affecting approximately 3% of the population and is thought to be due to augmented central nervous system (CNS) processing of pain. The aim of this study was to determine if there are significant differences in regional cerebral perfusion in fibromyalgia patients compared to normal healthy controls. Gray and white matter regions implicated in pain processing were examined using MR perfusion techniques.

**MATERIALS & METHODS**

Twenty-six FM patients and 21 age-matched control subjects were studied with pre and postcontrast-enhanced conventional brain MR imaging on a 1.5T magnet as well as a perfusion sequence (TE/TR = 60/2000). All subjects underwent similar baseline procedures, including self-report questionnaires, standard labs, and pain pressure testing. Postprocessing of perfusion data was done at an Advantage Windows workstation equipped with the Func-tool software (GE Medical Systems). Sixteen circular ROIs, 100 mm² in size, were placed in selected bilateral gray and white matter structures including: thalami, basal ganglia, caudate, insula, dorsal lateral prefrontal subcortical white matter, frontal white matter and parietal white matter. The mean time to enhance (MTE) and negative enhancement integral (NEI) for each region then was obtained. Parietal white matter was used as a perfusion baseline to calculate ratios for each measured region. Student’s t-test was used for statistical analysis. Results were considered significant at p < 0.05.

**RESULTS**

Relative NEI values were significantly lower in the right thalamus (p = 0.016) and significantly higher in the right dorsal lateral prefrontal subcortical white matter (p = 0.018) for FM patients compared to healthy controls. A trend towards lower NEI values in the left thalamus was also seen (p = 0.059). There were no significant differences in the relative MTE values for each region.

**CONCLUSION**

NEI as measured by MR perfusion techniques may be helpful in assessing patients with FM. The lower right thalamic NEI values in FM patients compared to healthy control subjects suggest that perfusion is decreased in this region which is in accord to previously reported SPECT and PET data. The increased NEI values in the right dorsal lateral prefrontal subcortical white matter is of particular interest as our previously reported data have shown significant spectroscopy changes in this region.

**KEY WORDS:** MR perfusion, Fibromyalgia

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**Paper 110 Starting at 4:27 PM, Ending at 4:35 PM**

**Withdrawn**

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**Paper 111 Starting at 4:35 PM, Ending at 4:43 PM**

**Hippocampus Restricted Single Voxel Spectroscopy in Temporal Lobe Epilepsy: A 3T MR Study with EEG and FDG-PET Correlation**

Jissendi Tchofo, P. · Baudry, S. · Leroux, D. · Detiege, X. · Goldman, S. · David, P. · Baleriaux, D.

Hôpital Erasme
Brussels, BELGIUM

**PURPOSE**

The aim of this study is to lateralize the epileptogenic focus in temporal lobe epilepsy (TLE) by using hippocampus
restricted single voxel spectroscopy (HRSVS) at short-echo time and, secondly to correlate the results with EEG and FDG-PET lateralization of the focus.

**MATERIALS & METHODS**

Eleven patients with TLE underwent a brain MR spectroscopy (MRS) at 3T (ACHIEVA, Philips) and a FDG-PET scan. Six healthy volunteers underwent MRS with same protocol. MRS was performed using a single voxel (TE/TR/Exc: 31/2000/144) with a volume of interest (VOI) including selectively the hippocampus. The NAA/Cr ratio was quantified and considered in the asymmetry index (AI) calculation. The patients were classified according to the MRI grade of hippocampal abnormalities, from normal appearance (0) to obvious mesial temporal sclerosis (MTS) (4). The concordance between MRS, EEG and FDG-PET scan was evaluated.

**RESULTS**

The AI integrating the NAA/Cr ratio showed significant difference between ipsilateral and contralateral sides, compared to the control group (p = 0.001). Based on the AI, epileptogenic hippocampus was lateralized correctly in nine of 11 patients (81.8%). The concordance with EEG and FDG-PET scan was 100% in lateralized patients. In two patients the NAA/Cr ratio was not different enough between both sides to lateralize. There was no evident correlation between the AI and the degree of hippocampus involvement. In seven patients (63.6%) with subtle signs of MTS, HRSVS showed a correct lateralization.

**CONCLUSION**

These preliminary results show that HRSVS at 3T is potentially accurate as well as previously tested and published MR spectroscopy protocols in lateralization of epileptogenic focus in TLE. Including more cases will validate our protocol.

**KEY WORDS:** Spectroscopy, epilepsy, mesio-temporal sclerosis

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**Monday Afternoon**

4:45 PM – 6:15 PM

**Grand Ballroom A**

(13) Temporal Bone — Advanced Anatomy, Imaging of Inflammatory Disease and Post-Treatment Evaluation (ASHNR)

(14) Temporal Bone Anatomy — The Advanced Course

— John I. Lane, MD

(15) Inflammatory Disease of the Temporal Bone

— Joel D. Swartz, MD

(16) Imaging the Temporal Bone Following Surgery

— Timothy L. Larson, MD

Moderator: Timothy L. Larson, MD

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**Monday Afternoon**

3:15 PM – 4:45 PM

Columbus G

(12) ELC Workshop B: Advanced PowerPoint

— H. Christian Davidson, MD

— Adam E. Flanders, MD

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**Temporal Bone Anatomy — The Advanced Course**

*John I. Lane, MD*

**LEARNING OBJECTIVES**

Upon completion of this presentation, participants will be able to:

1) Analyze and understand pertinent clinical anatomy of the Temporal Bone using Ex Vivo CT and MR microscopy techniques.

2) Review recent advances in CT and MR Imaging of the Temporal Bone as they relate to clinical otology and neurology.

**PRESENTATION SUMMARY**

Most radiology training programs teach temporal bone anatomy using images acquired from clinical scanners that currently achieve at best a resolution on the order of 400 um.3. Clinical trainees in otolaryngology are required to perform a number of cadaver temporal bone dissections under the operating microscope and to review micromed histology preparations in order to familiarize themselves with this complex anatomy. This presentation will focus on the utility of imaging microscopy (CT and MR) in producing images of the temporal bone in the 20–80 micron range. This approach can enhance the head and neck radiologists’s understanding of temporal bone anatomy and assist in advancing our abili-
ty to diagnose otologic disease using imaging techniques that continue to achieve progressively higher degrees of spatial resolution. The second part of this presentation will focus on recent imaging advances in clinical imaging with the advent of 64-slice MDCT and the wider availability of clinical 3T MR scanners. The discussion will emphasize volumetric data acquisition and postprocessing techniques. The utility of these techniques in demonstrating otologic disease will be reviewed.

Inflammatory Disease of the Temporal Bone

Joel D. Swartz, MD

LEARNING OBJECTIVES
Upon completion of this presentation, participants will be able to:
1) Differentiate inflammatory from neoplastic disease.
2) Illustrate the use of MRI in middle ear inflammatory disease.
3) Recognize the complications of Acute Otomastoiditis.
4) Recognize the complications of Chronic Otomastoiditis.

PRESENTATION SUMMARY
Acute otomastoiditis and chronic otomastoiditis are considered as two different disease processes for the purposes of this discussion. Acute otomastoiditis is the result of bacterial (or tuberculous) infection and chronic otomastoiditis is the result of eustachian tube dysfunction. Each of these entities have different attendant complications although both are associated with middle ear effusion. Complications of acute otomastoiditis include coalescent mastoiditis, subperiosteal abscess, dural sinus thrombosis, meningitis, intracranial abscess, labyrinthitis and petrous apicitis. When considering chronic otomastoiditis one must consider middle ear effusion, tympanic membrane retraction, acquired cholesteatoma, granulation tissue, cholesterol granuloma, and ossicular fixation and erosion.

Imaging the Temporal Bone Following Surgery

Timothy L. Larson, MD

LEARNING OBJECTIVES
1) Apply knowledge of standard surgical approaches to the temporal bone to understand the postoperative imaging appearance.
2) Differentiate the normal postoperative appearance of the temporal bone from signs indicating recurrent disease.
3) Recognize discontinuity of the reconstructed sound conducting mechanism.

PRESENTATION SUMMARY
This presentation will cover the basic surgical approaches to the temporal bone. Recognizing a normal post-operative appearance from complications or signs of recurrent disease will be emphasized. The basics of tympanoplasty will be discussed to include recognition of discontinuity of the reconstructed sound conducting mechanism.

Diffusion Basics

P. Ellen Grant, MD

Monday Afternoon

4:15 PM – 6:15 PM
Grand Ballroom C-F

(14) Case-Based Review Session (ASPNR) Audience Response Plus+ (AR+)*

Moderators: Gary L. Hedlund, DO
Charles M. Glasier, MD

*An educational grant was received by Bayer Healthcare Pharmaceuticals, Inc.** in support of the Audience Response Plus+ (AR+) technology in the programming of the Annual Meeting.

**Formerly Berlex

Monday Afternoon

4:45 PM – 6:15 PM
Columbus I-L

(15) Advanced Imaging Seminar — Diffusion

(117) Diffusion Basics — P. Ellen Grant, MD

(118) Diffusion Tensor Imaging — Aaron S. Field, MD, PhD

(119) Diffusion and Perfusion: Evidence from Trials — Howard A. Rowley, MD

Moderators: Timothy P. L. Roberts, PhD
Howard A. Rowley, MD

Diffusion Basics

P. Ellen Grant, MD
LEARNING OBJECTIVES
1) Review fundamental principles of diffusion tensor imaging (DTI).
2) Review methods of acquisition and post-processing for DTI data.
3) Review major clinical applications and pitfalls of DTI with or without fiber tracking.

PRESENTATION SUMMARY
The direction in which water molecules diffuse most readily in white matter is parallel to the neuronal fascicles. These directional patterns are detected with diffusion-sensitizing gradients during MRI and visualized using gray-scale maps of diffusion anisotropy or color maps depicting fiber orientation. Mathematical algorithms may be used to follow the trajectories of individual fiber tracts in 3D; the resulting tractograms are displayed in a variety of ways using computer-graphical techniques. Broadly categorized, clinical applications of DTI-tractography include: tissue characterization, lesion localization and tract mapping per se. Problems of tissue characterization are typically addressed using scalar DTI parameters on a voxel-wise basis. While such parameters are appealing for their high sensitivity to subclinical pathology, their clinical utility is limited by low specificity. Lesion localization is generally more straightforward; the ability to localize lesions to specific tracts has obvious importance to the clinician attempting to correlate a patient’s disease with neurological presentation. Although tractography can yield such quantitative measures as “connectivity” (the strength or likelihood of any functional connection between cortical or subcortical structures) or “fiber density” (the number of trajectories identified per voxel in a region of interest), the technique is used in the clinical setting primarily as a visualization tool. For example, DTI-tractography is uniquely suited to depict the deviation of a fiber tract by a space-occupying mass. Preoperative tractography can provide confirmation that a tumor-deviated tract remains intact and potentially facilitate preservation of the tract during resection. There are several limitations of DTI-tractography. The diffusion tensor is sensitive to image noise and assorted artifacts that can reduce the accuracy of tract mappings. Common algorithms are unable to resolve fiber crossings, such as the many intersecting pathways in the centrum semiovale. Intraoperative tract mapping has revealed errors in preoperative, DTI-based assessments of tract size and proximity to tumors. Several disease mechanisms can reduce the anisotropy of involved tracts without necessarily destroying them, yet still cause tractography algorithms to terminate at the site of reduced anisotropy; therefore, it is often difficult to interpret an apparent loss of fiber trajectories. Further validation of DTI-tractography as a clinically relevant technique is still needed. For applications in tissue characterization, correlations with voxel-specific histological data will be critically important (but difficult to obtain). For applications in preoperative planning, correlations with intraoperative findings and post-operative outcomes will be necessary. As further study along these lines proceeds, more widespread clinical application of DTI-tractography is likely to follow.
LEARNING OBJECTIVES
Upon completion of this presentation, participants will be able to:
1) Debate the relative merits of speech recognition vs. manual transcription.
2) Evaluate different speech recognition deployment strategies.
3) Identify elements of speech recognition that are specifically important to neuroradiologists.
4) Discuss the benefits of potential drawbacks of reporting macros.

PRESENTATION SUMMARY
Digital speech-to-text software has become a staple of many radiology practices, but some radiologists have not yet made the transition from medical transcriptionists, and some who have made the transition regret their decision to do so. This presentation outlines the advantages and disadvantages of a switch to SR. Different workflow models and options are discussed. Recommendations are given to ease the transition to SR.
Brain MRS Review Session

Alena Horska, PhD

**LEARNING OBJECTIVES**

Upon completion of this presentation, participants will be able to:

1. Identify the most important metabolites detected in proton MR spectra.
2. Evaluate the techniques of acquisition of the spectra.
3. Describe the characteristics of MR spectra for brain tumors, radiation necrosis, demyelinating diseases, stroke, MELAS.

**PRESENTATION SUMMARY**

Proton MRS can non-invasively assess regional brain biochemistry. Several important neurometabolites can be detected in brain tissue: N-acetyl aspartate, total choline and total creatine. A number of other metabolites can also be detected, including myo-inositol, glutamate/glutamine, and under certain pathologic conditions, lactate. The concentrations of some of these compounds depend on the cellular composition of the brain tissue. In particular, NAA is present only in neurons in mature brain, while glial cells have higher levels of choline and creatine. Non-invasive proton MR spectroscopy therefore has the potential to detect in vivo pathological changes in brain tissue.

Currently, the majority of clinical MRI systems are capable of performing proton MR spectroscopy. In these studies, both single-voxel MR spectroscopy and magnetic resonance spectroscopic imaging (MRSI) techniques are used. Single-voxel techniques are easy to perform both at long and short echo times while clinical MRSI is mostly limited to long echo times.

**REFERENCES**

Shown during the presentation at the conclusion of each case.
Pediatric Basal Ganglia Disorders
Zoltan Patay, MD

Dr. Zoltan Patay is Chief of the Section of Neuroradiology at St. Jude Children’s Research Hospital in Memphis, Tennessee. Previously he was Head of Neuroradiology at King Faisal Specialist Hospital and Research Center in Riyadh, Saudi Arabia, where he developed special interest in pediatric neuroradiology and inborn errors of metabolism in particular and during that period he authored four major book chapters on this subject. Earlier, he also served as Chief of Neuroradiology at the Central Military Hospital in Budapest, Hungary, and staff neuroradiologist at Erasmus Hospital of the Free University of Brussels, Belgium. He obtained his PhD degree in 1996 for works in the field of MR neuroangiography. Dr. Patay’s other areas of interest include myelination abnormalities, pediatric brain tumors and epilepsy.

LEARNING OBJECTIVES:
Upon completion of this presentation, participants will be able to:
1) Review anatomy of basal ganglia and surrounding structures.
2) Identify with MR imaging appearance basal ganglia involvement of various disease entities in pediatric patients.
3) Discuss possible underlying pathomechanisms in basal ganglia diseases.
4) Demonstrate complementary role of CT, 18-FDG PET and advanced MR techniques in diagnostic imaging evaluation of basal ganglia disease.

Adult Basal Ganglia Disorders
Doris D. M. Lin, MD, PhD

LEARNING OBJECTIVES:
Upon completion of this presentation, participants will be able to:
1) Describe the normal anatomy and function of the basal ganglia.
2) Describe common pathological processes affecting the basal ganglia, the characteristic imaging appearance, and differential diagnosis.
3) Describe advanced MRI techniques for imaging of the basal ganglia.
Functional Imaging in Parkinson’s Disease and fMRI of Deep Brain Stimulators

Michael D. Phillips, MD

Learning Objectives
Upon completion of this presentation, participants will be able to:
1) Review the pathophysiology, symptomatology, medical and surgical therapies as well as the role of conventional MR imaging in Parkinson’s disease.
2) Identify the role of functional MRI in studying pathophysiology and disease progression in Parkinson’s disease both before and after medical therapy.
3) Review the potential utility and issues surrounding MR imaging in DBS therapy for PD including safety issues, the use of fMRI to study DBS therapy, and the use of DTI imaging for modeling of electrical fields.

Presentation Summary
Parkinson’s disease (PD) is one of the most common neurodegenerative disorders. PD is characterized by tremor, bradykinesia, rigidity, and imbalance. PD affects approximately 1% of the population over the age 65. The cost related to care and treatment for these patients are staggering both in terms of human suffering and the financial burdens on the patient and families as well as national health care systems. In the US alone, some estimates suggest that over $30 billion is spent yearly in terms of direct and indirect health-care costs. This amount is expected to rise rapidly given the aging demographic in the US and other countries. PD has been studied extensively using a variety of imaging techniques including morphologic measurements as well and conventional MRI. Although MR findings which are characteristic of PD have been proposed, they typically demonstrate significant overlap with normal subjects. The primary role of conventional MRI in PD has been to exclude other pathologic processes including multisystem atrophy and progressive supranuclear palsy.

More recently, PD has been studied with a fMRI using a variety of paradigms including memory, learning, language and motor tasks. Investigators have shown changes in both the degree and position of activation in PD patients in comparison to controls. The most consistent finding during motor fMRI is a decrease in the extent of activation within the rostral portion of the supplementary motor area. Cognitive studies have shown significant differences between PD patients and controls particularly using tasks involving striatal regions. Several investigators have demonstrated significant changes in fMRI activation patterns following to medical therapy for PD utilizing motor tasks, typically demonstrating a normalization of activation following therapy.

The therapeutic window for medical PD therapy typically narrows with disease progression. This has led to the emergence of surgical therapies both lesional and for placement of deep brain stimulator's which have become an integral part of the treatment of PD. Imaging has played a critical role in the development of these therapies. Both preoperative and postoperative imaging techniques have been developed to optimize both lesional and deep brain stimulator therapies. Although lesional therapies can be safely imaged using MRI, there are significant safety issues associated with MR imaging with deep brain stimulator is in place. Despite these challenges, several investigators have applied functional MRI to the evaluation of deep brain stimulator's. DBS placed in the subthalamic nucleus appears to produce a consistent pattern of activation in the ipsilateral basal ganglia and thalamus. Functional MRI may provide confirmation for DBS function and appropriate placement in the future.

DTI imaging has not been used extensively for assessment of Parkinson's disease. It may, however, have a role to play in the future in developing appropriate planning for the placement of deep brain stimulator's. Several authors have suggested that deep brain stimulator functioned can be modeled using information from DTI images. Modeling of the electric fields generated by DBS may be used in the future in order to optimize therapy.
Determing Normal Diffusion Tensor Imaging Parameters in Premature Newborns

Veeraraghavan, S. · Miller, S. P. · Mukherjee, P. · Xu, D. · Barkovich, A. · Vigneron, D. B.
University of California San Francisco
San Francisco, CA

Purpose
MR diffusion tensor imaging (DTI) is a powerful technique for assessing tissue microstructure as many prior studies have shown (1-2). In this study, DTI from premature newborns with normal 1-year neurodevelopmental outcome was used to establish normative DTI values and investigate quantitative differences in DTI in those with poor outcome.

Materials & Methods
Neurologic outcome was performed at 1 year using validated measures (NMS and MDI of Bayley’s II). Subjects were born between gestational ages of 24-34 weeks and imaged between 27-43 weeks using an MRI-compatible incubator with a neonate head coil (3). To assess normal maturation, 62 exams from 41 newborns with normal neurodevelopmental outcome (NMS 0, MDI > 85) were used to form a normative database of mean values for the directionally averaged apparent diffusion coefficient (Dav) and fractional anisotropy (FA). A total of 43 exams from 24 premature newborns with abnormal neurologic outcome then were compared with the normative values defined in this study. Whole-brain axial interleaved DTI images were acquired as previously described (1). Three gray matter and five white matter regions were selected for ROI analyses (Fig 1a).

Results
The subjects with normal 1-year outcome showed a significant (p<0.05) decrease in Dav and increase in FA between regions and with increasing age. The subjects with abnormal neurodevelopmental outcome demonstrated spatial heterogeneity in abnormal DTI values and when grouped by NMS score did not show significant differences in Dav or FA from normative values, in any specific region. However, in individual subjects with abnormal outcome, 22/24 (4/4 severe) showed differences of at least two standard deviations from normal values in at least one of the regions studied (Fig 1b for example).

Conclusion
This study focused on defining normative values with anatomical location and development for premature infants with normal neurologic outcome and demonstrated that premature brain injury as detected by DTI varied anatomically between individuals. While no one region showed significant differences between outcome groups, all severely abnormal cases demonstrated abnormal DTI values in at least one region. Thus, this normative data may be clinically useful for identifying injury in preterm neonates by the deviation from normal diffusion values and to monitor the evolution of abnormal diffusivity.

References

Key Words: Diffusion tensor imaging, premature newborn
children and lack of longitudinal follow up makes it difficult to determine the accuracy of reported WM metrics emphasizing the need for reproducibility of measurements derived with DTI. We report normative WM metrics in children using rigorous quality assurance program.

**Materials & Methods**

Developmentally normal children ages 2-16 years referred for MR imaging for headaches, new-onset seizures, or extracranial pathology who had normal MR imaging underwent DTI (1.5T, Philips Medical Systems)(6-channel SENSE coil, SS-EPI, SENSE = 2.0, TR/TE 8292/100, b = 700, 2 mm isotropic voxel, 30-directions). Images were coregistered using PRIDE workstation (Philips); ROIs were placed on the color maps in the anterior corona radiate (ACR), callosal genu and splenium, cingulum, posterior limbs of the internal capsules (PLIC), superior longitudinal (SLF), inferior fronto-occipital fasciculus-uncinate, and inferior fronto-occipital-inferior longitudinal fasciculi (IFO ILF); voxel-based ADC for 6 canonical directions and FA were obtained. The tensor matrix and three principle eigenvalues were extracted using Matlab; FA and \( \lambda_1 \) were plotted against patient age. QA procedures included stability tests using doped water and oil and daily human phantoms, with assessment of intra and inter-scanner temporal stability, eddy current artifacts and image distortion. Data from individual gradient directions were analyzed in nICE™ and subjected to inclusion/exclusion based on SNR threshold and artifacts.

**Results**

The rigorous QA program resulted in reproducible data with inter-subject variability of < 15% for all metrics, and intra-regional SD \( \leq 15\% \) for every region except for FA in the cingulum (Table 1). The corpus callosum and PLIC have the highest FA and \( \lambda_1 \) in this age range and the lowest magnitude-normalized inter-subject variability in FA while the magnitude-normalized inter-subject variability in \( \lambda_1 \) is lowest for the ACR. The intra-regional variability in FA is lowest in the corpus callosum and highest in the cingulum. The intra-regional variability in \( \lambda_1 \) is lowest in the ACR and highest in IFO ILF. There were no significant left-right differences.

<table>
<thead>
<tr>
<th>ROI</th>
<th>Mean FA</th>
<th>Mean ( \lambda_1 )</th>
<th>Mean ( \lambda_2 )</th>
<th>Intra-Region SD</th>
<th>Intra-Region ( \lambda_1 ) SD</th>
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</thead>
<tbody>
<tr>
<td>ACR</td>
<td>0.542</td>
<td>0.120</td>
<td>1.465</td>
<td>0.052</td>
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<tr>
<td>Callosal splenium</td>
<td>0.827</td>
<td>0.051</td>
<td>1.869</td>
<td>0.063</td>
<td>0.085</td>
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<tr>
<td>Callosal genu</td>
<td>0.783</td>
<td>0.71</td>
<td>1.947</td>
<td>0.098</td>
<td>0.102</td>
</tr>
<tr>
<td>Cingulum</td>
<td>0.601</td>
<td>0.157</td>
<td>1.493</td>
<td>0.108</td>
<td>0.175</td>
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<tr>
<td>PLIC</td>
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<td>1.551</td>
<td>0.068</td>
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<tr>
<td>SLF</td>
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<td>0.146</td>
<td>1.330</td>
<td>0.073</td>
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<tr>
<td>IFO unc</td>
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<td>IFO ILF</td>
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<td>0.110</td>
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</table>

**Conclusion**

Acquisition of reproducible normative FA and \( \lambda_1 \) measurements is feasible in a routine clinical setting and is necessary before reaching conclusions about significance of changes in WM metrics in pathologic conditions. This standardized acquisition and data-processing protocol was robust across the age range studied; the central WM tracts FA and \( \lambda_1 \) show “adult” values by age 2.

**Key Words:** Diffusion tensor imaging, pediatrics, normative data

**Purpose**

During development, diffusion properties (FA and MD values) in normal white matter undergo significant changes due to the maturation of myelin and axonal membranes (1). Currently, normative pediatric diffusion tensor imaging (DTI) data are very limited (2), especially in children at very young ages. The purpose of the present study is to establish a standard data base and document the trends in normative DTI values as a function of age in young children and toddlers.

**Materials & Methods**

We retrospectively reviewed clinical DTI data collected on children under 6 years of age referred for MR imaging for clinical indications not associated with white matter abnormalities, and whose imaging and subsequent clinical course were both normal. All the DTI images were acquired on a 3T Siemens Trio scanner using a 6-direction single-shot spin-echo EPI sequence. FA values were calculated in the genu, body, and splenium of corpus callosum (gCC, bCC, sCC, respectively) and in the anterior and posterior limbs of the internal capsule (ALIC and PLIC).

**Results**

FA values in the bCC experience a sharp increase in the first 12 to 18 months, leveling out at 36-48 months (Fig 1). The same trend was seen in gCC, sCC, ALIC and PLIC (not shown here). All the coefficients from the curve fitting are listed in Table 1. FA values based on the y-intercept from the curve fitting suggest that myelination in PLIC is more complete at birth than that in ALIC. And that the sCC is more mature at birth and develops faster subsequently than the bCC and gCC.
Table 1. \( Y = a + b \cdot \exp(c \cdot X) \): \( Y \) is FA and \( X \) is Age.

<table>
<thead>
<tr>
<th>ROIs</th>
<th>Coefficients for curve fitting</th>
<th>( y )-intercept ((=a+b))</th>
</tr>
</thead>
<tbody>
<tr>
<td>bCC</td>
<td>0.72</td>
<td>-0.35</td>
</tr>
<tr>
<td>gCC</td>
<td>0.75</td>
<td>-0.38</td>
</tr>
<tr>
<td>sCC</td>
<td>0.76</td>
<td>-0.22</td>
</tr>
<tr>
<td>ALIC</td>
<td>0.57</td>
<td>-0.24</td>
</tr>
<tr>
<td>PLIC</td>
<td>0.64</td>
<td>-0.22</td>
</tr>
</tbody>
</table>

CONCLUSION

The exponential curve of increasing of FA values with age reflects the maturation process of major white matter tracts. The documentation and confirmation of normative DTI values in young children may allow its use as a control cohort in DTI research or as a reference to help distinguish normal from abnormal white matter in very young patients.

REFERENCES


KEY WORDS: Diffusion tensor imaging, normal value, children

Paper 129 Starting at 10:54 AM, Ending at 11:02 AM

Correlation of Diffusion Tensor Imaging with Neurocognitive Function in Patients with Sickle Cell Anemia

Helton, K. J. · Mattati, K. · Berkelhammer, L. · Bassin, C. · Wang, W. · Ware, R. · Zou, P. · Reddick, W. E. · Glass, J. · Ogg, R.
St. Jude Children’s Research Hospital
Memphis, TN

PURPOSE

Sickle cell anemia (SCA) is a devastating hematologic disease marked by vaso-occlusive events leading to vasculopathy, brain injury, stroke and cognitive deficits. We hypothesized that regional changes in fractional anisotropy (FA) of water diffusion would correlate with performance on a battery of sophisticated neurocognitive (NC) tests.

MATERIALS & METHODS

Seventeen patients with SCA and no history of clinical stroke were prospectively enrolled in an IRB approved imaging study. Patients received whole head cMR imaging, diffusion tensor imaging (DTI) and intensive NC testing. DTI images were normalized to the MNI template. Voxel-wise correlation between FA and NC Z-scores for all of the individual tests described were analyzed using SPM. Effects of interest were determined with a p-value of 0.001 and an extent threshold of 5 voxels.

RESULTS

Regions of significant correlation \((p < .001)\) were identified for each of the neuropsychological tests (intellectual aptitude, tests of visual and auditory attention, executive function, and verbal memory). Although some of these corresponded to specific white matter tracts, overall, areas of correlation appeared to cluster along “watershed zones” of cerebral arterial circulation.

CONCLUSION

DTI is a powerful tool for identifying subclinical white matter damage that is correlated with neurocognitive function. The location of FA changes along the “watershed zones” suggests a possible mechanism for occult ischemic damage. DTI and other quantitative neuroimaging techniques, along with neurocognitive testing, may improve detection of brain damage and define the efficacy of various therapies in a population known to be at high risk for cerebrovascular events.

KEY WORDS: Diffusion tensor imaging, neurocognitive testing, sickle cell anemia

Paper 130 Starting at 11:02 AM, Ending at 11:10 AM

Role of Diffusion Tensor Imaging in the Evaluation of Corticospinal Tracts in Patients with Schizencephaly

Ferreira, R. M. · Amaral, L. L. F. · Ferreira, N. P. D. · Mendonça, R. A.
Medimagem
São Paulo, BRAZIL

PURPOSE

The purpose of this study was to evaluate the corticospinal tracts (CST) in patients with schizencephaly, by using diffusion tensor imaging (DTI), and assess their correlation with characteristics of clefts, associated cortical dysplasia and motor dysfunction in such cases.

MATERIALS & METHODS

Seven patients with schizencephaly and seven age-matched normal controls were studied with DTI at 1.5T systems (GE Medical Systems). DTI was acquired in axial plane with a 25-direction, single-shot, echo-planar sequence \((TR=6000ms, TE=86ms, 240 \times 240 \text{mm FOV, } 128 \times 128 \text{ matrix, thickness } 5.0\text{mm, } b=1000s/mm^2)\). Conventional T2-weighted imaging (T2WI) were also obtained. All patients were prospectively enrolled and underwent physical examination after MR scanning, with special attention to motor dysfunction. DTI postprocessing was performed by using Volume-One and dTV 1.5 programs (University of Tokyo, Japan). Two neuroradiologists who were blinded to the clinical findings analyzed the images. FA color maps showing CST (in blue) in its greatest diameter at the pontine level.
were drawn and measured (in pixels) separately by using Workstations GE ADW4.2. These areas were compared to CST areas of controls and a relation (in %) was obtained. The relationship between CST area and contralateral motor impairment was analyzed. Special attention also was given to the features of the clefts and for the presence of associated polymicrogyric cortex involving the perisylvian or periorlandic areas on T2WI. Statistical analyses were performed using Fisher exact test.

RESULTS
Four of the seven patients with schizencephaly had bilateral clefts. Six of the hemispheres had open-lip clefts (two large and four small) and five had closed-lip schizencephaly. In seven hemispheres, polymicrogiric cortex were observed in the cortex of perisylvian or periorlandic areas on T2WI. The volume loss of CST was already identified on T2WI in five patients with schizencephaly, but in the remaining two patients DTI was useful to demonstrate atrophy of pontine CST that was not appreciated on T2WI. In patients with severe reduction of CST areas (seven cases), the motor dysfunction on the contralateral side of the body was more severe, as well as milder area reductions were related to milder motor deficits (four cases). The CST area was less reduced in cases with closed-lip clefts without cortical dysplasia involving the perisylvian or periorlandic cortex. In cases with open-lip schizencephaly with important tissue loss (two cases) or associated polymicrogiric cortex in the periorlandic/perisylvian areas (seven cases), the reduction of CST area was significantly more severe as well as the motor deficit on the contralateral side of the body.

CONCLUSION
Our results demonstrate significant correlation between the CST area at the pontine level and the severity of motor impairment in cases of schizencephaly: the more reduced is the CST area, the more severe is the motor impairment on the contralateral side of the body. Furthermore, more severe reductions of CST areas are related to large open-lips schizencephalies and to polymicrogiric cortex extending to perisylvian/periorlandic regions. As the CST is easily visualized on color-coded maps, DTI may add valuable information in such cases.

KEY WORDS: Schizencephaly, diffusion tensor imaging, corticospinal tract

paper 131 starting at 10:10 AM, ending at 11:18 AM
Fetal Motor and Sensory Tracts Visualized by in vivo Diffusion Tensor Imaging
Kasprian, G. J. · Brugger, P. C. · Lindner, C. · Stuhr, F. · Prayer, D.
Medical University of Vienna
Vienna, AUSTRIA

PURPOSE
Diffusion tensor imaging (DTI) already has been applied to demonstrate white matter maturation in term and preterm infants. The aim of this study was to demonstrate the feasibility of DTI in in vivo prenatal MR imaging (MRI).

MATERIALS & METHODS
MR studies were performed in five unsedated fetuses [28-32 gestational weeks (GW)], with the head engaged in the lesser pelvis. Indication for the examinations were to evaluate the risk of pulmonary hypoplasia in the condition of premature rupture of membranes with significant amniotic fluid loss. A DTI sequence (24 directions, FOV 230 mm, slice thickness 5 mm, acquisition time 1.46 min) was acquired in an axial plane. A T2-weighted fast spin-echo sequence was done in the same plane for anatomical correlation. Fiber tracking was performed using a Philips Intera release 11 workstation. In order to delineate nonmyelinated craniocaudally oriented fiber tracts, a multiregion of interest analysis was performed and a three-dimensional fiber model was calculated.

RESULTS
One adequate series of images for postprocessing could be acquired successfully in each case. Craniocaudally oriented fiber tracts could be delineated clearly at different levels of the fetal brain on the color-coded fractional anisotropy maps (pre and postcentral gyrus, posterior crus of the internal capsule and brainstem) in five of five. Fiber tracking readily could visualize fiber connections between the fetal primary motor and sensory cortex, thalamus and brain stem (Fig a) (2/5). Furthermore a strong connectivity between the temporal lobe and the brain stem could be demonstrated (2/5). The fetal pyramidal tract was depicted in its full intracranial length (3/5). The corpus callosum was displayed with its forming fiber bundles in its genu and splenium regions (2/5) (Fig b).

CONCLUSION
DTI can be applied to noninvasively study fiber connections in the living human fetus in utero. Prerequisites are reduced fetal movement, and the position of the fetal head in the center of the coil. As diffusion-weighted imaging is able to depict premyelinated states of brain development, fetal DTI will provide important insights in the maturation of the cerebral connectivity in normal and pathologic conditions.

KEY WORDS: Diffusion tensor imaging, fetal brain, in vivo
Brainstem Corticospinal Tract Diffusion Tensor Imaging in Patients with Primary Posterior Fossa Neoplasms Stratified by Tumor Type: A Study of Association with Motor Weakness and Outcome

Lui, Y. W.¹ · Law, M.² · Chacko-Mathew, J.² · Babb, J. S.² · Tuvia, K.² · Allen, J.² · Zagzag, D.² · Johnson, G.²
¹Montefiore Medical Center/Albert Einstein College of Medicine of Yeshiva University, Bronx, NY, ²New York University Medical Center, New York, NY

**PURPOSE**
Diffusion tensor imaging (DTI) allows in vivo delineation of brainstem white matter tracts. The purpose of this study is to determine if abnormalities of DTI metrics and fiber tractography correlate with neurologic deficits and clinical outcome in patients with primary posterior fossa tumors.

**MATERIALS & METHODS**
Review of patients with primary posterior fossa tumors who underwent MR imaging with DTI was performed. Patients were stratified by tumor type (well circumscribed or infiltrating lesions). Fractional anisotropy (FA) color maps of the brainstem were used to localize the corticospinal tracts within the brainstem. FA, mean diffusivity (MD), and eigenvalues were measured. Tractography was performed. Correlations between DTI metrics and clinical outcomes, and between DTI metrics and neurologic exam findings were assessed within each patient group, using Bonferroni correction for multiple comparisons. Comparisons of DTI metrics also were made between subject groups (infiltrating lesions vs well circumscribed lesions).

**RESULTS**
Thirty patients were studied (mean age = 14.1 years; 16 male, 14 female). Eighteen subjects had infiltrating lesions and 12 had well circumscribed lesions. Twelve subjects (4 well circumscribed and 8 infiltrating) demonstrated motor weakness on physical examination (4 right, 3 left, 5 bilateral). Subjects with well circumscribed lesions and weakness had higher MD and lower FA in the contralateral corticospinal tract (p < 0.05). No associations were seen in patients with infiltrating tumors. In 102 total patient-years of follow up (average follow-up time of 4.2 years), 17 patients (6 well circumscribed; 11 infiltrating) demonstrated complete response or stable disease and six patients (3 well circumscribed; 3 infiltrating) demonstrated progressive disease or death. Subjects with well circumscribed tumors and a poor outcome had significantly lower longitudinal and transverse eigenvalue measures in the corticospinal tracts compared to those with a good outcome. No similar associations were seen in patients with infiltrating tumors. No differences were seen in terms of DTI metrics between subjects with infiltrating lesions and subjects with well circumscribed lesions.

**CONCLUSION**
In patients with well circumscribed primary posterior fossa masses, higher MD and lower FA is associated with contralateral motor deficits. In addition, lower eigenvalues in these patients are associated with a poor clinical outcome.

**KEY WORDS:** Brain tumor, diffusion tensor imaging, outcome

**Paper 133 Starting at 11:26 AM, Ending at 11:34 AM**

Diffusion Tensor Imaging Study of Children with Supratentorial Tumors

Yuan, W. · Holland, S. K. · Jones, B. V. · Crone, K. · Mangano, F. T.
Cincinnati Children’s Hospital
Cincinnati, OH

**PURPOSE**
Measuring anisotropic diffusion characteristics in the brain using diffusion tensor imaging (DTI) has demonstrated important diagnostic value in differentiating tumor malignancy in adults (1, 2). The purpose of this study is to apply DTI in a pediatric population and evaluate the diffusion properties of supratentorial tumors and the integrity of white matter in the brain.

**MATERIALS & METHODS**
We retrospectively reviewed DTI datasets acquired from pediatric patients with supratentorial tumors between March 2004 and July 2006 at Cincinnati Children’s Hospital. Fifteen cases (age range 1-15 years; low grade/high grade = 9/6) were identified. Fractional anisotropy (FA) and mean diffusivity (MD) were computed from the diffusion tensor within selected regions of interest including tumor, adjacent normal appearing white matter (NAWM), and contralateral NAWM. Specific eigenvalue indices \( \lambda_{\text{axial}} = \lambda_1 \) and \( \lambda_{\text{radial}} = (\lambda_2 + \lambda_3)/2 \) that represent diffusion properties along axial and radial directions also were computed and evaluated.

**RESULTS**
FA in low-grade tumors was significantly lower than adjacent NAWM (p<0.0001) and contralateral NAWM (p<0.0001). MD values in low-grade tumors were significantly higher.
than adjacent NAWM (p=0.0014) and contralateral NAWM (p=0.0015). FA in high-grade tumors was significantly lower than adjacent NAWM (p<0.01) and contralateral NAWM (p=0.0007). MD values in high-grade tumors were higher than both adjacent NAWM (p=0.08) and contralateral NAWM (p=0.0009). MD value in low-grade tumor was significantly higher than high-grade tumors (p=0.012). Similarly, the tumor group difference was significant for both \( \lambda_{\text{axial}} \) (p=0.0004) and \( \lambda_{\text{radial}} \) (p=0.012). In both contralateral and adjacent NAWM, the absolute values of \( \lambda_{\text{axial}} \) and \( \lambda_{\text{radial}} \) and their relative difference were in accordance with published normative data (3) for both patient groups. The values of \( \lambda_{\text{radial}} \) in high-grade tumors were substantially greater than \( \lambda_{\text{radial}} \) in low-grade tumors. The fact that both \( \lambda_{\text{axial}} \) and \( \lambda_{\text{radial}} \) values were ~ 50% greater than that in high-grade tumors.

Table 1

<table>
<thead>
<tr>
<th>Tumor</th>
<th>Low-Grade Group</th>
<th>High Grade Group</th>
<th>P</th>
<th>Two-Tailed U test</th>
</tr>
</thead>
<tbody>
<tr>
<td>FA</td>
<td>0.155±0.045</td>
<td>0.139±0.044</td>
<td>0.456</td>
<td></td>
</tr>
<tr>
<td>MD(x10⁻⁶ mm²/s)</td>
<td>1614±544</td>
<td>1027±20</td>
<td>0.012</td>
<td></td>
</tr>
<tr>
<td>( \lambda_{\text{axial}} ) (x10⁻⁶ mm²/s)</td>
<td>1730±604</td>
<td>1066±209</td>
<td>0.004</td>
<td></td>
</tr>
<tr>
<td>( \lambda_{\text{radial}} ) (x10⁻⁶ mm²/s)</td>
<td>1556±516</td>
<td>1008±199</td>
<td>0.012</td>
<td></td>
</tr>
<tr>
<td>Adjacent NAWM</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FA</td>
<td>0.436±0.047</td>
<td>0.347±0.077</td>
<td>0.049</td>
<td></td>
</tr>
<tr>
<td>MD(x10⁻⁶ mm²/s)</td>
<td>905±146</td>
<td>861±64</td>
<td>0.689</td>
<td></td>
</tr>
<tr>
<td>( \lambda_{\text{axial}} ) (x10⁻⁶ mm²/s)</td>
<td>1136±177</td>
<td>1023±93</td>
<td>0.224</td>
<td></td>
</tr>
<tr>
<td>( \lambda_{\text{radial}} ) (x10⁻⁶ mm²/s)</td>
<td>795±165</td>
<td>780±81</td>
<td>0.607</td>
<td></td>
</tr>
<tr>
<td>Contralateral NAWM</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FA</td>
<td>0.427±0.055</td>
<td>0.388±0.062</td>
<td>0.328</td>
<td></td>
</tr>
<tr>
<td>MD(x10⁻⁶ mm²/s)</td>
<td>822±69</td>
<td>840±75</td>
<td>0.776</td>
<td></td>
</tr>
<tr>
<td>( \lambda_{\text{axial}} ) (x10⁻⁶ mm²/s)</td>
<td>1057±140</td>
<td>1023±172</td>
<td>0.689</td>
<td></td>
</tr>
<tr>
<td>( \lambda_{\text{radial}} ) (x10⁻⁶ mm²/s)</td>
<td>706±63</td>
<td>748±68</td>
<td>0.272</td>
<td></td>
</tr>
</tbody>
</table>

CONCLUSION

This study shows that MD values can have important diagnostic value in differentiating high-grade tumors from low-grade tumors. The fact that both \( \lambda_{\text{axial}} \) and \( \lambda_{\text{radial}} \) were different between the two tumor groups, not only in absolute value, but also in the magnitude of difference between tumor and the two NAWMs, may be a manifestation of the combined effects of axonal injuries, demyelination, and the cellularity/vascularity change in the tumors. Finally, the similarity of all the values of diffusion parameters between adjacent and contralateral NAWM is a direct indication that the integrity of WM adjacent to tumors, even for high tumor grades, is not affected significantly by tumor infiltration or compression.

REFERENCES


KEY WORDS: Diffusion tensor imaging, supratentorial tumor, children

Paper 134 Starting at 11:34 AM, Ending at 11:42 AM

Diffusion Tensor Imaging Study in Children Receiving Radiation Therapy for Treatment of Brain Tumors

Tannazi, F.¹ · McNutt, T.¹ · Ardekan, S.² · Brant, L. J.¹ · Bonekamp, D.¹ · Shokek, O.¹ · Cohen, K.¹ · Wharam, M. D.³ · Mori, S.¹ · Horska, A.¹

¹The Johns Hopkins University School of Medicine, Baltimore, MD, ²The Johns Hopkins University, Baltimore, MD, ³NIH/NIA/GRC, Baltimore, MD

PURPOSE

The aim of this study was to apply diffusion tensor imaging (DTI) to evaluate white matter injury in children treated by radiation. Our goal was to determine the relationship between changes in fractional anisotropy (FA) and apparent diffusion coefficient (ADC) and radiation doses delivered to specific white matter regions. We hypothesized that after radiation, damage to white matter will result in decreasing in FA and increasing in ADC and that the FA and ADC changes will be associated with radiation dose.

MATERIALS & METHODS

We examined 9 pediatric patients (3F, 5.5-19.3 years old) who received radiation therapy for brain tumors. The control group comprised of 18 healthy children (8F, 5.5-18.3 years old). All subjects were examined twice (baseline and 6 months follow-up). MRI was performed using a standard birdcage head coil at 1.5T. DTI data were acquired with the following parameters: 15 non-collinear diffusion gradient directions (b=1000 s/mm²), 24 axial slices (5mm thickness), matrix=96*96, FOV=240 mm². DTI Studio was used for data processing. ADC and FA were measured in 15 fiber tracts in both hemispheres using the ROI approach. To evaluate regional radiation doses, FA maps were imported into the Pinnacle Treatment Planning System and registered with the treatment plan using the CT simulation scan. The relative changes in FA (and ADC) were calculated according to \( \Delta FA = (FA_{\text{Second}} - FA_{\text{First}}) / FA_{\text{First}} \).

RESULTS

In the control group, average ADC decreased by 0.9% (one sample t test, p=0.011) but no changes in FA were found. In patients, no significant changes in average ADC were detected; however, FA changes (up to 30%) were observed, with a large variability in \( \Delta FA \). In regions proximal to the center of the radiation field, \( \Delta FA \) was variable, with no consistent pattern of dependence on radiation doses (Fig. 1 left). However, FA for several ROIs distant from the center of the radiation field decreased after radiation, with more prominent changes at higher radiation doses (Fig. 1 right).
CONCLUSION
Our results indicate that white matter changes in FA due to acute effects of radiation are not only a function of radiation dose but also have strong spatial dependency. While the findings for regions distant from the center of radiation are in agreement with our hypothesis, variability in AFA in fiber tracts near the center of the radiation field may be a result of tissue injury due to multiple factors, including presence of the tumor, chemotherapy, and surgery.

KEY WORDS: Diffusion tensor imaging, radiation therapy, pediatrics

Paper 135 Starting at 11:42 AM, Ending at 11:50 AM
Myelination in the Developing Human Brain: Quantitative Diffusion Tensor Correlates
Keshava, H. · Bluml, S. · Gilles, F. · Seri, I. · Nelson, M. D. · Panigrahy, A.
Children’s Hospital Los Angeles
Los Angeles, CA

PURPOSE
To test the hypothesis that developmental quantitative changes of fractional anisotropy correlate with myelination of the developing brain.

MATERIALS & METHODS
One hundred patients (postconceptional age between 25 weeks to 19 years) were studied with diffusion tensor imaging (DTI) on a 1.5T clinical General Electric MR scanner. All MR studies were interpreted as normal for age. A 25-direction DTI sequence was used with b-values between 700-1000 s/mm². Color directionality maps and T2-weighted MR imaging were used to identify anatomical structures of interest and for placements of region of interests (ROI) with rigorously standardized levels. DTI Studio 2.0 was used to measure the quantitative diffusion tensor values of fractional anisotropy (FA), mean diffusivity (Diff), relative anisotropy (RA), volume ratio (VR), and three eigenvalues (λ1, λ2, λ3) of six different structures: posterior and anterior limb of the internal capsule (PLIC and ALIC), genu, splenium, frontal periventricular white matter (FPWM), and peritrigonal white matter (PTWM). A custom-made MATLAB program was used for further data analysis. A mono-exponential function (y = A1*{1-exp[-A2(x)]}*A3) was used for curve fitting and the time constants (τ = 1/A2) were recorded. Large τ values correspond with a slow rate of myelination whereas small τ indicate a fast rate of myelination. Time constants were compared with previously published ex vivo data of CNS myelination obtained by the analysis of autopsy tissue of the same age range using H&E-LFB (hema-toxylin and eosin-luxol fast blue) staining (Brody et al).

RESULTS
Posterior structures (PLIC and splenium) have shorter time constants than their anterior counterparts (ALIC and genu) (Table 1) which correlates with the histologic sequence of myelination. In contrast, the PTWM has a larger time constant than the FPWM suggesting that the PTWM myelinates slower than the FPWM. The PTWM corresponds to the terminal myelination zone. The difference in time constants between anterior and posterior structures is greater for the FA and RA measurements compared with the Dav and the three eigenvalue measurements. The VR was measured and proper curve fitting could only be constructed for the genu and splenium. A difference in time constants for the VR calculation was observed between the genu and splenium.

CONCLUSION
Quantitative changes of fractional anisotropy correlate with histologic sequences of myelination in the developing brain. By using time-constant calculations, FA and RA best correspond to the histologic sequences of myelination in selected brain regions compared to eigenvalues and mean diffusivity quantitative measurements.

Table 1: Measured DTI Time Constants (τ)

<table>
<thead>
<tr>
<th></th>
<th>ALIC</th>
<th>PLIC</th>
<th>GENU</th>
<th>SPLEN</th>
<th>FPWM</th>
<th>PWM</th>
</tr>
</thead>
<tbody>
<tr>
<td>FA</td>
<td>0.316828</td>
<td>0.133292</td>
<td>2.906825</td>
<td>1.055237</td>
<td>0.56393</td>
<td>5.612365</td>
</tr>
<tr>
<td>RA</td>
<td>0.256429</td>
<td>0.148775</td>
<td>3.290026</td>
<td>1.204065</td>
<td>3.945178</td>
<td>6.4957</td>
</tr>
<tr>
<td>λ₁</td>
<td>0.154443</td>
<td>0.182263</td>
<td>0.67648</td>
<td>0.799079</td>
<td>0.159903</td>
<td>0.20431</td>
</tr>
<tr>
<td>λ₂</td>
<td>0.148727</td>
<td>0.168981</td>
<td>1.326365</td>
<td>0.652899</td>
<td>0.170319</td>
<td>0.20431</td>
</tr>
<tr>
<td>λ₃</td>
<td>0.174978</td>
<td>0.169868</td>
<td>1.372603</td>
<td>0.695875</td>
<td>0.195682</td>
<td>0.204327</td>
</tr>
<tr>
<td>Dav</td>
<td>0.146716</td>
<td>0.156398</td>
<td>1.068994</td>
<td>0.989756</td>
<td>0.189435</td>
<td>0.210907</td>
</tr>
<tr>
<td>VR</td>
<td>-</td>
<td>-</td>
<td>0.298145</td>
<td>0.841038</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

REFERENCES

KEY WORDS: DTI, myelination, neonatal

Supported in part by the Rudi Schulte Research Institute and the Radiological Society of North America.

Paper 136 Starting at 11:50 AM, Ending at 11:58 AM
Tonsilar and Spinal Cord Motion in Chiari I Patients
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1University of Wisconsin
Madison, WI

PURPOSE
Oldfield’s “piston theory” of syringomyelia, has prevailed as the most popular theory on the formation of syringomyelia in Chiari I malformations. The theory predicts that downward motion of the cerebellar tonsils creates a water-hammer effect, forcing CSF into the cord. The purpose of this study was to use dynamic MR imaging methods, including cardiac gated 2D-FIESTA, to measure the motion of the tonsils, and phase contrast (PC) imaging to measure spinal cord movement in controls and patients with Chiari I malformations.

MATERIALS & METHODS
Chiari I patients and healthy volunteers were imaged under an approved IRB protocol to evaluate tonsil position, motion and spinal cord motion. A 3 slice, cardiac gated, 2DFIESTA sequence, flip angle 45°, TR/TE minimum/1.3msec, 22 FOV, three 5 mm contiguous slices though the spinal cord and cerebellar tonsils, with 20 phases and 12 views/sequence, 256x256 matrix for a 0.86x0.86 pixel resolution SIxAP dimensions, and bandwidth of ±100 kHz. The sagittal images were analyzed with the most superior and most infe-
rior locations of the tonsils measured relative to the McRae foramen magnum line, from the basion to the opisthion. The difference taken as the tonsilar displacement.

Spinal cord motion was measured just inferior to the position of the tonsils using a PC-MR sequence. A single slice axial 2D, gated PC-MR, flip angle 20°; TR/TE 20/5ms; slice thickness 5mm; 18 FOV; 256x256 matrix, voxel resolution 0.7mm, velocity encoding \( v_{enc} \) 10 cm/s was used. The velocity and the total displacement of the cord during the cardiac cycles were calculated. The mean displacements of the cord and of the tonsils in normal subjects and in patients were compared and tested for significance with a student \( t \) test, \( p = 0.05 \). The accuracy and precision of the FIESTA and PC MR techniques have been validated in phantom studies.

**RESULTS**

Ten normal subjects and 5 Chiari I patients (to date) with evidence of tonsilar ectopia of 5 mm or greater, but without a syrinx have been imaged. The FIESTA sequence reproducibly demonstrates the superior and inferior positions of the tonsils during the cardiac cycle. The magnitude of displacement was 0-1 mm in 3 patients and 2 mm in one patient. PC MR shows two phases of the cardiac cycles in which motion of the spinal cord can be detected. The velocity of the spinal cord reaches 1 to 2 mm/sec in the Chiari I patients (\( p = 0.015 \)) which is calculated to displaced local CSF at a rate of approximately 6 -12 ml/min, within the reported normal range of CSF flow of 1-18 ml/min.

**CONCLUSION**

FIESTA imaging shows minimal displacement of the tonsils during the cardiac cycle. PC MR shows spinal cord velocities up to 2 mm/sec during the cardiac cycle, with a statistically significant, albeit small magnitude difference between controls and patients. Further studies need to be done in patients with Chari I and syrinx to adequately test Oldfield’s hypothesis.

**KEY WORDS:** Chiari I malformation, Tonsil motion, spinal cord motion

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**Tuesday Morning**

**10:30 AM – 12:00 PM**

**Columbus I-L**

(19b) Vascular Interventional (Scientific Papers 137 – 146)

See also Parallel Sessions

(19a) PEDIATRICS: Diffusion Tensor Imaging
(19c) HEAD AND NECK: Orbit, Face, New Techniques, Other
(19d) PEDIATRICS: Misc. Neoplasms, Trauma, Other and New Techniques

**Moderator:** Steven G. Imbesi, MD

**Paper 137 Starting at 10:30 AM, Ending at 10:38 AM**

**Intraarterial Thrombus Burden Is Highly Associated with Clinical Outcome in Acute Ischemic Stroke**

Barreto, A. D.¹ · Albright, K. C.² · Grotta, J. C.¹ · Noser, E. A.¹ · Khaja, A. M.¹ · Shaltoni, H. M.¹ · Gonzales, N. R.¹ · Martin-Schild, S.¹ · Hallevi, H.¹ · Cacayorin, E. D.¹ · Weir, R. U.¹

¹University of Texas at Houston, Houston, TX, ²Mayo Clinic Jacksonville, Jacksonville, FL

**PURPOSE**

Prior studies have established a relationship between successful arterial recanalization and favorable clinical outcome in acute ischemic stroke patients. Recanalization is determined through flow grading systems which routinely do not assess intraarterial thrombus burden. Few studies have examined the effect of thrombus burden in acute ischemic stroke patients. The purpose of this study was to describe the relationship of intraarterial thrombus burden on intraarterial treatment (IAT) time, stroke severity and clinical outcome.

**MATERIALS & METHODS**

A retrospective review was performed on a prospectively obtained data base of consecutive acute ischemic stroke patients treated with IAT between 11/1996 and 06/2005. Baseline NIHSS, intraarterial thrombus burden, IAT time, rate of recanalization, symptomatic intracranial hemorrhage (sICH), mortality and clinical outcome were collected. The modified thrombolysis in myocardial infarction (TIMI) criteria for thrombus grading was utilized to evaluate thrombus burden (1, 2). Thrombus grade was determined independently by both an interventional neuroradiologist and an interventional neurologist blinded to patient outcomes. Conflicts were resolved by a third blinded interventionalist. Successful recanalization was defined as a thrombolysis in cerebral infarction (TICI) score ≥2b. Favorable outcome was defined as discharge home or to inpatient rehabilitation. For the pur-
pose of this study, patients were dichotomized into Grades 0-3 (no clot or moderate thrombus, <2 vessel diameters) vs. Grade 4 (large thrombus, >2 vessel diameters) for comparison. Categorical variables were analyzed using Chi-square and Fisher’s Exact test. Continuous variables were analyzed using independent samples t-test and Mann-Whitney U.

RESULTS

Data were collected on 161 IAT patients, of which 147 had available thrombus grading. Demographic and group comparison data are shown in table. Drugs used for IAT included: 95 reteplase, 40 urokinase, 18 rt-PA, one tenecteplase and two combination.

<table>
<thead>
<tr>
<th>Thrombus Grade</th>
<th>Grades 0-3</th>
<th>Grade 4</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (mean ± SD)</td>
<td>n=66</td>
<td>n=81</td>
<td>0.205</td>
</tr>
<tr>
<td>Gender (% male)</td>
<td>n=66</td>
<td>n=81</td>
<td>0.347</td>
</tr>
<tr>
<td>Baseline NIHSS (median)</td>
<td>n=66</td>
<td>n=81</td>
<td>0.005</td>
</tr>
<tr>
<td>Symptom onset to IAT start (mean ± SD)</td>
<td>n=60</td>
<td>n=66</td>
<td>0.757</td>
</tr>
<tr>
<td>Total IAT time - minutes (median)</td>
<td>n=63</td>
<td>n=72</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Mechanical clot disruption (%) (balloon, snare, wire, etc)</td>
<td>33/65 (51)</td>
<td>58/80 (73)</td>
<td>0.007</td>
</tr>
</tbody>
</table>

Site of occlusion included 59% middle cerebral, 26% internal carotid and 15% basilar artery. Occluded artery did not significantly affect the IAT time, rate of recanalization or favorable clinical outcome. All patients with grade 4 thrombus who developed sICH expired.

CONCLUSION

Our data suggest that patients who present with grade 4 thrombus burden tend to have higher NIHSS scores and lower initial TICI scores. Further, they take longer to recanalize, are more likely to require mechanical clot disruption and may require a higher dosage of intraarterial lytic. Despite comparable recanalization, patients presenting to IAT at an average of 5 hours with a large thrombus burden have longer IAT times and are four times more likely to experience a nonfavorable clinical outcome. A high thrombus grade as measured by the modified TIMI criteria may be a risk factor that contributes to poor clinical outcome and should be addressed in IAT trials.

REFERENCES


KEY WORDS: Stroke, thrombus, Intraarterial

Paper 138 Starting at 10:38 AM, Ending at 10:46 AM

Hemorrhage Rates and Outcomes Associated with the Use of 100 mg Intraarterial tPA for Thrombolysis in Acute Ischemic Stroke

Christoforidis, G. A. · Sivapatham, T. · Mohammad, Y. · Karakasis, C. · Avatu, B. · Yang, M. · Caragine, L. · Slivka, A.

The Ohio State University Medical Center Columbus, OH

PURPOSE

This study assesses hemorrhage rates and volumes in relation to clinical and radiographic outcomes associated with intraarterial delivery of tissue plasminogen activator (tPA) doses as high as 100 mg for thrombolysis.

MATERIALS & METHODS

Prospectively collected angiographic, clinical and laboratory information on 61 consecutive patients with acute ischemic stroke involving either the horizontal portion of the middle cerebral artery, the intracranial internal carotid artery or the basilar artery were analyzed retrospectively. Patients who received more than 50 mg tPA were compared with those patients receiving 50 mg or less. Outcome measures included: symptomatic hemorrhage, significant hemorrhage volume (greater than 25 ml), hemorrhage rate, change in National Institutes of Health stroke scale score at 24 hours and at hospital discharge, modified Rankin score at 90 days, inhospital deaths, death within 90 days, reperfusion rate, and infarct volume.

RESULTS

Multivariate logistic regression analysis demonstrated that tPA dose over 50 mg was associated with higher rates of hemorrhage and larger hematomas; however, high and low dose groups had similar clinical outcomes (Table 1).

Table 1: Outcomes dichotomized by tPA dose

<table>
<thead>
<tr>
<th>N</th>
<th>P value</th>
<th>tPA ≤ 50 mg</th>
<th>tPA &gt; 50 mg</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>37</td>
<td></td>
<td>24</td>
<td>61</td>
<td></td>
</tr>
<tr>
<td>Median hemorrhage volume*</td>
<td>0.2031</td>
<td>1.62</td>
<td>17.1 (7.27-49.3)</td>
<td>47.7 (5.87 - 114.25)</td>
</tr>
<tr>
<td>Presence of hemorrhage</td>
<td>0.2041</td>
<td>1.63</td>
<td>7 (18.9%)</td>
<td>8 (33.3%)</td>
</tr>
<tr>
<td>Symptomatic hemorrhage</td>
<td>0.0202</td>
<td>5.40</td>
<td>12 (27.3%)</td>
<td>5 (20.8%)</td>
</tr>
<tr>
<td>Hemorrhage &gt; 25 ml</td>
<td>0.1500</td>
<td>2.07</td>
<td>3 (8.1%)</td>
<td>5 (20.8%)</td>
</tr>
<tr>
<td>Infarct volume</td>
<td>0.2313</td>
<td>0.0458</td>
<td>47.2 (15.0-155)</td>
<td>52.2 (11.0-156)</td>
</tr>
<tr>
<td>Modified Rankin ≤ 2†</td>
<td>0.9681</td>
<td>0.002</td>
<td>16.3 (47.6%)</td>
<td>10.1 (47.1%)</td>
</tr>
<tr>
<td>NIHSS by discharge</td>
<td>0.7000</td>
<td>0.291</td>
<td>-5.0 (-10.5-5.5)</td>
<td>-4.0 (-9.0-5.0)</td>
</tr>
<tr>
<td>NIHSS by 24 hours</td>
<td>0.5959</td>
<td>0.840</td>
<td>-3.0 (-8.0-1.0)</td>
<td>-2.0 (-5.75 - 5.0)</td>
</tr>
<tr>
<td>Death during hospitalization</td>
<td>0.9424</td>
<td>0.005</td>
<td>8 (21.6%)</td>
<td>5 (20.8%)</td>
</tr>
<tr>
<td>Death by 3 months</td>
<td>0.9622</td>
<td>0.002</td>
<td>11 (29.7%)</td>
<td>7 (20.2%)</td>
</tr>
</tbody>
</table>

* in patients who hemorrhaged (n=15); † in patients with baseline modified Rankin scale scores of 0 (n = 55). 25-75% quartiles presented in parentheses for continuous data and percentages presented in parentheses for nominal/ordinal data. ANOVA scores were treated as continuous. Wilcoxon Rank Sums 1-way test (continuous variables); Pearson χ^2 (nominal/ordinal variables); Bonferroni correction for multiple tests requires p < .005 for significance. ANOVA = change in NIHSS

Poor pial collaterals, poor reperfusion (less than 50% of the territory involved), and platelet count below 200 K/µL also influenced hemorrhage. Limiting tPA dose to 100 mg rather than 50 mg improved cumulative rates of complete reperfusion with complete recanalization from 37.3% to 69.5% (Figure 1).
Retinal Artery Occlusion

improvement in visual acuity (VA) in subjects with central activator (tPA) administered in aliquots is associated with Local intraarterial fibrinolysis (LIF) with tissue plasminogen

M either LIF or conventional treatment.

prospective cohort of subjects with CRAO who underwent We report the results of a single-center nonrandomized

tPA dose. The dotted lines represent 95% confidence inter-

vals. Note: because t-PA dose is delivered at a specified rate, it is time-dependent and is substituted here instead of time.

CONCLUSION

Restricting intraarterial tPA administration to 100 mg rather than 50 mg, is associated with greater efficacy but acceptable hemorrhage rates. Poor pial collateral formation and platelet count less than 200 K/µL may be reasons to curtail the use of higher tPA doses.

KEY WORDS: Stroke, hemorrhage rates, intraarterial tPA

Paper 139 Starting at 10:46 AM, Ending at 10:54 AM

A Prospective Study of Intraarterial Fibrinolysis versus Conventional Therapy for the Treatment of Central Retinal Artery Occlusion

Wyse, G. · Lee, A. W. · Gottesman, R. · Wityk, R. · Sasson, D. · Gailloud, P. · Miller, N. · Aldrich, E. · Murphy, K.

The Johns Hopkins Medical Institutions Baltimore, MD

PURPOSE

Local intraarterial fibrinolysis (LIF) with tissue plasminogen activator (tPA) administered in aliquots is associated with improvement in visual acuity (VA) in subjects with central retinal artery occlusion (CRAO), compared with patients who did not receive tPA. CRAO by thrombi or emboli results in visual loss with a poor chance of spontaneous recovery. We report the results of a single-center nonrandomized prospective cohort of subjects with CRAO who underwent either LIF or conventional treatment.

MATERIALS & METHODS

Consecutive subjects with CRAO from 2001-2006 were included. VA was documented by standard methods. Subjects underwent either conventional therapy of paracentesis and breathing carbogen (90% CO2/10% oxygen mixture) alone or a combination of conventional therapy and LIF by selective ophthalmic artery catheterization, followed by administration of tPA in 3-5 mg aliquots. The primary outcome was improvement of VA by 1 line or more on Snellen chart or its equivalent. Fisherâ€™s exact test and multivariate logistic regression with likelihood ratio testing were used to compare outcome in the two groups.

RESULTS

Each group included 21 subjects. Seventy-six percent of subjects in the tPA group had VA improvement, compared with 33% in the standard therapy group (p = 0.012, Fisher’s exact). Multivariate logistic regression including gender, history of prior stroke/TIA, and history of hypercholesterolemia, showed that patients who received tPA were 6 times more likely to have improvement in VA (p = 0.0001) and five times more likely to have a final VA of 20/200 or better (p = 0.03) after adjusting for these covariates. Use of additional conventional therapies and baseline VA did not change this point estimate significantly. Two groin hematoma occurred in the tPA group but there were no intracranial or intracranial hemorrhages.

CONCLUSION

LIF with tPA administered in aliquots is associated with an improvement in VA compared with conventional therapy and had few side effects.

KEY WORDS: Central retinal artery occlusion, intraarterial fibrinolysis, prospective study

Paper 140 Starting at 10:54 AM, Ending at 11:02 AM

New Animal Model of Catheter-Selective Middle Cerebral Artery Thrombo-Occlusive Stroke: Demonstration of Rapid Reperfusion by Local Plasmin Infusion

Jahan, R. · Stewart, D. · Vinuela, F. · Vinters, H. · Marder, V.

University of California Los Angeles Los Angeles, CA

PURPOSE

Thrombolytic therapy of ischemic stroke is limited to a single approved agent, rt-PA, and is hampered by a 10-fold increased risk of treatment-related intracranial hemorrhage. An agent that rapidly dissolves thrombus with reduced risk of bleeding is needed. To meaningfully assess such therapy, we developed a rabbit stroke model that is relevant to the commonest form and location of human stroke and which provides angiographic documentation of vascular occlusion and recanalization. The model is used to achieve recanalization using local infusion of a thrombolytic agent, plasmin.

MATERIALS & METHODS

Seven white New Zealand rabbits were utilized. After fluoroscopic-guided microcatheter placement at the terminal bifurcation of the intracranial internal carotid artery (ICA), selective thrombo-occlusion of the middle cerebral artery (MCA) was achieved by infusion of thrombin: thromboplastin, as documented by immediate and 2-hour follow up contrast angiography. Three animals were treated by local plasmin infusion into the distal ICA.

RESULTS

Durable (2 hour) MCA occlusion was verified in seven of seven animals, and rapid, complete recanalization was induced by plasmin in three of three animals, documented by contrast angiography. Cerebral infarction was demonstrated histologically at necropsy in all seven animals.
We describe a new model of MCA ischemic stroke in the rabbit which provides reliable, selective thrombo-occlusion and cerebral infarction, and which was utilized to demonstrate successful plasmin-induced recanalization. This model is relevant for human MCA ischemic stroke and applicable for definitive angiographic assessment of thrombolytic efficacy and safety.

**KEY WORDS:** Animal model, stroke, thrombolysis

**PURPOSE**
To evaluate results of carotid artery angioplasty and stenting (CAS) in octogenarians with symptomatic carotid stenosis (SCS).

**MATERIALS & METHODS**
We conducted a retrospective review of hospital records of all octogenarians who had undergone CAS at our center for SCS between October 2001 and May 2006. We identified 51 such patients: 39 males and 12 females; median age, 83 years; range, 80 to 91 years. The left carotid was stented in 25 patients, the rest of the 26 undergoing CAS on the right side. The degree of stenosis was 50-69% in three patients, severe (>70%) in 32 and near occlusive in 16 patients. None of the patients were asymptomatic. Fourteen patients had presented with an ipsilateral minor stroke, five with an ipsilateral major stroke, 25 with hemispheric TIAs, six with retinal TIAs/infarct and one with symptoms of hypoperfusion. Other than the first two patients in this series, all procedures were done using distal protection. Two octogenarians during this time period who had been chosen to undergo CAS could not have the procedure. One had severe proximal vessel tortuosity preventing access to the stenosed segment and the other had a tight lesion which could not be crossed.

**RESULTS**
Intraprocedural complications occurred in six of the 51 patients of whom three had minor groin access injuries, one had a minor asymptomatic carotid dissection. Two patients had neurologic symptoms of whom one had a minor stroke secondary to an air embolus and the other had transient dysphasia and hemiparesis. Intrahospital stay complications occurred in a total of four of the 51 patients of whom one was the previously mentioned patient with a minor stroke secondary to an air embolus. One patient had a postprocedure major stroke leading to death. This patient had not been properly loaded with clopidogrel before the procedure and we suspect that this may have been the cause. One patient had hyperperfusion with vitreal hemorrhages and hemispheric hyperperfusion on a perfusion scan. However, this patient did not have any hemispheric symptoms. One patient died in hospital due to nonneurologic causes. Follow up is available for 47 of the 51 patients. One patient died in hospital as mentioned previously. Three patients died later of nonneurologic causes. Follow up ranges from 3 months to 57 months with a mean of 16 months. Other than five of these 47 patients, 42 remained free of new neurologic symptoms.

**CONCLUSION**
The safety and efficacy of CAS as borne out by the aforementioned results make CAS a viable option in the management of SCS in the geriatric population.

**KEY WORDS:** Carotid angioplasty and stenting, octogenarians, symptomatic carotid artery stenosis

**Paper 142 Starting at 11:10 AM, Ending at 11:18 AM**
**Wingspan Stent for the Treatment of Symptomatic Intracranial Atheromatous Disease: U.S. Wingspan Registry Results after 1 Year**

Turk, A. S. 1 · Fiorella, D. 2 · Levy, E. 3 · Albuquerque, F. 4 · Niemann, D. 2 · Aagaard-Kienitz, B. 1 · Hanel, R. 2 · Woo, H. 1 · Rasmussen, P. 1 · Hopkins, L. N. 3 · Masaryk, T. 2 · McDougall, C. 4

1 On behalf of Neuroendovascular Research Collaboration, University of Wisconsin, Madison, WI, 2 Cleveland Clinic Foundation, Cleveland, OH, 3 University of Buffalo, State University of New York, Buffalo, NY, 4 Barrows Neurologic Institute, Phoenix, AZ, 5 University of Wisconsin, Madison, WI

**PURPOSE**
Up to 10% of the 700,000 acute strokes that occur each year are related to intracranial atherosclerosis. Aside from medical therapy, an acceptable surgical therapy has not been identified. Similar to aneurysm therapy, the treatment of medically refractory atherosclerotic stenosis is a process well suited for endovascular therapy. The Wingspan, a flexible, self-expanding, microcatheter-delivered, microstent is the first stent system designed specifically for the treatment of symptomatic intracranial atheromatous disease (ICAD). The current study details our experience with the device in a series of 97 patients.

**MATERIALS & METHODS**
All patients undergoing angioplasty and stenting with the Gateway balloon-Wingspan stent system related to medically refractory symptomatic intracranial stenosis were tracked prospectively in our collaborative four institution endovascular data base. Patient data, lesion characteristics, procedural details, pre and periprocedural antithrombotic pharmacology, and clinical and imaging follow up were recorded.

**RESULTS**
Over a 12-month period 97 patients (42 females, 55 males; average age 63.2 years, range 35-85 years) with 104 intracranial atheromatous lesions were treated with the Gateway balloon and Wingspan stent system. Stents were delivered with a 98.1% first session technical success rate. The treated
lesions involved the internal carotid (n = 38; 10 petrous, 11 cavernous, 14 supraclimoid segment, 3 terminus), vertebral (n = 18; V4 segment), basilar (n = 19), and middle cerebral (n = 28) arteries. The average pretreatment stenosis was 74.7 percent, improving to 43.2 percent after Gateway balloon angioplasty and to 25.8 percent after Wingspan stent placement. Seventy-two of 104 lesions treated were greater than 70% narrowed at presentation. Of these 104 lesions treated, there were six major neurologic complications (5.8%), four of which resulted in patient death within 30 days of the procedure. Imaging follow up is currently available for 59 lesions (45 angiography, 11 CTA, 3 MR imaging only). Fifteen lesions have demonstrated in-stent restenosis (ISR), five of which have been symptomatic and 11 of which have been retreated. During retreatment, three in-stent dissections were encountered, two of which required placement of an additional Wingspan stent, 1 reperfusion hemorrhage occurred after retreatment.

**Conclusion**
Angioplasty and stenting for symptomatic intracranial atheromatous disease can be performed with the Gateway balloon-Wingspan stent system with a high rate of technical success and relatively low peri-procedural morbidity. ISR is not uncommon, but was only symptomatic 8.5% of the time. Further clinical follow up currently is being obtained and will be available at the time of presentation.

**Key Words:** Stent, intracranial stenosis, outcomes

**Paper 143 Starting at 11:18 AM, Ending at 11:26 AM**
Emergency Carotid Artery Stenting for Total or Near Occlusion with or without Proximal Flow Control in Acute Stroke Stage

Mori, T. · Isumoto, H. · Yamamoto, S. · Kunieda, T.
Shonan Kamakura General Hospital
Kamakura, JAPAN

**Purpose**
It remains controversial whether or not emergency carotid artery stenting (CAS) for carotid total or near occlusion with thrombi in acute stroke stage can be performed safely and improve clinical outcome, because more thrombi is there in the affected carotid artery, a higher risk of distal migration is expected. The purpose of our study was to investigate and compare retrospectively the feasibility, safety, and effectiveness of emergency CAS with or without proximal flow control (PFC).

**Materials & Methods**
Criteria of CAS in acute ischemic stage were patients with (1) serious or progressing neurologic symptoms or crescendo transient ischemic attacks (TIAs), (2) no cerebral hemorrhage on CT scans or extensive high signal-intensity on MR diffusion-weighted images, (3) decrease of cerebral blood flow displayed by MR perfusion-weighted images, and (4) carotid total or near occlusion with thrombi diagnosed by cerebral angiography. Between 2001 and 2006, emergency CAS for total or near occlusion with thrombi was performed without PFC to prevent distal migration of thrombi. Since 2004, PFC is utilized. Technical success, 7-day NIHSS after CAS, and 3-month modified Rankin Scale (mRS) were investigated.

**Results**
One thousand three hundred fifty patients suffering acute ischemic stroke were admitted consecutively to our institution from February 2001 to June 2006. Among them, emergency CAS for total or near occlusion with thrombi was attempted in 17 patients, and technically successful in 16 patients. Ten patients were treated without PFC, and seven with PFC. In 10 patients without PFC, NIHSS scores before and 7-day after CAS were 16.5 and 15, respectively. In seven patients with PFC, NIHSS score improved from 10 of pre-CAS to four 7 days after CAS. Three-month median mRS score in patients without and with PFC was four and two, respectively.

**Conclusion**
Emergency CAS utilizing PFC may be feasible, safe, and effective to achieve favorable 3-month clinical outcome even in patients with total or near occlusion with thrombi.

**Key Words:** Carotid occlusion, proximal flow control, thrombus

**Paper 144 Starting at 11:26 AM, Ending at 11:34 AM**
Hemodynamic Instability Is Significantly Less Frequent During “Stent Only” versus Balloon-Assisted Carotid Stenting

Bussiere, M. · Pelz, D. · Lee, D. · Gulka, I. · Leung, A. · Lownie, S.
1University Hospital, London, ON, CANADA, 2University of Western Ontario, London, ON, CANADA

**Purpose**
Hemodynamic instability may complicate balloon angioplasty and stent placement for the treatment of carotid stenosis in up to 40% of patients. We have demonstrated previously that deployment of a self-expanding stent alone can gradually dilate severely stenosed carotid arteries without deliberate use of balloon angioplasty. We hypothesized that elimination of the balloon might reduce trauma to the vessel wall preventing stimulation of carotid baroreceptors and thereby reduce the incidence of hemodynamic instability.

**Materials & Methods**
Over 6 years, 99 consecutive patients with 104 symptomatic severely stenosed carotid arteries, considered high risk for carotid endarterectomy, were treated with the initial intention of using a “stent only” approach. Eighty-four arteries (81%) were treated with stent alone and 20 required pre- or poststent balloon angioplasty.

**Results**
Intraprocedural hypotension requiring vasopressor treatment (systolic blood pressure < 90 mmHg) developed in one patient (<1%) treated with a stent alone and in four patients (20%) treated with angioplasty and stenting. The incidence of intraprocedural bradycardia (heart rate <60 bpm) was 30% (37 patients) in the stent only group and 70% (14 patients) in the stent and angioplasty group. Four of the patients (5%) treated with stent alone required atropine or glycopyrrolate treatment as compared to five patients (25%) treated with stent and balloon. Similar high rates of hypotension and bradycardia were observed in the postprocedural period in patients treated with balloon angioplasty and stent-
ing as compared to stent alone. No patient in either group, however, developed persistent postprocedure hemodynamic depression requiring treatment with intravenous vasopressors. One patient with hemodynamic instability treated with angioplasty and stenting developed a stroke in the perioperative period (< 30 days). No cases of hyperperfusion syndrome or intracranial hemorrhage were observed. Factors predicting hemodynamic instability in this cohort of patients will be determined by logistic regression analysis.

CONCLUSION
Carotid stenting without the use of balloons is an effective and potentially safer approach to the treatment of severe carotid stenosis. Peri-procedural hemodynamic instability, which may lead to ischemic complications such as myocardial infarction or stroke, occurs significantly less often in patients treated with this approach as compared to patients treated with angioplasty balloons.

KEY WORDS: Carotid stenosis, stenting, angioplasty

Paper 145 Starting at 11:34 AM, Ending at 11:42 AM
Stenting of the Carotid and Vertebrobasilar System Results in Improved Cognitive Performance

Chaudry, I. · Pulfer, K. · Niemann, D. · Aagaard-Kienitz, B. · Haughton, V. · Rowley, H. · Turski, P. · Herman, B. · Turk, A. S.
University of Wisconsin Hospital and Clinics
Madison, WI

PURPOSE
Endovascular treatment of cerebrovascular stenosis is directed primarily at stroke prevention, targeting patients that are symptomatic despite medical therapy. Progressive cognitive decline among patients with cerebrovascular stenosis may be an even greater problem than actual stroke, but is not a recognized symptom and has yet to be addressed in any study. The purpose of our study is to measure cognitive performance in patients with unilateral cerebrovascular stenosis before and after endovascular stenting.

MATERIALS & METHODS
Patients who have a single significant stenosis of a cerebrovascular territory who were candidates for endovascular stenting were selected for the study. All patients received preoperative CTA and perfusion CT (pCT), or MR, MRA and MR perfusion as well as neuropsychometric testing consisting of the Repeatable Battery for the Neuropsychological Status (RBANS), Trail Making Test A & B, Mini-Mental State Examination (MMSE), Informant Questionnaire on Cognitive Decline in the Elderly (IQCODE) and Center for Epidemiologic Studies Depression Scale, Revised (CES-D). All patients undergo poststenting follow up including CT, CTA, pCT and neuropsychometric testing at 3 months and 1 year.

RESULTS
Twenty-four patients underwent stenting procedures for single symptomatic cerebrovascular stenosis, 20 in the anterior circulation and four in the posterior circulation. To date, all patients have completed 3 month follow up and 12 patients have completed 1 year follow up evaluations. The average stenosis of these patients was 79%. The patients with 3-month follow up showed significant improvements in their RBANS score from 84 to 88 (p = 0.03) and IQ-CODE scores from -1.96 to 2.21 (p = 0.01). The remaining neuropsychometric tests also showed improvement with a trend towards significance. The 12 patients with 1-year follow up showed continued overall improvement in RBANS score from 82 to 85 (p = 0.05), Trail Making Test B from 37 to 42 (p = 0.02), and IQ-CODE -2.17 to 4.42 (p = 0.06). The patients with anterior circulation lesions showed the most significant improvement on the RBANS (p = 0.03) and IQ-CODE (p = 0.02) test at 3 months and are trending towards significance at 1 year compared to posterior circulation lesions.

CONCLUSION
In this study, we have found that endovascular stenting of the cerebrovascular system results in improved performance on formal prospective neurocognitive evaluation. While the current focus of endovascular treatment of stenosis involving the cerebrovascular centers around stroke prevention, the ability to improve cognitive performance may provide another indication. Our study suggests that stenting may improve cognitive function in certain patients. Further prospective testing with larger patient populations is warranted.

KEY WORDS: Cerebrovascular, stent, cognition

Paper 146 Starting at 11:42 AM, Ending at 11:57 AM
Contrast-enhanced MRA for Follow-up of Coiled Intracranial Aneurysms - “Is There a New Standard?”

Lum, C.
University of Ottawa
Ottawa, ON, CANADA

Imaging follow-up of intracranial aneurysms treated by endovascular coiling is necessary to evaluate for possible recurrences. This is especially true in patients who have undergone coiling for previously ruptured aneurysms. The late re-bleed rate is small however definable. Conventional catheter cerebral angiography has long been the “gold standard” for imaging follow up of aneurysms. However, catheter angiography still carries a measurable risk of complication including stroke, in spite of newer catheters and imaging equipment. MR angiography (MRA) has been used for several years to follow coiled aneurysms. Literature has been published on both time-of-flight and contrast-enhanced techniques. CT angiography also has been attempted to follow coiled aneurysms; however, it is typically contaminated by artifact around the coil mass. In our institution, we have chosen to follow coiled aneurysms with contrast-enhanced MRA (CEMRA). We have found CEMRA to provide concordant information with catheter angiography and in some cases, have found CEMRA to provide additional information about recurrences that are not evident even on rotational catheter angiography.

This paper was selected to receive the Eastern Neuroradiological Society (ENRS) Norman E. Leeds Award at the ENRS 18th Annual Meeting in Cambridge, Maryland.
Paper 147 Starting at 10:30 AM, Ending at 10:38 AM
MR Functional and Quantitative Evaluation of Extraocular Muscles in Patients Affected by Thyroid Orbitopathy Who Underwent an Experimental Pharmacologic Treatment Protocol

Conti, M. · Salis, A. · Urigo, C. · Frau, S. · Canalis, L. · Lai, R. · Palermo, M.
University of Sassari
Sassari, ITALY

PURPOSE
To evaluate functional and quantitative parameters of extraocular muscles (EOM) in patients affected by thyroid orbitopathy who underwent an experimental pharmacologic treatment protocol.

MATERIALS & METHODS
From March 2005 to October 2006, 30 patients underwent MR examinations (Philips Intera Achieva 1.5T) before (group A1) and after (group A2) the therapy and their data were compared to 10 healthy subjects (group B). On the four rectus muscles coronal and axial diameters and the areas at the largest extent of the muscle belly were evaluated on T1-weighted images as well as peak enhancement ratio (rP) versus temporalis muscle and maximum intensity peak in time-intensity curves were calculated on a dynamic CE fat-suppressed sequence. Statistical analyses were performed by t student test between group B and A1 and A1 and A2.

RESULTS
Diameters and areas of each EOM were bigger in group A1 than B (p < 0.001); peak enhancement ratio versus temporalis muscle was higher in group B (p < 0.001) and maximum intensity peak was faster in group B (p <0.001). After therapy the differences were not statistically significant (p > 0.005) for either quantitative and functional parameters even if a functional improvement was described.

CONCLUSION
Dynamic CE fat-suppressed sequence provides optimal parameters concerning functional abnormalities correlated with the clinical course of the disease. They are useful in evaluating both effectiveness and dose-related changes of extraocular muscles involvement in thyroid orbitopathy. Furthermore this new metil-prednisone-based therapy is emerging in clinical practice so that it needs a safe and appropriate confirmation which can be achieved only by evaluation of clinical data as well as muscles functional and quantitative analysis performed by MR study.

KEY WORDS: Dynamic CE fat-suppressed MR imaging, thyroid orbitopathy
Quantitative MR Imaging of the Orbit: Age-Related Changes in the Intraorbital Structures

Sugarman, M. · Jara, H. · Irving, R. · Sakai, O.
Boston University
Boston, MA

PURPOSE
Orbits can be involved in many clinical conditions such as infection, inflammation including various connective tissue disorders, neoplasms, and endocrine disorders. It is not well known to what extent the information of MR imaging, particularly the pixel intensities may be diagnostic or confounded by normal aging patterns. The purpose of this work was to study the normal aging patterns of T1, proton density (PD) and T2 measurements in orbital structures.

MATERIALS & METHODS
MR images through the orbits were obtained with the mixed-TSE pulse sequence (0.9x0.9x3 mm³ voxel) in 32 research subjects (64 orbits) without known orbital abnormalities (23-87 years, mean 49.0) by 1.5T MR unit. Using a rectangular region of interest (ROI), T1, T2 and PD were simultaneously measured in the intraorbital structures (vitreous body, anterior chamber, retrobulbar fat, lateral and medial rectus muscles (EOMs), optic nerve, lens, lacrimal gland) as well as in the extraorbital structures (CSF, corpus callosum, mas- seter muscle, buccal fat).

RESULTS
The vitreous body, anterior chamber and CSF showed age-related increases in T1 and T2 and nonmeasurable age-related changes in PD. Age-related increase was observed in T1 in the retrobulbar fat, but not in the buccal fat (Fig). No age-related changes were observed in T2 value of the retrobulbar or buccal fat. PD values showed insignificant age-related decreases in the retrobulbar fat, while the buccal fat showed very large age-related increase in PD. Compared to the corpus callosum, the optic nerve showed higher T1 values with age-related increase and higher T2 values without age-related change. PD values were essentially the same in these structures with slight age-related increase. EOMs and mas- seter muscles showed no age-related change in T1, but age-related increase in T2, which was greater in the EOMs. EOMs showed a small age-related increase in PD, while the masseter muscles showed a very large age-related increase. The lens showed a small age-related decrease in T1, large decrease in T2 and large increase in PD. The lacrimal gland showed small age-related decrease in T1 and PD and large age-related increase in T2.

CONCLUSION
T1, T2, and PD Q-MRI normal aging patterns of the orbital structures and basic tissue types have been measured. Several Q-MRI parameters show distinct age-dependences. Paradoxically, some basic tissue types appear to age differently in the orbit compared to the extraorbital tissues. These results may be instrumental for diagnosing clinical conditions affecting the orbits as well as for monitoring age-related changes.

KEY WORDS: Orbit, MR imaging, aging

Orbital Blowout Fractures: Further Observations

Hines, N. · Lantos, G. · Chiu, P.
Jacobi Medical Center and Albert Einstein College of Medicine
Bronx, NY

PURPOSE
The mechanism of orbital blowout fracture remains controversial. Hypotheses include transiently increased orbital hydraulic pressure as well as transmitted forces resulting in buckling of orbital wall structures. Because of the close proximity of the nasal bones to the medial orbital wall, we wanted to examine the hypothesis that nasal fractures might be more frequently associated with lamina papyracea fractures than with orbital floor fractures if the buckling mechanism were responsible for some of the fractures. Furthermore, some authors believe that medial wall (lamina papyracea) fractures should be less frequent than orbital floor fractures because of the support provided by ethmoid septa to the medial orbital wall. Nonetheless, the relative frequency of involvement of the medial wall vs the orbital floor is also controversial, with various reports giving different frequencies. This prompted us to review our experience with orbital blowout fractures.
Bisphosphonate-induced osteonecrosis has been reported extensively in oral-maxillofacial surgery and medical oncology journals. The condition and its imaging findings have not been published to a sufficient degree in the radiology literature, with the exception of recent case reports. We present the imaging features of this not so rare condition with the aim of trying to identify imaging findings that may help in distinguishing it from similar appearing conditions such as osteomyelitis and osteoradionecrosis. It is important that radiologists be aware of osteonecrosis as a complication of bisphosphonate use as these patients often are imaged with panorex radiographs and computed tomography (CT).

**Materials & Methods**

We retrospectively reviewed the medical records and imaging studies of 15 patients with bisphosphonate-induced osteonecrosis. Data collected included patients' demographics, symptoms and exam findings; diagnosis leading to bisphosphonate therapy; relationship of osteonecrosis onset to prior dental procedures; mandibular or maxillary involvement; findings on imaging studies including pattern of bony change, presence of pathologic fractures, sequestra, or fistulae; culture results; and management. The imaging features of three patients with mandibular osteomyelitis, one patient with osteoradionecrosis, and one patient with florid osseous dysplasia also were reviewed.

**Results**

The patients included 11 females and 4 males ranging in age from 48 to 78 years (mean = 63). Of the 15 patients, nine had metastatic breast carcinoma, four osteoporosis, three multiple myeloma, and one prostate carcinoma. The onset of osteonecrosis followed a dental procedure in all 15 patients (tooth extraction in 14 and mandibular torus resection in one). The patients presented predominantly with symptoms of pain, swelling, and V3 paresthesia. Exposed, necrotic bone was identified clinically. Eight patients were imaged with both CT and panorex views, seven with panorex alone, and one patient had magnetic resonance (MR) imaging. The mandible alone was involved in 13 patients, the maxilla alone in two patients, and both mandible and maxilla in one patient. Imaging findings included predominantly sclerotic (3/15), lytic (2/15) or mixed (9/15) areas of bony change often associated with periosteal reaction. Sequestra were noted in three cases. Pathologic fractures were identified in three patients and an oral-antral fistula was noted in one. No gas was noted at any of the osteonecrosis sites and no fluid collections suggestive of abscess were present. Patients were managed conservatively, with hyperbaric oxygen, or with surgery including debridement, local excision, or wide resection with reconstructive surgery.

**Conclusion**

Bisphosphonate-induced osteonecrosis can affect the maxilla or mandible and without the appropriate clinical knowledge, can be indistinguishable from osteomyelitis on imaging. As the indications for the use of bisphosphonates are expected to broaden in the future, it is important for radiologists to be aware of this clinical entity and to suggest this diagnosis in the appropriate clinical setting.

**Key Words:** Mandible, osteonecrosis, bisphosphonate
Paper 151 Starting at 11:02 AM, Ending at 11:10 AM
Randomized Controlled Trial of a Diagnostic Test Assessing Physicians’ Treatment Decision: Does a Screening Sinus CT Reduce Antibiotic Prescription for Patients Presenting with Acute Sinusitis Symptoms?

Anzai, Y. · Neighbor, W. · Watts, M. · Jobe, K. · Megassy, P. · Jarvik, J.
University of Washington
Seattle, WA

PURPOSE
Physicians often prescribe antibiotics without definitely knowing whether an individual patient with sinusitis symptoms is infected or not. Over-prescription leads to antibiotic resistance infection and increased health care costs. This is in part due to lack of an inexpensive definitive diagnostic test to differentiate virus from bacterial sinus infection. The purpose of this study is to determine if a screening sinus CT reduces antibiotic prescription for patients presenting with acute sinusitis symptoms.

MATERIALS & METHODS
We performed a randomized controlled trial of screening sinus CT performed in the primary care/urgent care clinics from a single academic institution. Patients with acute sinusitis symptoms whose primary care physicians were considering antibiotic prescription were randomized to 1) immediate screening sinus CT, and 2) no imaging with usual care. We asked clinical referring clinicians about the necessity of antibiotics at the time of enrollment and followed patients to determine if antibiotics were subsequently administered. We measured symptoms and sinusitis-related quality of life using the well validated Sino-Nasal Outcome Test (SNOT-20), and duration of illness at the time of presentation.

RESULTS
To date, 46 patients were enrolled, 21 were randomized to CT arm, and 25 were no imaging study. Table 1 summarizes patient demographics, SNOT-20 score, and duration of illness at the time of presentation. The Table demonstrates the success of randomization with no significant difference between two study arms. Two patients randomized to CT arm did not undergo CT due to scheduling conflicts. Of 19/21 patients who underwent screening sinus CT, six patients had positive CT scans for acute sinusitis (air-fluid level and purulent secretion), and 13 patients had negative CT scans (mild mucosal thickening only or normal CT). Twenty of 25 patients in the no imaging arm received antibiotic prescriptions (80%), as opposed to 11/21 patients in the CT arm (52%). Despite negative CT scans, seven patients received antibiotic prescriptions.

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<thead>
<tr>
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<th>CT arm</th>
<th>No imaging arm</th>
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<tr>
<td>Age (average)</td>
<td>37.4</td>
<td>42.8</td>
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<tr>
<td>Gender</td>
<td>14F:7M</td>
<td>13F:12M</td>
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<tr>
<td>SNOT-20 score average</td>
<td>51.9</td>
<td>48.4</td>
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<tr>
<td>Duration of illness</td>
<td>8.96 days</td>
<td>8.68 days</td>
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</table>

CONCLUSION
A randomized controlled trial of a diagnostic test is a powerful research design to assess the impact of diagnosis on treatment decisions. Screening sinus CT resulted in 30% reduction of antibiotic prescription compared to no imaging arm. These preliminary results demonstrate that 62% of patients with sinusitis symptoms had no CT evidence of acute sinusitis. Despite the negative diagnostic test, primary care physicians treated some patients with antibiotics. The reasons given for the antibiotic prescriptions were long duration of illness, concern for other respiratory tract infection, patients’ history of asthma, and good response to antibiotic treatment in the past medical history.

KEY WORDS: Randomized controlled trial, CT, sinusitis

Paper 152 Starting at 11:10 AM, Ending at 11:18 AM
Kuttner’s Tumor of the Major Salivary Glands: Imaging Features Can Mimic Malignancy

Wallach, A. P. · Patel, S. G. · Carlson, D. L. · Shah, J. P. · Stambuk, H. E.
Memorial Sloan-Kettering Cancer Center
New York, NY

PURPOSE
Kuttner’s tumor is a term used to describe chronic sclerosing sialadenitis (CSS) of the major salivary glands and is seen more commonly in the submandibular gland. Imaging features can often be nonspecific, and the condition can mimic a malignant tumor on radiologic imaging with significant impact on therapeutic decision making. We present two cases of Kuttner’s tumor to highlight the radiologic imaging features and the dilemma in therapeutic decision making that these tumors can pose.

MATERIALS & METHODS
Two cases with the final diagnosis of CSS were identified from institutional data bases and their medical records were reviewed retrospectively for clinical and histopathologic features. CT and MR scans were reviewed for imaging features.

RESULTS
Case 1. A 63-year-old female presented with an enlarged right submandibular salivary gland that she had first noted 4 months prior to seeking medical attention. Clinical examination was consistent with chronic right submandibular gland sialadenitis with no discretely palpable parenchymal mass. Fine needle aspiration cytology was inconclusive. MRI revealed a 1.4cm, enhancing, T2 moderately hyperintense, focal, round intraparenchymal mass in the right submandibular gland. Surgical excision confirmed the diagnosis of CSS. Case 2. A 77-year-old female presented with a firm 3cm mass in the left retromandibular region. Facial nerve function was intact and the tumor was clinically thought to be a deep lobe parotid tumor. On noncontrast CT scan of the neck, an ill-defined mass was noted from the deep lobe of the left parotid gland extending into the superficial lobe. There was obvious extraparenchymal extension with tumor infiltration into the posterior belly of the digastric muscle. A working diagnosis of a malignant tumor was made and the patient underwent a total parotidectomy with a plan for intraoperative frozen section confirmation of histology and facial nerve sacrifice if dictated by intraoperative findings. The main trunk of the facial nerve and its peripheral branches were found to be encased by the tumor. In spite of multiple biopsies, frozen section analysis was reported to show a fibroinflammatory lesion. The lack of a malignant diagnosis
created an intraoperative dilemma regarding sacrifice of a functioning facial nerve. A decision was taken to attempt preservation of the nerve, and the tumor was carefully dissected from the main trunk, the upper division and its branches, the lower division and its buccal branch. The marginal mandibular and cervical branches of the lower division were intimately enmeshed within the lesion and had to be sacrificed along with a cuff of the posterior belly of the digastric muscle. Histopathologic examination of the specimen confirmed the diagnosis of CSS.

CONCLUSION
Two cases of CSS with differing radiologic features are presented to raise awareness of this entity. CSS easily can be confused with a neoplasm and may even have features suggestive of an aggressive malignant tumor on imaging. Clinical correlation is crucial and histologic diagnosis of malignancy is imperative prior to sacrifice of a functioning facial nerve in patients with tumors of the parotid even if they look obviously malignant on radiologic imaging.

KEY WORDS: Kuttner’s, salivary gland, imaging

Paper 153 Starting at 11:18 AM, Ending at 11:26 AM

Quantitative MR Imaging of the Parotid Gland Using Mixed-TSE Sequence and Semiautomated Segmentation: Age-Related Change in the Parotid Gland

Konowicz, A. • Jara, H. • Fedele, J. • Sakai, O.
Boston University
Boston, MA

PURPOSE
Parotid glands often are involved in connective tissue disorders and other inflammatory and infection diseases. Parotid gland composition includes variable percentages of lymphoid and glandular tissues and also fat. Variable degrees of fatty infiltration often are seen in the gland and the question arises as to whether the fat fraction is the result of normal aging or due to a chronic inflammatory process. The purpose of this work was to study normal age-related changes in PD, T1, T2, and volume of whole parotid glands using multispectral quantitative MR imaging (MRI) and dual-clustering segmentation.

MATERIALS & METHODS
Images through the parotid glands were acquired with the mixed-TSE pulse sequence (80 contiguous slices, 0.9x0.9x3.0 mm³ voxel) in 32 research subjects by 1.5T MRI. The parotid glands were segmented using semiautomated dual-clustering technique. Then, T1 and T2 spectra of the whole parotid glands were generated.

RESULTS
Our quantitative MRI using mixed-TSE pulse sequence and semiautomated technique was successful to separate glandular tissue from fat and allow analyzing their volumes and T1, and T2 values. Fat percentage increased with age (Fig. 2). The linear relationship between fat content and age was statistically significant for both T1 and T2 models (p <0.0001). No statistically significant relationship was found between age and total gland volume or fat fraction and total volume (p >0.5). Spectrally, the T1 peak positions of parenchyma and fat were found age-independent (p >0.3).

CONCLUSION
The presented Q-MRI technique could separate the fat from the glandular tissue in the parotid glands and allowed quantitative analysis separately. With aging, increased fat volume is noted with relatively constant total glandular volume (i.e., fat replacing the glandular tissue). Furthermore, the “quality” of the remaining glandular tissue fraction as characterized by the positions of the T1 and T2 spectra appears to be age-independent.

KEY WORDS: Salivary gland, MR imaging, aging

Paper 154 Starting at 11:26 AM, Ending at 11:34 AM

Extracranial and Lymphatic Spread of Glioblastoma to the Parotid Gland and Neck

Ginsberg, L. E.
The University of Texas M. D. Anderson Cancer Center
Houston, TX

PURPOSE
Extraneural involvement by GBM, despite its highly malignant nature, is very uncommon. We present an unusual case of GBM in which extracranial extension led ultimately to lymphatic dissemination of tumor to involve cervical nodes and the parotid gland.

MATERIALS & METHODS
A 24-year-old male presented with episodic confusion. MR imaging revealed an irregularly enhancing and centrally necrotic left temporal lobe tumor. This lesion was subtotally resected elsewhere, and histologically identified as GBM. At our institution, despite repeat craniotomy for further tumor resection, the lesion recurred massively, with radiographic-ly evident extension into the left orbit and extracranially into the suprazygomatic aspect of the left masticator space. This disease was completely resected, but unnoticed at that time were multiple enhancing masses within the left parotid gland. On follow-up imaging, there was no apparent orbital or extracranial recurrence, but the intraparotid lesions were enlarging. Subsequent imaging revealed cervical adenopathy as well. The patient was referred to Head and Neck Surgery.
RESULTS
The patient underwent left parotidectomy and neck dissection. Metastatic GBM was found within the parotid gland and in four of 23 lymph nodes.

CONCLUSION
Even though extraneural spread of GBM is very rare, this possibility needs be considered when previous surgical procedures have been performed, such as biopsies, ventricular shunting or repeated craniotomies. In our case, it is likely that the extracranial spread of tumor facilitated lymphatic dissemination to the intraparotid and cervical lymph nodes. Specifically, the proximity of the site of extracranial tumor extension in our patient, relative to the parotid gland, made spread by lymphatics a reasonable diagnosis radiographically. Although routine neck imaging hardly seems indicated in cases of posttreatment GBM, for those cases that entail extracranial extension, the possibility of lymphatic dissemination should be considered.

KEY WORDS: Brain, neoplasm, cervical nodes

Paper 155 Starting at 11:34 AM, Ending at 11:42 AM
Clival Chordoma: Radiologic-Pathologic Correlation
Bleicher, A. G. · Branstetter, B. F. · Hamilton, R. · Murdoch, G. · Kellermieir, H. C.
University of Pittsburgh Medical Center
Pittsburgh, PA

PURPOSE
Chordomas are malignant neoplasms that derive from notochordal remnants. They are encountered most commonly in the clivus, although they may be seen anywhere along the anterior spinal column. The classic radiologic appearance is that of an erosive mass with uniform high T2 signal. The purpose of this study was to determine how often clival chordomas have this classic appearance, and to determine whether MR characteristics of this tumor correspond to pathologic characteristics.

MATERIALS & METHODS
We reviewed our electronic medical record to identify patients with clival chordomas who had undergone MR imaging for local staging. Two fellowship-trained neuroradiologists, under consensus review, characterized the T1, T2, and diffusion-weighted imaging (DWI) signal, as well as contrast enhancement of the lesions compared to the pons and cerebrospinal fluid. Preoperative and recurrent tumors were evaluated separately. We compared these findings to the histopathologic results after resection, as determined in consensus by three neuropathologists.

RESULTS
Peroperative MR images were available on 11 patients, and 14 patients had MR imaging of recurrent tumors. The imaging findings in preoperative cases are summarized in the Table. Higher myxoid content histopathologically correlated with lesser contrast enhancement, but the other radiologic parameters failed to correlate with histopathologic descriptors.

CONCLUSION
The most striking feature of clival chordomas on MR imaging is their variable appearance. Chordomas may have any signal intensity on T1, T2, and DWI, and may have variable degrees of contrast enhancement. Chordomas may mimic pituitary adenomas, epidermoid tumors, or craniopharyngiomas, as well as the classic differential of chondrosarcoma. Contrast enhancement of these tumors may correspond to the percentage of myxoid material within the tumor.

KEY WORDS: Chordoma

Paper 156 Starting at 11:42 AM, Ending at 11:50 AM
Clinical and Radiographic Manifestations of Extraosseous Chordoma
Nguyen, R. P. · Harnsberger, H. R. · Salzman, K. L. · Wiggers, R. W. · Ahuja, A. · Stambuk, H. E.
1University of Utah, Salt Lake City, UT, 2Chinese University of Hong Kong, Hong Kong, HONG KONG, 3Sloan-Kettering Memorial Cancer Center, New York City, NY

PURPOSE
Chordomas are a relatively rare tumor of the skull base and axial spine thought to originate from the embryonic remnants of the notochord. Chordomas arising from the clivus are typically intracranial with extensive lytic bone destruction. We present four cases of primarily extraosseous chordoma involving the nasopharyngeal spaces. A review of notochordal embryology will be presented along with this case series in order to explain this variant tumor location.

MATERIALS & METHODS
Four pathologically proved cases of extraosseous chordoma of the nasopharynx seen or reviewed at our institution over the last decade had their clinical and imaging records reviewed. Images were declassified of any identifying information making the study HIPPA compliant.

RESULTS
The primary clinical complaint in the four patients with extraosseous nasopharyngeal chordoma was nasal obstruction. All had both CT and MR preoperative imaging. Volumetric analysis demonstrates the majority of the tumor within the nasopharynx. Bony lytic-destructive findings to the anterior surface of the clivus were seen on 4/4 CT studies. A midline clival tract was seen in 2/4 patients’ CT studies. MR imaging showed low to intermediate T1 signal (4/4) with heterogeneous intermediate T2 signal (4/4).

CONCLUSION
Extraosseous nasopharyngeal chordoma is a rare lesion. As the embryonic notochordal tract normally enters the midline nasopharyngeal soft tissues, this tumor is not unexpected to arise in this location. When imaging shows a midline clival tract associated with a mass in the nasopharyngeal soft tis-
sues, chordoma enters the differential diagnosis. High T2 signal reported with the more common clival chordoma is not seen in extraosseous nasopharyngeal chordoma however.

**Key Words:** Chordoma, extraosseous

**Paper 157 Starting at 11:50 AM, Ending at 11:58 AM**

**Radiologic Response of Vestibular Schwannomas to Gamma Knife Therapy**

Ho, A. · Branstetter, B. F. · Bleicher, A. · Seo, S. · Escott, E.

University of Pittsburgh

Pittsburgh, PA

**Purpose**

Gamma knife stereotactic radiosurgery is a noninvasive method for controlling the growth of intracranial neoplasms. It has become a popular alternative to conventional surgical resection in the treatment of vestibular schwannomas. Although tumor control rates of 97% are reported in the literature, there have been no large-scale studies describing the expected changes of treated tumors on surveillance MR imaging. The purpose of this study was to confirm earlier research on the response of vestibular schwannomas to gamma knife therapy in a large patient population.

**Materials & Methods**

A retrospective review of our electronic medical record revealed 971 patients with vestibular schwannomas who had undergone surveillance MR examinations after gamma knife therapy. Two head and neck radiologists established guidelines for a team of reviewers to evaluate and measure imaging findings. The following parameters were measured specifically on sequential surveillance examinations: lesion growth/regression, heterogeneity of contrast enhancement, and increase/decrease of intracannilicular extent.

**Results**

Six months after gamma knife therapy, only 4% of schwannomas had decreased in size. By 2 years, however, more than half of the tumors had become smaller than their size at the time of treatment. Twelve percent of schwannomas initially increased in size, but then shrank, presumably due to post-treatment edema. Six months after therapy, the cystic component of the tumor became predominant in 75% of cases, but after 2 years, this figure fell to 25% as the tumors began to fill in with enhancing tissue. Few tumors (8%) extended further into the internal auditory canal after treatment, and 25% of tumor eventually had decreased intracranial extent. The response of schwannomas to gamma knife therapy could be classified into several reproducible categories: simple shrinkage, simple growth, initial edema with eventual shrinkage, and cystic change with contrast filling and eventual regrowth.

**Conclusion**

The MR findings of vestibular schwannomas treated with gamma knife radiosurgery can be classified into several reproducible patterns. Radiologists should be familiar with these patterns so that expected posttreatment findings are not confused with recurrent tumor, and so that patients who are at greater risk for recurrence can be monitored closely.

**Key Words:** Vestibular schwannoma, gamma knife radiosurgery, surveillance MR imaging

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**Tuesday Morning**

**10:30 AM – 12:00 PM**

**Grand Ballroom B**

(19d) PEDIATRICS: Misc. Neoplasms, Trauma, Other and New Techniques

(Scientific Papers 158 – 168)

*See also Parallel Sessions*

(19a) PEDIATRICS: Diffusion Tensor Imaging

(19b) VASCULAR INTERVENTIONAL

(19c) HEAD AND NECK: Orbit, Face, New Techniques, Other

Moderators: Timothy N. Booth, MD

Michael C. Morriss, MD

**Paper 158 Starting at 10:30 AM, Ending at 10:38 AM**

**Assessment of Reproducibility of Brain Proton MR Spectroscopic Imaging in Children**

Abdalla, W. M. A. · Degaonkar, M. · Barker, P. B. · Horska, A.

The Johns Hopkins University

Baltimore, MD

**Purpose**

The aim of our study was to evaluate the reproducibility of brain proton MR spectroscopic imaging (MRSI) in healthy children and adolescents.

**Materials & Methods**

Ten healthy children (7 M, 8.6-17.6 years old) were examined. Proton MRSI was performed in four 15 mm thick slices, with TR/TE=2000/140 ms at 1.5T. Data were collected twice; the second scan was completed within 6 weeks of the initial examination. Spectra were evaluated in six brain regions (Wernicke area, temporal-occipital white matter, occipital cortex, dorsolateral prefrontal cortex, corona radiata, motor cortex) using an in-house program “csx3”. Metabolite ratios choline/creatinine (Cho/Cr) and N-acetyl aspartate (NAA)/Cr were calculated. Inter-rater reproducibility was evaluated by two raters. Using a common template, the first rater identified one voxel within the region of interest, while the second rater identified two or more voxels in the same region for analysis. One rater evaluated the scan-rescan reproducibility data (using at least two voxels per region). Intraclass correlation coefficients (ICCs) were computed to assess the agreement in metabolite ratios between the raters and between the two scans.
RESULTS
Since no difference in metabolite ratios between the left and right hemispheres was detected, data were averaged for the comparisons. For the inter-rater reproducibility, Cho/Cr ratio showed a better agreement between the two raters (ICC=0.93, p<0.001) than the NAA/Cr ratio (ICC=0.79, p<0.001). In individual regions, the best inter-rater agreement for Cho/Cr was achieved in the motor cortex while for NAA/Cr it was in the temporal-occipital white matter. Similarly as for the inter-rater reproducibility, agreement between two separate scans was better for Cho/Cr (ICC=0.88, p<0.001) than in NAA/Cr (ICC=0.64, p<0.001). In individual regions, the best agreement was achieved in the corona radiata for both Cho/Cr and NAA/Cr ratios (Figure, 13.5-year-old boy, baseline and follow-up spectra). In general, the lowest reproducibility in both analyses was detected in the occipital cortex.

CONCLUSION
Our data demonstrate that good overall reproducibility in Cho/Cr and NAA/Cr metabolite ratios can be achieved in children, although some regions show better agreement than others. The variable results among the regions may be due to metabolite differences within the individual regions of interest themselves, differences in spectral quality (which is affected by susceptibility artifacts in some regions), and possible differences in sampled regions due to variations in positioning of the subjects in the scanner. These factors are particularly important in the planning of and evaluation of data from longitudinal studies.

KEY WORDS: Reproducibility, MR spectroscopy, healthy children
CONCLUSION
Localization of brain function is less well understood at younger ages. Our study demonstrated association between frontal white matter NAA levels and measures of manual dexterity and speed, and working memory. Since the frontal lobe is affected by a number of brain pathologies, our data may provide a quantitative basis for assessment of frontal lobe impairments in disease states.

KEY WORDS: MR spectroscopy, brain, pediatric

Paper 160 Starting at 10:46 AM, Ending at 10:54 AM
Differentiation of Encephalitis from Astrocytomas in Pediatric Patients by Quantitative In Vivo MR Spectroscopy

Panigrahy, A. · Krieger, M. · Gonzalez-Gomez, I. · Gilles, F. · Finlay, J. · Nelson, M. D. · Bluml, S.
Children’s Hospital Los Angeles
Los Angeles, CA

PURPOSE
While most encephalitic processes can be distinguished from astrocytomas with conventional MRI, there are a subset of lesions which cannot be differentiated. The purpose was to determine metabolic features of untreated encephalitis which may differentiate this process from untreated astrocytomas in pediatric patients using quantitative proton MRS.

MATERIALS & METHODS
MR spectra of 12 patients with encephalitis were analyzed. All spectra were acquired from lesions. Encephalitis was confirmed by laboratory values, clinical course and/or biopsy. Data from 26 patients with untreated astrocytoma (14 grade II, III astrocytoma including two patients gliomatosis cerebri, 12 diffuse intrinsic brain stem glioma) and 141 control patients were compared. All spectra were acquired on 1.5T GE scanner using a PRESS sequence with short echo time (TE=35ms). Automated processing with LCModel software was performed.

RESULTS
When comparing encephalitis and astrocytoma, myoinositol (ml) was significantly reduced (p<0.000001, unpaired, two-tailed t-test). N-acetyl-aspartate (NAA) was significantly higher in encephalitis than in astrocytoma (p<0.01) (Table).

<table>
<thead>
<tr>
<th>Table: Metabolite concentrations (mmol/kg)</th>
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<tr>
<td>Encephalitis</td>
</tr>
<tr>
<td>Subjects</td>
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<td>Age</td>
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Notes: *p<0.01, **p<0.001, ***p<0.0001, ****p<0.00001 versus encephalitis (unpaired, two-tailed t-test). Lactate concentrations are reported in mmol/liter volume. Glx = Glu+Gln, absolute intensity (arbitrary units)

When NAA was plotted versus ml, there was complete separation of data points from tumors and encephalitis patients (Fig 1).
**Conclusion**

Brain lesions due to encephalitis have a metabolic fingerprint that is significantly different from that of astrocytoma. This is useful when the pattern on MRI and clinical data are inconclusive. Accurate noninvasive diagnosis of encephalitis is important as biopsies with potential complications could be avoided.

**Key Words:** MR spectroscopy, encephalitis, pediatrics

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**Paper 161 Starting at 10:54 AM, Ending at 11:02 AM**

**Metabolism of Unidentified Bright Objects in Neurofibromatosis Type-1**

Mohamed, M. A. · Abel, J. R. · Cutting, L. E. · Barker, P. B.

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**Purpose**

The pathophysiology associated with T2 hyperintense lesions (unidentified bright objects, or UBOs) in patients with neurofibromatosis type-1 (NF1) is unclear. Proton MR spectroscopic imaging (MRSI) allows the measurement of various compounds [N-acetyl aspartate (NAA), creatine (Cr) and choline (Cho)] that are related to tissue cellular composition (neurons, glial cells). This study therefore was undertaken to: 1) measure UBO metabolism in patients with NF1 using high-resolution proton MRSI and 2) correlate UBO metabolite ratios with neuropsychological tests.

**Materials & Methods**

Sixteen children with NF1 (7 to 15 years old, 8 males and 8 females) and 16 age- and gender-matched healthy control subjects underwent a battery of neuropsychological tests, brain MR imaging and proton MRSI in a 1.5T magnet. MRSI was performed using a multi-slice spin-echo pulse sequence (TR/TE = 1900/280 msec) with CHESS water suppression and outer-volume lipid suppression. Three 15 mm thick slices (gap 2.5 mm) were recorded covering from the cerebellum to the centrum semiovale. The size, location and mean intensity of UBOs seen in T2-weighted images were recorded. Peak areas in spectra from the UBOs and corresponding locations in the control subjects were integrated. Ratios of metabolite peak areas for NAA, Cr and Cho were calculated. Student t-tests were used to determine between group differences. Correlations between UBO metabolite ratios and neuropsychological tests were evaluated.

**Results**

Forty-two UBOs were identified in 16 NF-1 subjects; however, only 22 UBOs were covered by the MRSI slice locations (and also had good comparison regions in control subjects) and included in this study. UBOs were mainly found in the basal ganglia (Fig1), thalamus, cerebellum, midbrain, and frontal white matter. There was significant decrease in NAA/Cho (p = 0.0016) and increase in Cho/Cr (p = 0.03) in UBOs as compared to matched locations in healthy controls. The mean ± SD of NAA/Cho was 1.04 ± 0.5 and 1.48 ± 0.35 in UBOs and controls respectively, and was 2.08 ± 1.2 and 1.55 ± 0.5 for Cho/Cr in UBOs and controls respectively. There also was significant positive correlation between NAA/Cho and judgment of line orientation (JLO) neuropsychological test (p = 0.025).

**Figure 1.** Right basal ganglia UBO in a 7-year-old NF1 male subject.

**Conclusion**

The findings of increased Cho/Cr and reduced NAA/Cho in UBOs (which correlates with cognitive impairment in these children) suggest neuroaxonal loss and increased myelin turnover, consistent with myelin vacuolation in patients with NF1.

**Key Words:** Unidentified bright objects, neurofibromatosis, MR spectroscopic imaging

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**Paper 162 Starting at 11:02 AM, Ending at 11:10 AM**

**MR Spectroscopy Findings in Patients with Zellweger Syndrome**

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1University of Arkansas for Medical Sciences, Little Rock, AR, 2Arkansas Children’s Hospital, Little Rock, AR, 3Cincinnati Children’s Hospital Medical Center, Cincinnati, OH

**Purpose**

Zellweger syndrome (ZS) is an autosomal recessive disorder arising from defects in peroxisome biogenesis. The metabolic consequences can include elevated long chain fatty acids and elevated phytanic acid. ZS is typically seen in the neonatal period with features such as dysmorphic skull, muscle hypotonia, seizures, and progressive degeneration of kidneys and liver. Using proton MR spectroscopy, we sought to evaluate patients for evidence of biochemical abnormalities in the brain, useful for diagnosis and characterization of the disorder.

**Materials & Methods**

This study employed brain MR imaging (MRI) and MR spectroscopy conducted at 1.5T. We examined five patients. The four infant patients ranged in age between 3 days to 23 days. One male patient previously diagnosed with ZS was admitted for diminished mental status at 3 years of age. All patients had an MRI examination performed with only four patients having MR spectroscopy completed. The patients were ultimately diagnosed with ZS based upon results from clinical, laboratory and imaging studies.

**Results**

Conventional brain MRI for two of the infant patients revealed polymicrogyria and hypoplasia of the corpus callosum. The two other infant patients showed very subtle changes of neuronal migration anomalies. The 3-year-old male patient demonstrated abnormal white matter signal and moderate parenchymal volume loss without evidence of neu-
ronal migration anomalies. MR spectroscopy revealed long chain fatty acid peaks at 0.9 and 1.3 ppm, when sampled in the white matter of all of the patients.

**Conclusion**

The brain features of ZS include neuronal migration anomalies which may be very subtle or absent upon MRI. However, proton MR spectroscopy demonstrated elevated long chain fatty acid peaks which appear to be typical for peroxisomal disorders. With the clinical presentation and metabolic features, the application of proton MR spectroscopy would be helpful from an imaging perspective in reaching a diagnosis of Zellweger syndrome.

**Key Words:** Zellweger syndrome, metabolic, MR spectroscopy

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**Paper 163 Starting at 11:10 AM, Ending at 11:18 AM**

**Posterior Reversible Encephalopathy Syndrome in 36 Children: Clinical Factors and MR Findings**

Booth, T. · Koral, K. · Veltkamp, D. · Rollins, N. · Seikaly, M. · Wright, J. · Waber, P.

Children’s Medical Center

Dallas, TX

**Purpose**

Posterior reversible encephalopathy syndrome (PRES) is well known in adults who present with headaches, confusion, visual disturbances, seizures. The clinical findings are not specific and the diagnosis is made when MR imaging shows vasogenic edema involving predominantly the parieto-occipital region and to a lesser extent the frontal region. Superimposed cerebral infarction is associated with restricted diffusion and pseudonormalized apparent diffusion coefficient (ADC) values. We describe the clinical conditions associated with and the MR abnormalities in a large cohort of children with PRES.

**Materials & Methods**

A computer data base was searched to locate MR studies diagnosed as PRES which was confirmed by two experienced pediatric neuroradiologists. MR sequences included T1-, T2-weighted, FLAIR, diffusion-weighted imaging and ADC maps; 16 also received gadolinium. Medical records were reviewed for clinical presentation and risk factors for PRES, systemic disorders, and medications.

**Results**

There were 36 patients with PRES; mean age 10.9 years (3-16 years), M:F/3:2. Seizure was the most common clinical presentation, followed by altered mental status, headache, and vision loss. Twenty-one patients had renal disorders; in eight the diagnosis was made after the MR study. Twelve patients had had lymphoma or leukemia; two were s/p stem cell transplant. Two patients had sickle cell disease and one had a heart transplant. Thirty-two of 36 had a hypertensive event within 24 hours of the onset of clinical symptoms; four had no documented hypertension. Medications preceding onset of symptoms included methotrexate, cyclosporine, tacrolimus, and L-asparaginase. Four patients had no history of hypertension; all were receiving cyclosporine. MR imaging showed cortical and subcortical edema in all patients; within the parietal (n = 34) and occipital (n = 33) regions; some involvement of the parieto-occipital region was seen in all patients. Additional locations included frontal (n = 23), cerebellar (n = 12), temporal (n = 5) and thalamic (n = 1). Restricted diffusion was identified in 22%. Follow-up MR imaging was obtained in nine patients; two were normal while seven showed gliosis and focal volume loss in regions outside the typical parietal and occipital lobe distribution. The abnormal regions did not consistently correlate with regions of restricted diffusion on the initial diffusion-weighted imaging.

**Conclusion**

The diagnosis of PRES has important therapeutic and prognostic implications as prompt control of blood pressure and/or discontinuing the inciting drug are needed to prevent progression to irreversible cytotoxic edema. Findings by MR imaging in children with PRES may include the cerebellum,
in addition to parietal or occipital lobe. We were unable to document a consistent correlation between restricted diffusion at presentation and subsequent cerebral infarction at follow up.

**Key Words:** PRES, pediatrics, hypertensive encephalopathy

**Paper 164 Starting at 11:18 AM, Ending at 11:26 AM**

**Pituitary Gland in Fetal MR Imaging: Detectability and Imaging Features**

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Medical University of Vienna Vienna, AUSTRIA

**Purpose**
The presence or absence of the pituitary gland is of vital importance for survival. Thus, the proof of existence of the pituitary gland may have an influence on the decision of further management in case of a fetal cerebral malformation. While the pituitary gland can be demonstrated in in vitro MR imaging (MRI) from gestational week (gw) 11 onwards (1), in vivo data about the time of morphologic proof of the pituitary gland are not yet available. The purpose of this retrospective study was to evaluate the detectability of the pituitary gland and infundibulum with in vivo fetal MRI.

**Materials & Methods**
MRI studies of 100 fetuses from gw 16 to 40 (average ± std 28 ± 6) were assessed. Indications for MRI were suspected central nervous system (CNS) or extra CNS pathologies. MRI was performed on a 1.5 T magnet using a cardiac coil (matrix: 256 x 256 (96%) or 512 x 512 (4%); reconstruction diameter: 200-325 mm, slice thickness: 3-6 mm). T1-weighted GRE and T2-weighted SSFSE sequences were used to screen for the pituitary gland and infundibulum. For statistical analysis crosstabs and Chi-Square tests as well as logistic regressions using gw (5 groups à 4 gestational weeks), examination plane, region (head sequence/whole body sequence) and slice thickness as predictors were assessed.

**Results**
The pituitary gland could be detected in 76% of cases, with a significant increase of detectability between group gw 16-20 and 21-24 (14 versus 77%, p < 0.001). It appeared hyperintense on T1-weighted images (Fig 1a) and iso- to hypointense on T2-weighted images. The maximum pituitary diameter was 3 to 8 mm, increasing with gw (Pearson correlation: .693). The infundibulum could be depicted on T2-weighted images in 85% of cases as a hypointense thread (Fig 1b), with a better delineation after week 20 (57 (gw 16-20) versus 86% (gw 21-24); p = 0.048). Gestational week was the only predictor for pituitary detectability.

**Conclusion**
The pituitary gland and infundibulum are detected readily on prenatal MRI from gw 21 onwards. Its presence should be evaluated especially in cerebral midline malformations which may be associated with pituitary pathologies.

**References**

**Key Words:** Pituitary gland, fetal brain, MR imaging

**Paper 165 Starting at 11:26 AM, Ending at 11:34 AM**

**Voxel-Based Morphometric Study in Male Survivors of Childhood Leukemia**

Porto, L.1 · Preibisch, C.1 · Good, C.2 · Kieslich, M.1 · Bartels, M.1 · Zanella, F.1 · Lanermann, H.1

1Uni-Klinikum Frankfurt, Frankfurt, GERMANY, 2Brighton & Sussex University Hospitals NHS Trust, Hurstwood Park, Brighton, UNITED KINGDOM

**Purpose**
Survivors of acute childhood leukemia demonstrate post-treatment neurocognitive deficits in a number of areas. However, there is no definitive understanding of the neuropathology underlying these functional deficits. The aim of this study was to detect morphologic changes in neuroanatomical components in male adult survivors of acute childhood leukemia when compared with matched controls. Our a priori hypothesis was that these patients might demonstrate hippocampal atrophy because acute childhood leukemia has been found to be associated with mesial temporal sclerosis in three cases. Furthermore radiation-induced learning and memory deficits have been observed in an animal model.

**Materials & Methods**
Voxel-based morphometry (VBM) is a whole-brain, unbiased technique for characterizing regional cerebral volume and tissue concentration differences in structural MR images. We used an optimized method of VBM to examine 10 male survivors of acute lymphoblastic leukemia (ALL) (mean age 22.0 +/- 3.2 years, range 18 to 28) and eleven healthy male-matched controls (mean age 22.5 +/- 1.4 years, range 21 to 24). All but one survivor of ALL underwent cranial radiation, all patients received chemotherapy. Imaging was performed on a 3.0T MR head scanner. Structural imag-
RESULTS
VBM showed significantly reduced gray matter concentration within the caudate nuclei and within the thalamus bilaterally in male survivors of ALL. The frontal, mainly periventricular white matter concentration was decreased in both hemispheres. Areas of CSF enlargement were seen bilaterally in the frontal horns of lateral ventricles and at the CSF-filled frontobasal subarachnoid space. The CSF and white matter changes correlate with the deep gray matter concentration reduction. Generally the changes were more pronounced in the left hemisphere. No significant group differences were found in hippocampi.

CONCLUSION
Male survivors of ALL, who received intrathecal Methotrexat and cranial radiation during childhood, demonstrate abnormal concentration reduction within the caudate, thalamus and periventricular white matter with corresponding areas of CSF enlargement. We suggest that the caudate changes are related to irradiation treatment, but may in part reflect adjacent CSF and white matter changes. Interestingly the white matter concentration reduction usually was not associated with white matter abnormalities on diagnostic T2-weighted MR images. Conventional MR imaging is therefore insensitive for predicting long-term CNS damage. Younger age at diagnosis seems to be a predisposing factor for white matter loss. Our hypothesis of hippocampal atrophy was not supported. Our study suggests that the hippocampus may be less vulnerable to treatment than previously suggested.

KEY WORDS: Morphometry, Leukemia

Paper 166 Starting at 11:34 AM, Ending at 11:42 AM
Participation of an Academic Neuroradiology Division in a Peer-to-Peer Ordering Support Program (HealthHelp RadConsult): Early Results

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PURPOSE
To describe the methodology and initial experience of an academic neuroradiology division participating in a radiology peer-to-peer ordering support program (HealthHelp RadConsult).

MATERIALS & METHODS
The RadConsult program provides real time decision support for physicians ordering high-cost outpatient imaging examinations such as CT and MR imaging. HealthHelp has established evidence-based guidelines for ordering these procedures. After review between the provider and HealthHelp personnel, if the provider’s rationale for ordering a procedure is inconsistent with these guidelines (or if no guidelines have been established), a subspecialty radiologist in our department reviews the case. The radiologist can approve the procedure based upon the “chart” review, or call the ordering physician (or their designee) to ensure that the most appropriate test is ordered. If an appropriate contact is unavailable, a message is left; if a return call is not received with 48 hours, the procedure request is deleted. After discussion between the ordering physician/designee and radiologist, possible outcomes for the procedure include: 1) approved by consensus, 2) approved, but no consensus, 3) procedure not performed by consensus, and 4) procedure changed by consensus (to a different CT, MR, PET, or nuclear medicine study); a procedure changed to a modality other than these is recorded as a procedure not performed. Procedures are not denied by the radiologist; if consensus is not reached for studies requiring precertification, the case is referred to the RadConsult medical director. Information is managed on a web-based program maintained by HealthHelp; all patients are enrolled in Humana Health Services. Data recorded for this study included (1) number and type of procedures ordered, (2) referring physician specialty, (3) number of cases approved by chart review, (4) number of cases requiring calls, and (5) disposition of cases requiring calls. We report the early experience of our neuroradiology division in this program.

RESULTS
Four hundred seven procedures (18 procedure types) were reviewed; the most common procedures were MR lumbar spine imaging (70), MR brain imaging (68), and CT brain (56). The most common specialties of referring physicians were internal medicine (77), neurology (59), family practice (56), otorhinolaryngology (51), pediatrics (49), and neurosurgery (41). A total of 145 procedures were approved after electronic “chart” evaluation on the HealthHelp website. Of the remaining 262 procedures involving a phone consultation, 79 were not performed by consensus, 20 were changed by consensus to a different procedure, and one procedure requiring precertification was referred to the medical director (no consensus reached). The procedure most frequently not performed/changed after phone consultation was MR imaging of cervical spine (37%). Overall, 25% of ordered procedures were not performed/changed (38% of procedures involving a phone consultation). Procedures ordered by family physicians were most often “not performed/changed” (41%); procedures ordered by neurosurgeons were least often “not performed/changed” (17%).

CONCLUSION
Real-time decision support provided by subspecialty academic neuroradiologists impacts the performance of high-cost outpatient imaging examinations in a significant minority of cases. This has implications for patient care as well as the overall cost of health care.

KEY WORDS: Guidelines, consultation, consensus
Radiological Classification and Electromagnetic Safety of Adjustable Cerebrospinal Fluid Valves

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¹University of Heidelberg Medical Centre, Diagnostic Radiology, Heidelberg, GERMANY, ²University of Heidelberg Medical Centre, Neurology, Heidelberg, GERMANY, ³University of Heidelberg Medical Centre, Neurosurgery, Heidelberg, GERMANY

PURPOSE
Adjustable cerebrospinal fluid valves (AV) have been inaugurated by Bush & Matson in the early fifties and Kuffer & Strub 1969. Since then AVs have become widely accepted and routinely implanted devices over the last decades. 2006 16 different designs are on the market, using 7 basic constructions. Despite the widespread use of these valves, there is only limited information regarding electromagnetic safety of AVs and no radiological classification available which may be useful for valve identification and evaluation of pressure settings.

MATERIALS & METHODS
We investigated and classified 84 adjustable Medos, 7 Medos Micro-Valves, 2 Medos MicroValves with SiphonGuard 16 Sophy SU8/3, each 1 Sophy Mini SU8/3, 3 Sophysa Polaris, and 6 Miethke ProGAV valves. The valves that were investigated were all adjustable. Tests were dedicated to the adjustability, decentration tolerance and stability in magnetic fields (Siemens Magnetom). Radiological identification was performed using digital flat panels (Siemens Aristos 2) and was based on body design, size, shunt assembly, number of pressure ranges and technical valve details.

RESULTS
Pressure-flow-graphs of AVs showed similar properties of ball-in-cone-valves with fixed adjustment. Except of the early Sophy-specimen the accuracy of new AV-valves was sufficient. After high field MRI Medos-P showed failures in adjustability, probably in high settings; Sophysa Polaris remained adjustable. Radiological examination allowed a complete and precise classification of all adjustable shunts.

CONCLUSION
Radiological determination and identification of adjustable cerebrospinal fluid valves and of pressure settings of adjustable cerebrospinal fluid shunt valves is possible. The accuracy of new adjustable valves is sufficient. Medos-P can be irreversibly changed in high field MRI. The third generation (Miethke ProGAV, Sophysa Polaris) avoids these problems.

KEY WORDS: Hydrocephalus, cerebrospinal fluid valves
Imaging in Alzheimer’s Disease: Past, Present and Future
Jeffrey R. Petrella, MD

LEARNING OBJECTIVES
Upon completion of this presentation, participants will be able to:
1) Review the current role of imaging in the workup of patients with dementia.
2) Discuss the possible role of PET and quantitative structural MR imaging techniques in differential diagnosis and treatment trials in Alzheimer disease.
3) Evaluate the potential of advanced MR techniques in elucidating the pathophysiology of Alzheimer disease, and as possible markers for early diagnosis and treatment monitoring.

PRESENTATION SUMMARY
Imaging has played a relatively minor, though important, role in the diagnostic workup of patients with memory complaints, to rule out potentially preventable or treatable causes of dementia, such as intracranial mass lesions, normal pressure hydrocephalus, infarcts, or other less common pathologies such as thiamine deficiency or Creutzfeldt-Jakob disease (1). In the coming decade, imaging for Alzheimer disease (AD) and related dementias is likely to become a much larger focus in the radiologic community (2). This is driven by the increasing incidence of AD in an aging population, as well as the promise of several disease-modifying therapies currently in the clinical trial pipeline. The future focus will be on early diagnosis at the prodromal and preclinical stages when interventions might have maximal benefit. Screening may be widespread, using a combination of imaging, genetic, serum and CSF biomarker profiles. Serial volumetric imaging will play an increasingly important role in differential diagnosis, early identification, assessment and monitoring of therapeutic interventions. PET and molecular imaging are on the horizon for similar applications (3, 4). New MR imaging approaches are helping unravel the pathophysiology of AD, and also may play a future role in early identification and treatment monitoring (5).

REFERENCES

Alzheimer Disease: Pathology and Therapeutic Targets
David A. Bennett, MD

PRESENTATION SUMMARY
The presentation will review the neurobiologic hallmarks of AD and discuss the current FDA approved treatments, including cholinesterase inhibitors and NMDS receptor inhibitors. It will then go on to discuss six different sets of targets for therapy including ongoing studies aimed at augmenting the cholinergic system with growth factors. It will review AMPA modulation of the glutamnergic system as a potential therapeutic target. It will examine the role of inflammation and oxidative stress and review studies that have addressed these targets. It will review the metabolism
Molecular Imaging in Alzheimer’s Disease

Carolyn C. Meltzer, MD

LEARNING OBJECTIVES
Upon completion of this presentation, participants will be able to:
1) Critically review the role of FDG in the evaluation of Alzheimer's disease
2) Discuss new strategies for disease-specific imaging biomarkers with prognostic, diagnostic, and therapeutic monitoring potential
3) Evaluate the role of imaging in early detection of dementia

PRESENTATION SUMMARY
The public health and financial impact of Alzheimer disease (AD) in our aging society is enormous and increasing. Accordingly, the role of imaging in dementia evaluation is expanding rapidly. An imperative for noninvasive tools with early diagnostic capability has resulted from a targeted focus on developing effective forms of pharmacotherapy for AD. Combined with clinical, neuropsychological, and genetic information, imaging promises to be uniquely useful for diagnosis and therapeutic monitoring, as well as guiding further drug discovery. Novel strategies include applying noninvasive means to identify AD neuropathology among high-risk individuals, such as those with mild cognitive impairment. We will review the use and promise of positron emission tomography with FDG and new amyloid radiotracers in AD and associated neurodegenerative disorders.

Tuesday Afternoon
1:15 PM - 2:45 PM
Columbus I-L

(24) Upper Aerodigestive Tract: Tumor Detection, Staging and Post-Treatment Evaluation (ASHNR)

(173) Carcinoma of the Upper Aerodigestive Tract: Critical Anatomy and Initial Detection
— Hugh D. Curtin, MD

(174) Current Concepts in Imaging Staging of Head and Neck Cancer: Better Accuracy or “Stage Creep”?
— Suresh K. Mukherji, MD

(175) Imaging Evaluations of Treatment Response during and after Therapy: Pearls and Pitfalls
— Lawrence E. Ginsberg, MD

Moderator: Hugh D. Curtin, MD

Carcinoma of the Upper Aerodigestive Tract: Critical Anatomy and Initial Detection

Hugh D. Curtin, MD

LEARNING OBJECTIVES
Upon completion of this presentation, participants should be able to:
1) Recognize the key fat pads that are involved in perineural spread particularly along the second and third division of the trigeminal nerve.
2) Describe the complex anatomy of the junction of the oral cavity and oral pharynx including retromolar trigone, glossotonsillar sulcus and anterior tonsillar pillar.
3) Utilize imaging to assess key osseous structures particularly the mandible.

PRESENTATION SUMMARY
Head and neck carcinoma is almost always diagnosed clinically before the patient comes to be imaged. The anatomy critical to imaging relates to precise determination of the extent of the lesion. Bone involvement is always important. The inner (lingual) cortex of the anterior mandible and the anterior margin of the ramus are of particular importance. Direct soft tissue extension focuses on landmarks such as the midline tongue and the lingual artery. The session explores
the complex anatomy at the junction of the retromolar trigone, anterior tonsillar pillar and the glossoptonsillar sulcus where tumor can extend submucosally from the palate into the tongue margin or extend through the gap between constrictor muscles near the submandibular gland. In the larynx are the ventricle and the superior edge of the cricoid cartilage are key. Nasopharyngeal tumors extend into the skull base in midline or along the petroclival synchondrosis. The most important landmarks in sinonasal tumors are the orbit wall, sinonasal roof, carotid artery and optic nerve. Perineural spread is particularly important. Several fat pads and planes are key to this assessment. Important fat pads include those along the trigeminal II and III. The pterygopalatine fossa is the key landmark for extension along V2 but small fat pads are present at the infraorbital foramen and the palatine foramina nerves at the roof of the mouth. Obviously the bony canals are important as well including foramen rotundum, Vidian’s canal, the infraorbital canal, and the canals for the palate nerves. The third division of trigeminal passes into the trigeminal fat pad just external to foramen ovale. This is the fat pad along the medial aspect of the lateral pterygoid muscle. The gasserian ganglion is the intracranial target for trigeminal perineural spread. Lymph node involvement by cancer changes therapy and prognosis. The nodes are situated in a few characteristic locations. The session will cover several of the key landmarks emphasizing landmarks for detection of perineural spread as well as some of the most important landmarks for direct extension.

**Presentation Summary**

The patient who has imaging following head and neck cancer therapy presents unique difficulty to the radiologist. In terms of treatment efficacy, while on occasion a lesion may resolve completely, more often, with respect to either the primary lesion or one of its sites of spread, there will be some type of residual imaging abnormality for which a distinction between benign tissue and persistent tumor must be made. In order for the radiologist to accurately make this determination, he or she must be familiar not only with the expected effects of that treatment, but those radiologic findings that can be associated reliably with successful treatment, vs those that suggest recurrent or residual tumor. Given the complex variety of such post-treatment situations, this can be very challenging. Getting a properly timed post-treatment baseline study is important, but very often that study presents the radiologist and clinical team with some level of uncertainty for which a follow-up decision must be made. These include alternative imaging (e.g., PET/CT or ultrasound with FNA if necessary), CT-guided biopsy, neck dissection or other surgery, or follow-up imaging at some point in the future. These are difficult decisions determined by a host of patient and clinical factors, and are beyond the intended scope of this presentation. In terms of complications and pitfalls, contributors to the difficulty of post-therapy imaging include significant distortion of anatomy, frequent lack of pre-treatment or baseline post-treatment comparison studies, and a vast array of confusing imaging appearances that may or may not indicate disease recurrence or complication. Certain surgeries result in very typical and predictable postoperative appearances that nonetheless may suggest the presence of disease to the uninitiated. In other cases, the findings are so complex that in a single examination, the determination of disease recurrence borders on impossible. Unfortunately, looking back in retrospect on the subtlety of a finding is of little consolation when faced with obvious recurrent disease that was missed earlier. Other forms of therapy, including chemotherapy and especially radiation therapy, can result in confounding radiologic appearances as well as treatment-related complications that may challenge the radiologist. Obviously, there is no substitute for experience and the lessons learned from prior mistakes to help the radiologist recognize and prevent misinterpretation in this very challenging patient population. It is the goal of this presentation to familiarize the audience with some of the complexities that they may confront when interpreting CT and MR studies in the post-treatment head and neck cancer patient. My presentation will be supported by case material from the M.D. Anderson Cancer Center, where we currently are seeing 45-55 new head and neck malignancies every week, and have a proportionally large group of patients in various stages of follow up undergoing post-treatment surveillance imaging on a daily basis.
Tuesday Afternoon
1:15 PM - 2:45 PM
Columbus EF

(26) ASNR Business Center Programming: Part I

(177) Strategic Planning in Private Practice
— Jonathan Breslau, MD

(178) Strategic Challenges to Radiology in the 21st Century
— Frank J. Lexa, VII, MD

Tuesday Afternoon
3:15 PM - 4:45 PM
Columbus EF

(27) ASNR Business Center Programming: Part II

(179) Protecting Your Private Practice Turf in the 21st Century: Fighting Gravity
— Jonathan Breslau, MD

(180) 300 Million Customers: Patient Perspectives on Service and Quality in Radiology
— Frank J. Lexa, VII, MD
Tuesday Afternoon

3:15 PM – 4:45 PM
Grand Ballroom C-F

(28a) ADULT BRAIN: fMRI
(Scientific Papers 181 – 191)

See also Parallel Sessions
(28b) SPINE: Spinal Injections and Vertebroplasty
(28c) PEDIATRICS: Developmental/ Congenital Malformations and Neonatal Imaging
(28d) INTERVENTIONAL: New Devices and Techniques

Moderators: Edmond A. Knopp, MD
Maresh V. Jayaraman, MD

Paper 181 Starting at 3:15 PM, Ending at 3:23 PM
Comparison of Unilateral and Bilateral Complex Finger Tapping-Related Activation in the Precentral Gyrus

Phillips, M. D. · Horenstein, C. I. · Lowe, M. J.
Cleveland Clinic Foundation
Cleveland, OH

PURPOSE
To understand the etiology of functional MR imaging (fMRI) ipsilateral premotor and motor activation during performance of unilateral motor tasks. We hypothesized that ipsilateral motor activation during unilateral finger-tapping tasks primarily involves premotor regions and reflects a bilateral motor network rather than contralateral inhibition.

MATERIALS & METHODS
Gradient-echo echo-planar imaging fMRI at 3T were obtained in 16 right-handed controls during right hand, left hand and bilateral complex finger-tapping tasks. Performance was monitored with a data glove and analyzed for tapping rate, error rate and unwanted mirror movements. Head motion was monitored using a prospective motion correction method and motion corrupted data sets were discarded. FMRI timeseries data were analyzed using previously described techniques to generate Student’s t maps which were overlaid onto high-resolution T1-weighted images. Talairach transformed data sets were averaged together voxel-by-voxel to generate composite activation maps for each task. In each individual subject, ROIs were defined bilaterally around the primary sensorimotor cortex (SMC), supplementary motor area (SMA), ventral premotor (PMv) and dorsal premotor (PMd) cortex. For all three tasks, activation volume and Student’s t-location of the maximally activated voxel were determined for each ROI. For both the right hemisphere (RH) and left hemisphere (LH), we also identified the percentage of ipsilaterally activated SMC, PMd and PMv voxels (Student’s t>3.5, uncorrected p<5x10^-4) that had spatial overlap with the activation from the contra and bilateral tasks.

RESULTS
All subjects performed the task well with no mirror movements. Data from five subjects was discarded due to motion corruption. Composite activation maps revealed significant ipsilateral cortical activation (p<5x10^-17) in the PMv and the PMd without significant ipsilateral SMC activation. Individual subject analysis revealed similar right and left hemisphere PMv and PMd activation volumes for all three tasks, whereas ipsilateral SMC activation was decreased significantly for all tasks. On individual subject maps the maximally activated pixel in the contralateral brain was typically in the SMC, whereas the maximally activated pixel in the ipsilateral brain was virtually always in the premotor region. The spatial overlap analysis revealed no unique areas of activation during ipsilateral finger tapping. Further, mean percent signal in the overlapping SMC was diminished in the ipsilateral task, whereas, the mean percent signal change of the overlapping voxels in the PMd and PMv was similar for all three tasks. Overall, ipsilateral activation within the SMC/PMd/PMv had an 88%/80%/65% spatial overlap with the activation occurring during contralateral/bilateral finger tapping.

CONCLUSION
During unilateral finger tapping, ipsilateral activation occurred in all subjects, mainly in the PMv and PMd. These regions of ipsilateral activation also were activated during contralateral and bilateral finger tapping for all subjects. The mean percent signal change of activated voxels was similar in PMv and PMd between all tasks, but was significantly less in the SMC during ipsilateral tapping than contra or bilateral tapping. These results suggest that the ipsilateral fMRI activation in unilateral motor tasks is not inhibitory in nature, but may reflect part of a bilateral network involved in the planning and/or execution of tapping in the ipsilateral hand.

KEY WORDS: Functional MR imaging, motor

Paper 182 Starting at 3:23 PM, Ending at 3:31 PM
Altered Basal Ganglia Activation during Complex Finger Tapping in Multiple Sclerosis

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PURPOSE
To evaluate changes in the pattern of functional MR imaging (fMRI) activation in deep brain structures during complex finger tapping in patients with MS.

MATERIALS & METHODS
GE EPI fMRI was performed at 3T on 21 MS and 15 matched controls. Subjects performed a unilateral lateral left (LT), unilateral right (RT) and bilateral complex finger tapping (BT) tasks in an interleaving 32s “rest”/32s “tapping” block paradigm. Task performance was recorded with a data glove and analyzed for tapping rate, error rate and mirror
movements. Head motion was monitored rigorously and data were discarded if motion corruption was present in one or more of the fMRI scans. Time series data were analyzed and Student's t maps were generated and overlaid onto high-resolution T1-weighted images. For each subject, anatomical ROIs were drawn bilaterally around the SMC, SMA, basal ganglia BG (putamen and globus pallidus) and thalamus. Student's t maps and ROIs for each subject were transformed into Talairach space. Talairach transformed Student's t maps were averaged voxel-by-voxel to generate composite maps for each group. For each individual subject, activation volume was determined for each ROI for a range of thresholds from t>2.0 to t>12 and the xyz coordinates of the maximally activated voxel in each ROI were determined. Correlations between the subcortical and cortical activation volumes at a threshold of t>3.5 were determined for MS patients and controls.

RESULTS
Ten control subjects and eight MS subjects demonstrated adequate task performance without mirror movements and no significant head motion. No significant difference in the extent of activation was seen in the SMC, SMA or thalamus between MS and control subjects. MS subjects demonstrated significantly decreased volume of activation within the left BG during BT (control = 509 +/- 366, MS = 201 +/- 167, p < 0.04), right BG during BT (control = 577 +/- 418, MS = 243, p < 0.06) and left BG during RT (control = 839 +/- 735, MS = 185 +/- 283, p < 0.03). No significant difference was identified within the left BG during LT or RT or within the right BG during RT. Control subjects showed strong correlation in activation volume between the ipsilateral SMA and BG for all tapping conditions, r=0.61, p<.06 to r=0.94, p<.0005. Similarly, significant correlations were identified for the ipsilateral BG and SMC in nearly all of the tapping conditions ranging from r = 0.69, p<0.03 to r = 0.85, p < 0.002. No significant correlations between the volume of ipsilateral BG and SMA or BG and SMC were identified in MS subjects.

CONCLUSION
The present study suggests that patients with MS demonstrate significantly reduced activation during motor tasks within the basal ganglia. Further, there is a loss of the strong correlation in the volume of activation between the BG and SMA as well as the BG and SMC seen in control subjects. Findings suggest potential disconnection/disruption of motor pathways involved in complex motor task performance. Note this disconnection is apparent even though subjects maintain an adequate level of task performance.

KEY WORDS: Functional MR imaging, motor, multiple sclerosis

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**Paper 183 Starting at 3:31 PM, Ending at 3:39 PM**

**Paired Pulse Functional MR Imaging of Multiple Sclerosis**

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**PURPOSE**
We investigate whether paired pulse functional MR imaging (fMRI) is able to distinguish a patient population with clinically definite multiple sclerosis (MS) from normal controls.

**MATERIALS & METHODS**
Patient and control volunteers were imaged using standard BOLD EPI technique at 3T while viewing pairs of flashed checkerboard stimuli presented with interstimulus interval ranging from 100 to 400 ms. Event-related BOLD response waveforms were calculated in a dominant cluster in primary visual cortex and response integrals were computed as a function of interstimulus interval.

**RESULTS**
Quantitative BOLD responses exhibit a local minimum at interstimulus intervals in the neighborhood of 200 ms, suggesting that additive response from the second stimulus is partially blocked at interstimulus intervals consistent with visual cortical inhibitory effects. Preliminary results show that in MS patients compared to controls, minimal BOLD response occurs at longer interstimulus intervals. The delayed minimal BOLD responses discriminate patient from control populations, similar to whole brain magnetization transfer contrast imaging performed concurrently.

**CONCLUSION**
Paired pulse fMRI demonstrates population differences between MS patients and controls in interstimulus intervals generating minimal BOLD responses, presumably representing delayed neural conduction. This technique may serve as a quantitative adjunct diagnostic and surveillance modality for imaging multiple sclerosis.

**REFERENCES**

**KEY WORDS:** Functional MR imaging, multiple sclerosis, magnetization transfer
Reorganization of Cortical Language Areas in Patients with Refractory Epilepsy: A Functional MR Imaging Study

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PURPOSE
An abnormal organization of cortical language areas has been demonstrated in epileptic patients using positron emission tomography and functional MR imaging (fMRI). The aim of this study was to evaluate the association between these differences seen on fMRI with the different features of epilepsy.

MATERIALS & METHODS
Twenty-three right-handed patients with refractory epilepsy (13 men, 10 women; age 17-51 years) underwent fMRI while performing a word and a verb generation task. Twelve age- and gender-matched right-handed healthy controls underwent the same fMRI procedure. Regions of interest (ROI) were created from the control group activation maps. The mean signal change and the number of activated voxels were calculated for all patients and controls in each ROI. Laterality indices [LI: equal to (L-R)/(L+R)] then were calculated. Differences in lateralization between the two groups were evaluated using t-test and p < 0.01 was considered statistically significant. In the patient group, the degree of lateralization was compared with the etiology, the site (lobe and hemisphere) and the age of onset of epilepsy, using ANOVA (p < 0.05 was considered statistically significant).

RESULTS
The patients had the following characteristics: epilepsy was lesional (18/23) and cryptogenetic (5/23); the focus was in the right (15/23) and in the left hemisphere (8/23); and the age of onset was before five (early onset: 8/23) and after five (late onset: 15/23). In the patient group, language was less lateralized to the dominant hemisphere compared to controls (p < 0.001). Language was more lateralized to the dominant hemisphere in patients with a right hemisphere seizure onset compared with patients with a left hemisphere epilepsy (p < 0.01). Patients with an early onset of epilepsy and a left hemisphere seizure had the weakest left lateralization for language compared to all other patients (p < 0.01).

CONCLUSION
Language is less lateralized to the dominant hemisphere in epileptic patients compared to normal subjects. The site of the epileptogenic focus and the onset influence language reorganization in the two hemispheres. The association of early onset of epilepsy with a left-hemisphere epileptogenic focus determine the highest reorganization of language function towards the nondominant hemisphere.

KEY WORDS: Functional MR imaging, language, epilepsy

Quantitative Statistical Measurements of Language Laterality with Functional MR Imaging: Group Comparisons of Male, Female Adults and Adolescents

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PURPOSE
Measurements designed to characterize the laterality of language related activations with functional MR imaging (fMRI) should capture not only the spatial extents of activated voxels, but also the magnitudes of statistical significance contributed by voxels within the interested areas. Here we extend the direct statistical test method (Leigeois et al., 2002) to study the gender differences of language laterality in normal adults and adolescents. First, voxel-wise t-tests of laterality are obtained by direct contrasts between pairs of original and flipped image sets with SPM2. Voxels within region of interest (the Wernicke’s area) then are treated as samples from populations in random effects analyses (two-sample t tests) between comparison groups. Results quantify the differences in laterality of language processing that can be generalized to the corresponding population groups.

MATERIALS & METHODS
Subjects were healthy, right-handed volunteers (adults: 11 males/14 females, age: 25+ years; adolescents and young adult: 14 male/12 female, ages: 14-24 years ). Images were collected with a GE Signa CVi 1.5T Magnet, using a blood-oxygen level dependent spiral imaging technique. The test stimuli were 30 see segments of auditory tracks of story telling and the control stimuli were the same audio tracks played backwards. Subjects were instructed to listen carefully to answer questions about the story after the scanning session.

RESULTS
All 4 groups were found to have statistically significant lateralization to the left in the temporal language region. This left laterality was found to be significantly higher in males compared to females in both adults and adolescents groups. There were no significant differences between adolescent and adults, either for males or female groups.

CONCLUSION
The described method reveals gender differences of language laterality in agreement with many previously published results. Degrees of laterality are represented voxel-wise by signed real numbers (positive = left, negative = right). These quantities then can be drawn from regions of interest to take part in higher-level statistical tests according to demands of experimental hypotheses.

KEY WORDS: Functional MR imaging, language and gender, lateralization laterality
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**Purpose**

A significant limitation of BOLD functional MR imaging (fMRI) studies is the inability to make inferences about neuronal population responses beyond relative increases or decreases in BOLD activation. However, determining neuronal response properties is critical to improving BOLD neurosurgical planning, BOLD pharmcotherapeutic or physical therapeutic studies and planning for placement of brain-machine interfaces (BMI) or brain-computer interfaces (BCI). A well established electrophysiologic feature of neuronal activity is the "tuning" of neuronal activity to specific sensory stimuli or movement parameter encoding. Nevertheless, tuning of the BOLD signal that corresponds to known neuronal responses has not been systematically investigated. We sought in this study to determine whether directional tuning of the BOLD signal is observable in hand reaching tasks, and to characterize the tuning in different cortical areas.

**Materials & Methods**

Five healthy adult subjects were imaged using conventional BOLD fMRI techniques on a 3T MR system. The subjects performed a center-out task with cued movement of a joystick in the direction of a visually presented circular array of targets while BOLD images were obtained using an event-related paradigm. Directional tuning of image voxels was determined using a sinusoidal regression model, and the preferred directions computed. Tuning of the BOLD signal with target direction was identified in the premotor, motor and parietal cortices with either unimodal or bimodal tuning. Tuning curve characteristics differed across cortical sites and across cerebral hemispheres.

**Results**

Wavelet analysis of tuned voxels revealed a complex self-affine structure that parallels the frequency band distribution of tuned neurons.

**Conclusion**

These findings suggest that BOLD contrast techniques can be used to identify functional parameters of neuronal populations such as directional tuning, and that tuning characteristics may differ both within motor regions as well as across hemispheres.

**Key Words:** Functional MR imaging, neuron, response

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**Purpose**

Children prenatally exposed to tobacco have been found to exhibit problems related to behavioral inhibition and impulsivity, including symptoms of ADHD, conduct disorder, and substance use. Behavioral inhibition is regulated primarily by the prefrontal cortex, but research has yet to examine whether differences in prefrontal cortical function exist when children exposed to tobacco perform a task requiring behavioral inhibition.

**Materials & Methods**

Children 10 to 12 years of age (n=18; 7 prenatally exposed to tobacco, 11 controls) enrolled in a longitudinal study on the effects of prenatal substance exposure served as subjects. Tobacco exposure was assessed at the time of birth based on maternal report of cigarette smoking during pregnancy. The Go-No Go paradigm commonly is used to assess behavioral inhibition and has been shown to activate diverse frontal brain regions. Subjects press a button as quickly as possible to targets (e.g., any letter except for the letter “V”), and inhibit to the “No-Go” stimulus (e.g., the letter “V”). An event-related functional MR imaging (fMRI) design presented 160 stimulus letters (40 “V”’s interspersed with 120 other letters) one at a time for 1000 msec, with a 1000 msec ISI. Scanning was done using a 1.5T General Electric MR imaging unit [matrix size=64*64; TR=2sec (stimuli presented for 1000 msec); FOV=22cm; slices=24; slice thickness=5mm]. To assess the specific effects of behavioral inhibition, estimates for the No-Go minus Go trials were computed for each child. Whole brain analyses on the BOLD signal assessed differences in activation between the exposed and unexposed groups using regressions that controlled for prenatal alcohol exposure, neonatal health problems, and environmental risk (longitudinally assessed at 6 points between birth and age 10). Analyses were conducted using SPM2, with differences in activation defined by a minimum of 10 contiguous voxels, each activated at p<.001.

**Results**

Tobacco-exposed children showed significantly greater activation in the left superior and middle frontal cortex (Brodmann areas 6 and 8) and in the putamen. The results show that controls had greater activation in medial regions of the cerebellum and the occipital lobe. In contrast, exposed youth exhibited greater activation in a variety of frontal, temporal, and parietal regions, particularly in the left hemisphere. Frontal regions included the middle frontal gyrus, superior frontal gyrus, and mid and inferior mid frontal regions. Temporal regions consisted of the middle and inferior temporal gyrus, while parietal regions included the inferior and superior parietal lobules and the precuneus. In addition, exposed youth also showed greater activation of the claustrum and the insula.
CONCLUSION
In summary, the present findings are the first to examine the relation between response inhibition and brain function among youth prenatally exposed to tobacco. While controlling for a number of potential confounds, youth prenatally exposed to tobacco showed increased activation in a relatively large and diverse set of regions, including frontal, left temporal, parietal, and sublobar regions.

KEY WORDS: Functional MR imaging, pediatrics

RESULTS
Based on group analysis on all nine patients our results show 15 statistically significant (p<0.01, extent threshold = 10) brain regions to be involved in the process of urge to void. They are as follows: A. superior anterior putamen, B. thalamus, C. anterior subinsular cortex, D. inferior lateral frontal, E. medial mid frontal, F. anterior mid frontal, G. anterior medial frontal, H. medial posterior mid frontal, I. mid lateral frontal, J. mid medial frontal, K. mid superior frontal, L. anterior superior frontal, M. frontal anterior medial, N. frontal mid medial, and O. frontal anterior lateral.

CONCLUSION
These results suggest that there may be unique area(s) in the brain modulated by bladder control in OAB patients that can be measured using functional MR imaging. These preliminary results are encouraging and warrant further investigation with a larger patient population.

KEY WORDS: Function, urology

PAPER 189 STARTING AT 4:19 PM, ENDING AT 4:27 PM
EFFECTS OF MR IMAGING PARAMETERS ON SUSCEPTIBILITY ARTIFACT

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PURPOSE
Postoperative spine evaluations with MR imaging are commonly requested, and surgical hardware is often present, which can severely limit visualization of the operative area. Although some special susceptibility artifact reduction sequences have been developed, they are not available on most routine clinical scanners. Although the effects of some parameters, such as bandwidth, on this type of artifact have been reported, often different sources erroneously advise adjustment of additional parameters. The efficacy of artifact reduction with adjustment of different parameters varies considerably and also depends greatly on the pulse sequence. This study systematically examines the effects of numerous routine imaging parameters that can be adjusted on the majority of clinical scanners on susceptibility artifact-related signal loss and spatial distortion. The associated effects with adjustment of these parameters are discussed.

MATERIALS & METHODS
A phantom was used to study the effects of sequence parameters (bandwidth, TE, TR, phase-encoding direction, echo-train length, acceleration factor with parallel imaging and slice thickness) on artifacts arising from a small ferromagnetic object and two internal fixation plates with a variety of sequences (spin-echo, fast spin-echo, gradient-echo and echoplanar sequences). The effects of the most useful parameter adjustments are demonstrated on routine patient scans.

RESULTS
Susceptibility artifacts are reduced most effectively by an increase of bandwidth on spin-echo sequences, while a reduction of TE proved most valuable on gradient-echo sequences. The appropriate choice of the phase-encoding direction also can help to project the artifact away from the region of interest.
CONCLUSION
Routine parameters, which can be adjusted on the majority of clinical scanners, can have a substantial effect on the severity of susceptibility artifact. Targeted adjustment of these parameters can improve visualization of the region of interest.

KEY WORDS: Artifact, hardware

Paper 190 Starting at 4:27 PM, Ending at 4:35 PM
Cerebral Perfusion: Comparison between Arterial Spin Labeling and Dynamic Susceptibility Contrast MR Imaging in Subjects at Risk for Alzheimer Disease

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PURPOSE
Regional differences in cerebral perfusion are related to Alzheimer disease (AD), raising interest in using cerebral blood flow (CBF) measures as biomarkers for AD risk in preclinical populations. The two principal magnetic resonance imaging (MRI) techniques for CBF measurement are dynamic susceptibility contrast-enhanced (DSC) imaging and arterial spin labeling (ASL). In order to evaluate the efficacy of these two imaging methods in detecting CBF changes targeted for AD assessment, we acquired image data using both techniques on healthy middle-aged subjects at risk for AD before and after administration of statin drug therapy.

MATERIALS & METHODS
Asymptomatic middle-aged adult children of persons with AD (n=14, 10 women, age 55±8 years) were recruited for a statin intervention trial. Complete baseline data sets from 11 subjects are reviewed here. All subjects were scanned in a 3T scanner (GE Healthcare, WI) first with a background suppressed pseudo-continuous ASL sequence followed by DSC MRI with a 0.1 mmol/kg Gadodiamide injection using gradient-echo (GRE) echo-planar imaging (EPI). To correct for signal saturation and partial volume effects in the DSC data, a Look-Locker EPI sequence was used to scan a single slice that contained a large vessel (such as the sagittal sinus) before and after contrast injection. Pre- and post-T1 changes were used to quantify blood volume and further to correct the CBF map. Since the ASL and DSC had different slice prescriptions, perfusion maps from both methods were coregistered to a brain template in the Talairach space using the AFNI software. Cerebral blood flow measurement was analyzed in predefined regions of interest (ROIs) as well as whole brain white matter (WM) and gray matter (GM) areas in the Talairach space. Voxelwise comparison was performed by calculating the Pearson correlation coefficient.

RESULTS
A qualitative comparison of CBF maps showed that the in-plane resolution and the signal-to-noise ratio (SNR) of the DSC map were superior to ASL map. However, the DSC map suffered from artifacts such as macrovascular contamination. The CBF measurement from ASL across all ROIs were higher than those with the DSC method (paired t-test, p<0.01), which was also observed in the whole brain GM/WM measurement (GM: 56±14 ml/100g/min, WM: 45±11 for ASL; GM: 41±9, WM: 32±8 for DSC). Correlation between the ASL and DSC maps showed that in most cortical areas the two imaging techniques were highly correlated (p<0.025, R>0.7). Nonetheless, the deep white matter areas were less correlated, which might be caused by the lower flow and thus lower SNR in these areas.

CONCLUSION
A major advantage of the ASL technique is that no exogenous contrast is needed, and is not affected by the susceptibility and macrovascular shine-through artifacts. However, the DSC technique provides more information including the mean transit time (MTT) and CBV maps. Using both methods, most cortical areas show high correlation in gray and white matter. For longitudinal studies designed to detect changes in flow in these areas, either technique seems to be appropriate, which may be confirmed with our ongoing investigation.

KEY WORDS: Cerebral perfusion, dynamic susceptibility contrast (DSC), arterial spin labeling (ASL)

Paper 191 Starting at 4:35 PM, Ending at 4:43 PM
Functional Organization of the Primary Sensorimotor Cortex in Patients with Congenital Paraplegia

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PURPOSE
To investigate the functional organization of the human primary motor cortex (M1) in patients with congenital paraplegia.

MATERIALS & METHODS
Standardized block-designed BOLD-fMRI was performed in 11 congenitally paraplegic patients and 14 healthy volunteers during executed movements (EM) of hand and tongue, imagined movements (IM) of hand, tongue and foot, and
automated tactile stimulation of fingers, lips and toes to investigate the motor cortex somatotopy and functional activation pattern. All MMC-patients had a thoracic spinal lesion and congenital paralysis of the lower part of the body. The activation areas in the primary sensorimotor cortex were characterized in patients and in volunteers by means of anatomical correlates of centers of BOLD-clusters, Euclidean coordinates, Talairach coordinates, relative signal change (?S%) and correlation between BOLD-signal and applied reference function (r).

RESULTS
Motor cortex somatotopy was preserved in 10/11 patients (91%) in the right and 6/7 patients (86%) in the left hemispheres. In four additional patients the left hemispheres could not be evaluated due to shunt-valve metal artifacts. One patient (9%) showed abnormal functional organization. Functional localizations within the different body representations, except tongue, showed significantly larger variation compared to controls (p < 0.05). During unilateral-imagined foot movements 5 MMC patients (45%) showed bilateral activation.

CONCLUSION
This is the first study to investigate the functional organization of M1 in congenital paraplegia. In congenital paraplegics somatotopy was preserved indicating the “typical” functional organization of M1; however, with a higher variability of functional activations within the different body representations. Whether the bilateral activation of the foot representations during unilateral-imagined movements reflected atypical activation or simply incorrect task performance cannot be distinguished.

KEY WORDS: fMRI, motor system, congenital paraplegia

Percutaneous Vertebroplasty: Results and Complications in 4330 Consecutive Patients Treated by the European Vertebroplasty Research Team


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PURPOSE
To retrospectively evaluate the results and complications of percutaneous vertebroplasty performed in 12 different centers belonging to the European Vertebroplasty Research Team (EVEREST) in a large series of patients.

MATERIALS & METHODS
Four thousand three hundred thirty patients (3097 female and 1233 male; mean age 70.2 years) underwent percutaneous vertebroplasty (PV) in 12 different centers in Europe and in the United States for a total of 9287 vertebrae (26 cervical, 4214 thoracic, 4995 lumbar, 52 sacral). Three thousand two hundred sixteen (74.3%) patients had osteoporotic fractures, 765 (17.7%) had metastases, 88 (2%) had myeloma, 74 (1.7%) suffered from symptomatic hemangioma and the remaining 187 (4.3%) had a recent traumatic fracture. A unilateral approach, under fluoroscopic (lower thoracic and lumbar levels) or combined CT-fluoroscopic guidance (cervical and upper thoracic levels), usually was employed. All procedures were performed in local anesthesia; general anesthesia was applied when PV was performed in cervical vertebra treated with transoral approach (12 cases; 0.3%).

RESULTS
Four thousand sixty-three of 4330 (93.8%) patients had significant pain relief (difference > or = 2 point in pain evaluated with an 11-point Visual Analog Scale; p < 0.0001) within 48 hours: an average of 8.0 ± 0.6 dropped to 2.0 ± 0.9 in the osteoporotic patients; 8.3 ± 0.5 to 2.4 ± 0.4 in metastases; 8.2 ± 0.4 to 1.8 ± 1.0 in myeloma; 6.2 ± 4.1 to 0.3 ± 0.2 in hemangioma and 7.3 ± 0.4 to 1.0 ± 0.3 in trauma. Three hundred seventy osteoporotic patients (11.5%) were retreated for a subsequent fracture, in 232/370 patients (62.7%) the new fracture occurred in the contiguous vertebra. No major neurologic complications were reported. Forty-six out of 4330 patients (1.1%) had asymptomatic bone cement (PMMA) pulmonary embolism while in 1461 patients (33.7%) a venous and disk cement leakage was observed; the venous leak was in the foraminal vein in 51 patients (1.2%) and caused symptomatic radiculopathy successfully treated with steroid local injection. In eight patients (0.2%) a subcortaneous hematoma required hospitalization. In six metastatic patients (0.1%) postprocedural CT confirmed a small PMMA leakage into the canal that did not cause any neurologic symptoms. In one patient (0.02%) recurrence of back

Tuesday Afternoon
3:15 PM – 4:45 PM
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(28b) SPINE: Spinal Injections and Vertebroplasty
(Scientific Papers 192 – 202)
See also Parallel Sessions
(28a) ADULT BRAIN: fMRI
(28c) PEDIATRICS: Developmental/Congenital Malformations and Neonatal Imaging
(28d) INTERVENTIONAL: New Devices and Techniques

Moderators: Gregory A. Christoforidis, MD
Gregg H. Zoarski, MD
pain was due to mycobacterial infection (previously misdiagnosed Pott’s disease) in the treated vertebra. In four patients (0.1%) the tip of the vertebroplasty needle fractured and was left in the vertebral body without any side effects.

CONCLUSION
This large series of patients confirms that percutaneous vertebroplasty is a safe procedure especially if high-quality radiologic guidance is used as normally occurs in a radiology department. Percutaneous vertebroplasty is similarly effective in the treatment of back pain from vertebral collapse in patients suffering from osteoporosis, metastases, myeloma, symptomatic angioma and trauma.

KEY WORDS: Vertebroplasty, spine, interventional radiology

Paper 193 Starting at 3:23 PM, Ending at 3:31 PM
Value of Preprocedure MR Imaging in Patients Scheduled to Undergo Vertebroplasty or Kyphoplasty

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PURPOSE
The incidence of vertebral compression fractures is increased in patients with a prior vertebral compression fracture. We sought to evaluate the utility of a preprocedure MR imaging protocol in patients scheduled to undergo vertebroplasty or kyphoplasty. Specifically we wanted to evaluate the frequency of change in the number and location of vertebral fractures between the time of their earlier MR imaging (MRI) and the preprocedure MRI.

MATERIALS & METHODS
We retrospectively reviewed clinical and imaging data from all patients who had undergone either vertebroplasty or kyphoplasty performed at Dartmouth-Hitchcock Medical Center from January 2001 through September 2006. Of these patients, a total of 24 met the following criteria: each patient had had both an MRI within the year prior to the vertebroplasty or kyphoplasty, a repeat MRI within 7 days prior to the procedure, and no history of prior vertebroplasty or kyphoplasty. A repeat MRI was obtained in these patients scheduled for vertebroplasty or kyphoplasty either because of a change in symptoms, or because more than 3 months had elapsed since the prior MR study. Clinical and imaging data of these patients were reviewed for number and site of new compression fractures, degree of height loss, corresponding symptoms, and bone density.

RESULTS
There were a total of 74 fractures amongst the 24 patients prior to intervention, 43 of them targeted for vertebroplasty or kyphoplasty. Thirteen of 24 patients had developed new (12 patients) or worsening (2 patients) fractures, and 11/13 of these patients had new symptoms or had a change in their symptoms between their initial evaluation and their preprocedure MRI. Of these 11, three patients had fractures with less than 10% height loss, making them likely to be occult on radiographs. Of the two patients whose pain had not changed, but who had new fractures, both of them had at least one fracture with less than 10% height loss. Of the 17 new fractures in the 13 patients, 76% (13/17) occurred at levels adjacent to a prior fracture, and 24% (4/17) occurred at nonadjacent levels. Twenty-nine percent of patients (7/24) developed a total of 15 new fractures after their vertebroplasty or kyphoplasty. Forty-seven percent (7/15) occurred at a level adjacent to a treated vertebra, and 53% (8/15) occurred at nonadjacent levels, although three of these eight fractures were adjacent to other nontreated fractures, either new or existing.

CONCLUSION
New fractures additional to those targeted for treatment are present in many patients about to undergo vertebroplasty or kyphoplasty. Some of these fractures are unlikely to be seen on radiographs. Preprocedure MRI can be useful for identifying additional fractures in a select group of patients.

KEY WORDS: Vertebroplasty, compression fracture

Paper 194 Starting at 3:31 PM, Ending at 3:39 PM
Imaging Findings after Vertebroplasty May Predict Subsequent Fracture Risk

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PURPOSE
There is little literature describing the expected findings after vertebroplasty (VP), or distinguishing successful from less successful procedures. We report our experience with postvertebroplasty MR imaging (MRI).

MATERIALS & METHODS
This is a retrospective review of a group of consecutive vertebroplasty patients who had preVP MRI and at least one follow-up MRI. There were 24 patients, 30 vertebral bodies and 41 sets of MR studies; 10 patients had more than one follow-up MR scan. Average body height on midline sagittal images and the extent of apparent marrow edema on Sag STIR images were calculated and graded. We assessed the changes in these parameters between the pre and postVP MR scans to assess effects of therapy. Note also was made of extravasation of cement outside the vertebral body at VP and we determined whether this was associated with a greater risk of loss of vertebral body height on subsequent scans.

RESULTS
Ten patients had more than a single MR study after VP. Six of these patients had a decrease in marrow edema within 6 months. In five of these six patients, this was a small change, and in one there was a moderate decrease. Two had no change in edema within 6 months but had mild and moderate decrease respectively beyond 6 months. Of the remaining two patients with multiple MR studies, one did not have edema at the initial presentation and continued to be free of edema on subsequent imaging and the other had persistent metastatic disease, preventing analysis of possible edema. Only two patients demonstrated an increase in edema after VP. In both cases, this was seen within 6 months of the procedure. Nine vertebral bodies had extravasation of cement beyond vertebral body. Two of these had subsequent loss of vertebral body height (22.2%); one had mild loss of height (2 - <4 mm) at 4 months and another one had moderate height loss (> = 4 mm) at 1 year postVP. However, of 21 bodies
without extravasation, three had subsequent loss of body height (14.3%), two of whom had mild (2.6-<4 mm) and one had moderate (4 mm) height loss.

**Conclusion**

1) Although mild increase in vertebral body edema can occur within 6 months post VP, moderate or marked edema should make one consider other etiologies. 2) Cement extravasation within 6 months post VP, moderate or marked edema should increase association with future height loss of vertebral body.

**Key Words:** Vertebroplasty

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**Paper 195 Starting at 3:39 PM, Ending at 3:47 PM**

**Can We Predict which Adjacent Vertebra Has Higher Risk of New Fracture after Vertebroplasty or Kyphoplasty Using CT Hounsfield Units?**

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**Purpose**

To evaluate if the adjacent vertebra with lower bone marrow density as measured by CT number has higher risk of fracture after vertebroplasty or kyphoplasty procedure.

**Materials & Methods**

This is a retrospective study of the data available for over 50 refractures presented after over 250 initial vertebroplasty or kyphoplasty procedures done at our center. In all these patients, CT examination was obtained within 2 hours of the procedure as a part of routine protocol at our center. In retrospect, we measured the bone density of the vertebral bodies adjacent to the one treated with kyphoplasty/vertebroplasty using CT hounsfield units at the time of initial treatment. Statistical analysis of the significance of correlation between the density of vertebra and risk of fracture was obtained.

**Results**

The adjacent vertebra with a lower bone density measured using CT hounsfield units has higher risk of refracture after vertebroplasty or kyphoplasty procedure.

**Conclusion**

We can predict the adjacent vertebral level at higher risk of refracture using CT obtained at the time of initial vertebroplasty or kyphoplasty treatment. This may be helpful in deciding the level for prophylactic treatment at the time of initial treatment.

**Key Words:** Vertebroplasty, kyphoplasty, fracture risk

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**Paper 196 Starting at 3:47 PM, Ending at 3:55 PM**

**Prophylactic Cement Injection into Nonfractured Vertebral Bodies during Percutaneous Vertebroplasty**

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Tokyo, JAPAN

**Purpose**

Percutaneous vertebroplasty (PV) has been in clinical use for almost 10 years as an excellent treatment for painful osteoporotic compression fractures of the vertebral body. However, subsequent compression fracture after successful PV is problematic and is reported to occur up to 30%. We investigated the efficacy of prophylactic cement injection into the vertebral body adjacent to fractured vertebra to prevent new compression fractures after PV.

**Materials & Methods**

Institutional review board approval and written informed consent were obtained. From February 2002 to August 2004, PV was performed for osteoporotic compression fractures in 89 consecutive patients. All of them underwent PV only for fractured vertebrae. From August 2004, we prospectively performed prophylactic cement injection consecutively. For these patients, cement was injected into nonfractured vertebra immediately above fractured vertebra at the same procedure. This prophylactic injection was mainly performed for the lower thoracic and upper lumbar spine adjacent to fractured vertebrae because new fracture tended to occur in these vertebrae. Prophylactic treatment also was performed for the vertebral body or bodies between two fractured vertebrae. When cement leakage occurred into the disk, we also treated the vertebra adjacent to the disk, because previous investigators suggested that new fracture tended to occur in adjacent disc in which cement leakage occurred. We evaluated the frequency of new vertebral fractures and efficacy of the prophylactic therapy. Data were compared between the prophylactic group and nonprophylactic group. Follow-up examination was performed at 3 months and a year after PV.

**Results**

In nonprophylactic group: 15 of 89 (16.8%) developed new fractures within 3 months and 20 of 89 (22.4%) developed new painful compression fractures within a year after their first PV. These fractures occurred mostly in adjacent vertebra, especially in the vertebra immediately superior to the treated one and occurred in the lower thoracic and upper lumbar spine. In prophylactic group: only seven of 155 (4.5%) developed new compression fractures within 3 months and only eight of 80 (10%) developed new compression fractures within a year. The statistical analysis showed that new fractures developed fewer in prophylactic group than in non-prophylactic group with P-value 0.001 (chi-square test, Pearson) at 3 months and 0.038 at 1 year. This was statistically significant and there was a strong trend of decreasing new fractures by prophylactic cement injection with relative risk reduction of 0.27.
CONCLUSION
Prophylactic cement injection into nonfractured vertebra adjacent to fractured vertebrae may justify preventing new compression fracture after vertebroplasty for osteoporotic patients.

KEY WORDS: Vertebroplasty, prophylactic, osteoporosis

Paper 197 Starting at 3:55 PM, Ending at 4:03 PM
Withdrawn

Paper 198 Starting at 4:03 PM, Ending at 4:11 PM
Withdrawn

Paper 199 Starting at 4:11 PM, Ending at 4:19 PM
Trabecular versus Focal Distribution of Polymethylmethacrylate Cement in Pathologic Vertebral Fractures during Vertebroplasty of Lytic Metastasis: Case Series and Correlation to Outcomes

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PURPOSE
We describe a unique imaging appearance of focal cement accumulation inside lytic metastatic lesions of patients with pathologic vertebral fractures undergoing vertebroplasty. We contrast this appearance to the normal trabecular or lace-like appearance of cement distribution and correlate this imaging finding to pain control outcomes.

MATERIALS & METHODS
Three patients underwent cement augmentation of painful pathologic vertebral fractures. CT or conventional radiographs were obtained in all patients before and after fluoroscopically-guided vertebroplasty. Pain assessment scores were done using the Visual Analog Scale (VAS) before and after the procedures.

RESULTS
At the time of vertebroplasty, we observed a focal distribution of cement into a site of a previously demonstrated lytic metastasis. The appearance is unlike the trabecular or lace-like distribution of cement normally seen. In all three of these patients we observed good pain reduction after the procedure (VAS decreased from 10/10 to 0/10 in two patients and 6/10 to 3/10 in the other patient). The incomplete response was observed in one patient in whom the lytic metastasis could only be partially filled.

CONCLUSION
We describe a new radiographic sign of focal cement accumulation in a site of lytic metastasis during vertebroplasty. This sign may relate to favorable patient outcomes.

KEY WORDS: Spine, vertebroplasty, lytic metastasis

Paper 200 Starting at 4:19 PM, Ending at 4:27 PM
Percutaneous Cement Augmentation in Lytic Lesions of the Sacrum and Pelvis

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PURPOSE
To evaluate the feasibility, effectiveness, safety and clinical outcome for percutaneous cement augmentation of patients with lytic lesions in the sacrum and ileum

MATERIALS & METHODS
Prospective study of eight patients (4 males and 4 females, with a median age of 74 years) was performed. Patients had different types of benign and malignant metastatic lytic lesions. Informed consent was obtained according to our Institutional protocol. All patients underwent preprocedure CT and MR except one patient. All patients had a postprocedure CT. A biopsy was performed in all cases before cement augmentation. All patients had sacral lesions. Four patients had a second lesion in the ileum. All cases were done under CT guidance except one case done under fluoroscopy guidance. In four patients, more than one needle was used.

RESULTS
Adequate cement deposition was seen in all cases except one. Two patients had minimal clinically insignificant extravasations. All treated patients reported decreased pain level using visual analog pain scale except two cases within 2-4 weeks follow up (75%). No other subsequent surgical interventions were required, to our knowledge, to maintain improvement in any case.

CONCLUSION
Percutaneous cement augmentation of lytic lesions of the sacrum and ileum is a feasible and safe technique that can be performed under CT or fluoroscopy guidance. The technique results in decreased pain levels and allows patients to tolerate future treatment.

KEY WORDS: Augmentation, malignant, sacrum

Paper 201 Starting at 4:27 PM, Ending at 4:35 PM
Clinical Results for Radiologic Intervention in Symptomatic Tarlov Cysts in 30 Patients

Murphy, K. · Schnupp, S. · Wyse, G. · Gailloud, P. · Oka, M. · Sasson, D. · Long, D.
The Johns Hopkins Medical Institutions Baltimore, MD

PURPOSE
To report our experience and results at 3- and 12-month follow up of 30 patients treated for symptomatic Tarlov cysts, by percutaneous CT fluoroscopy (DTF) guided aspiration and fibrin glue injection.

MATERIALS & METHODS
Thirty patients (29 females, 1 male) were examined by an experienced neurosurgeon and interventional neuroradiologist. Two patient groups were established following initial
screening: 1) candidates with imaging characteristics consistent with narrow-necked cysts on CT myelography or MR imaging. These patients were offered cyst aspiration and Fibrin glue injection under CTF; 2) candidates with imaging characteristics consistent with wide-necked cysts on CT myelography or MR imaging, who underwent surgical repair. Those patients in whom cyst neck diameter could not be determined based on their initial imaging, had additional CT myelogram with early and delayed imaging in order to examine the cyst neck and determining whether they belonged to groups 1 or 2. Treatment modality was applied accordingly. Cyst aspiration and Fibrin glue injection in group 1 was achieved by using a two-needle technique, instead of the more widely used one-needle approach. This method involves accessing the cyst with one needle placed superficially, and the other at the deepest point of the cyst. It allows for pressure to remain near constant during the procedure, and provides markedly reduced procedural pain in comparison with the one-needle approach.

RESULTS
Three-month follow up was available on 30 patients, and showed significant pain improvement in 63.3% of patients (19/30), no change in 20% (6/30), slight worsening in 13.3% (4/30), and significant worsening in 3.3% (1/30). Twelve-month follow up was available on 12 patients of which one was lost to follow up. Sixty-six percent were found to be significantly better, 16% were better, and 8% were the same. None of our patients developed aseptic meningitis after fibrin injection.

CONCLUSION
We report preliminary results in 30 patients with symptomatic Tarlov cyst who were treated with percutaneous FCT-guided aspiration and Fibrin glue injection, using a two-needle technique. Treatment provided with a significant reduction of periprocedural pain in most patients, and a significant reduction of pain at 3- and 12-month follow up in a large proportion of patients. No postoperative complications in the form of aseptic meningitis were observed. To this day, 88 patients have been treated in total. We believe this is a promising technique which delivers significant pain relief to an overlooked patient population.

KEY WORDS: Tarlov cyst, pain relief, fluoro CT-guided percutaneous treatment

Paper 202 Starting at 4:35 PM, Ending at 4:43 PM
Incidence, Management and Treatment of Intractable Positional Headache Post Fluoroscopy-Guided Lumbar Puncture in a Busy Neuroradiology Department

Zhang, J.1 · Wang, A. M.2 · Vyas, A.2 · Times, C.2 · Tech, K.2 · Silbergleet, R.2
1General Hospital, Tianjin Medical University; visiting fellowship in William Beaumont Hospital, Tianjin, CHINA, 2William Beaumont Hospital, Royal Oak, MI

PURPOSE
To determine the overall and procedure-specific incidence of intractable positional headache post fluoroscopy-guided lumbar puncture in a busy neuroradiology department of a large community-based hospital. To review the management protocol and determine the efficacy of epidural blood patch (EBP) as treatment for intractable positional headache related to lumbar puncture.

MATERIALS & METHODS
Retrospective analysis of lumbar punctures performed during four consecutive years (11/30/2002 - 11/30/2006) at our institution revealed 1371 patients (611 males, 760 females, age range 2-93 years, mean age 55.1 ± 16.0) had undergone 1580 lumbar punctures. Indications for lumbar puncture were 1) CSF specimen collection, 2) intrathecal contrast administration for spinal myelography or 3) intrathecal chemotherapy administration. All patients were monitored in our department for 6 hours on strict bed rest postprocedure. Upon discharge, patients were further advised to lie in supine position for at least another 12 hours. Patients were provided with instructions to contact the neuroradiology department if they experienced a headache lasting over 48 hours postprocedure to schedule an appointment for EBP. The patient would be scheduled for EBP placement using fluoroscopy guidance during business hours on the same day. Intractable positional headache was defined as lasting over 48 hours after procedure. Mild positional headache which resolved within 48 hours with no specific treatment was excluded. Incidence was calculated by determining the number of patients contacting the neuroradiology department with intractable positional headache. After EBP placement, patients demonstrating resolution of headache immediately and no recurrence were considered treated successfully. Efficacy of treatment with EBP thus was determined.

RESULTS
The overall incidence of intractable positional headache post lumbar puncture at our institution was 3.3% (45/1580). Incidence related to the specific type of procedure was as follows: 1) CSF specimen collection 4.5% (20/447), 2) Intrathecal contrast administration for spinal myelography 2.3% (25/1083), and 3) Intrathecal chemotherapy administration 0% (0/50). The procedure-specific incidences of intractable positional headache were statistically significant. (Pearson Chi-Square χ² = 6.878, p = 0.03 < 0.05). A total of 45 EBPs were placed using fluoroscopy guidance. The complication rate was 0%. Forty-three of 45 intractable headaches were resolved completely after placement of EBP. For the two cases that were not resolved for 24 hours post initial EBP an additional patch was placed which relieved the headache. The efficacy of successful initial EBP placement was 95.6%, and the overall efficacy was 100%.

CONCLUSION
We demonstrated a 3.3% incidence of intractable positional headache post fluoroscopy-guided lumbar puncture at our institution, which was relatively lower compared with that reported by Luostarinen (1) (10%) and Vallejo (2) (5.7%) in the literature. We demonstrated an effective, safe management protocol and the ability to successfully treat intractable positional headache post lumbar puncture using EBP placement when it does occur. More importantly, we established a good relationship and gained the trust of our patients.

REFERENCES

KEY WORDS: Intractable positional headache, lumbar puncture, epidural blood patch
Tuesday Afternoon
3:15 PM – 4:45 PM
Grand Ballroom A

(28c) PEDIATRICS: Developmental/Congenital Malformations and Neonatal Imaging
(Scientific Papers 203 – 213)

Pre and Postnatal Imaging of Neural Tube Defects

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Neural tube defects are commonly detected on screening prenatal ultrasound. It is becoming increasingly more common to perform prenatal MRI for further evaluation of these defects. This is a review of the more common neural tube defects: embryology, prenatal imaging, management, and postnatal imaging.

This paper was selected to receive the Southeastern Neuroradiological Society (SENRS) 2006 Best Paper Award during the SENRS 2006 Annual Meeting in Longboat Key, Florida.

Lamination of the Fetal Brain on Prenatal MR Scans: An Early Indicator of Normal or Abnormal Cerebral Development

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Vienna, AUSTRIA

Purpose
Delineation of the ventricular zone (vz), the subplate (sp), and the cortical plate (cp) in the fetal brain may be done in vivo, using T2-weighted (w) and diffusion-weighted (DWI) sequences reliably up to gestational week (gw) 25/26. Purpose of this study was to evaluate whether the missing delineation of these zones might be used as a prognostic parameter with respect to cortical development and/or general outcome.

Materials & Methods
Images of 181 fetuses who underwent MR imaging (MRI) between gw16 and 25 for suspect extra central nervous system (CNS) pathologies, and in whom normal neurologic development and/or postnatal brain-imaging studies were available, were reviewed with respect to the identifiability of these three zones. Findings of 83 fetuses with cerebral pathologies were compared with the normals.

Results
In 136 (75%) normal cases with sufficient image quality delineation of the vz, sp, and cp was possible on one or both sequences (Fig 1, normal fetus at gw 21). In the pathologic group sufficient image quality was present in 80 (96%). In the latter group vz, sp, and cp could be delineated in 49 (55%). Thirty-two (65%) of these children survived, six (12%) were lost for follow up, 11 (33%) pregnancies were terminated. In the remaining 31 cases sharp delineation of the zones was not possible on T2w and/or on DWI. The latter group consisted of: hydrocephalus (13) acute brain edema (3), Chiari II malformation (9), malformations of cortical development (3), HPE (2) and CMV (1). In this group 3 (4%) survived, the other pregnancies were terminated or fetuses died in utero.

Conclusion
Missing delineation of the vz, sp and cp on fetal MRI before 25 gw is observed with pressure on brain tissue and/or impairment of cortical development, even before onset of gyration. Thus, delineation of the mentioned laminae may be of prognostic significance regarding the severity of a brain pathology.

Key Words: Fetal MR imaging, cerebral development, lamination
**Paper 206 Starting at 3:39 PM, Ending at 3:47 PM**

**MR Imaging, Magnetoencephalography, and Surgical Outcomes of Taylor’s and non-Taylor’s Focal Cortical Dysplasia in Pediatric Population**

Widjaja, E. · Otsubo, H. · Raybaud, C. · Ochi, A. · Rutka, J. · Snead, C. · Halliday, W. · Sakuta, R. · Galicia, E. · Chuang, S.

Hospital for Sick Children
Toronto, ON, CANADA

**PURPOSE**
Focal cortical dysplasia (FCD) encompasses a range of abnormalities from heterotopic neurons in the cortex to dyslamination with dysmorphic neurons. The aims of the study were to determine if (1) MR and (2) MEG features could distinguish between subtypes of FCD and to evaluate the (3) surgical outcomes of subtypes of FCD in children presenting with intractable epilepsy.

**MATERIALS & METHODS**
Thirty-six children were recruited. The histologic classification was divided into Taylor’s (type II FCD) and non-Taylor’s FCD (mild MCD and type I FCD). Two children with both Taylor’s and non-Taylor’s FCD were excluded from analysis. The MR features and patterns of MEG dipoles (clusters and scatters) were assessed using chi-square analysis to determine if there was an association with Taylor’s or non-Taylor’s FCD. Postsurgical seizure outcome of subtypes of FCD as well as lesion location were evaluated.

**RESULTS**
There was no significant difference in seizure duration, age of seizure onset or lesion location between Taylor’s and non-Taylor’s FCD (p > 0.05). Tapering of abnormal signal in white matter to the ventricles, cortical thickening and high T2 signal in the white matter were more likely seen in Taylor’s FCD (p < 0.05). Focal hypoplasia and white matter atrophy were more likely seen in non-Taylor’s FCD (p < 0.05). The presence of MEG clusters alone were more likely seen in Taylor’s FCD whilst MEG clusters and scatters were more likely seen in non-Taylor’s FCD (p < 0.05). There was no significant difference in surgical outcome between Taylor’s and non-Taylor’s FCD (p > 0.05) and also no significant difference in surgical outcome based on lesion location.

**CONCLUSION**
Whilst there were MR features and MEG patterns that were more likely to be associated with subtypes of FCD, we have not found the surgical outcome to be dependent on histologic subtypes or location of FCD. This suggests that other factors, such as completeness of lesion resection, are more important in determining seizure outcome in epilepsy surgery.

**KEY WORDS:** Focal cortical dysplasia, magnetoencephalography, MR imaging

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**Paper 207 Starting at 3:47 PM, Ending at 3:55 PM**

**Multimodality Approach for the Diagnosis of Palmini Type I Cortical Dysplasia**

Salamon, N. · Wu, J. · Koh, S. · Sankar, R. · Mathern, G. · Vinters, H.

University of California Los Angeles
Los Angeles, CA

**PURPOSE**
Cortical dysplasia is a major cause of pediatric intractable epilepsy. Subtle type of cortical dysplasia is difficult to define by conventional MR imaging (MRI) and considered as “non-lesional case.” The purpose of this study is to evaluate the subtle cortical dysplasia (Palmini type I), using multimodality approach, with MRI, PET and magnetic source imaging (MSI).

**MATERIALS & METHODS**
A total of 70 operatively proved cases of cortical dysplasia from 1999 to 2006, including 35 males and 35 females, were reviewed retrospectively. MRI and MRI-PET fusion were obtained for all 70 cases. The MSI were obtained in 21 cases. MRI of the brain was performed using 1.5T GE Sigma or Siemens Sonata scanner. T1 sagittal, T2 axial, T2 coronal, FLAIR coronal, FLAIR axial, MPRAGE (SPGR) coronal sequences were obtained. PET was done in Siemens Scanner. PET and MR images were fused using Mirada fusion7 software. All cases underwent surgery and pathology specimens were reviewed, compared to the MRI findings.

**RESULTS**
Fifteen cases of Palmini type I cortical dysplasia was confirmed by pathology. Most cases were shown in anterior or inferior temporal lobe. MRI of the brain demonstrated very subtle iso to hyperintense T2-weighted signal abnormality in the corresponding area. MRI-PET fusion showed hypometabolism in all cases. When the MRI and PET were analyzed separately, the lesion was difficult to define; however, after the fusion, the area of abnormality became significant. Pathology showed increased cells in the molecular layers, or very few scattered dysmorphic neurons in the gray-white matter junction.

**CONCLUSION**
Multimodality approach, especially MRI-PET fusion will help identify the subtle Palmini type I cortical dysplasia.

**KEY WORDS:** Epilepsy, MRI-PET fusion, magnetic source imaging
The postnatal brain anomalies in congenital muscular dystrophy (CMD) have been well described. However, fetal cobblestone complex are difficult to identify antenatally on ultrasound and MR imaging, and disruption of laminar organization of the fetal cerebrum on MR imaging has not been reported. We described the MR imaging findings of cobblestone complex in a fetus with (1) in utero MR imaging, and (2) postmortem MR imaging including diffusion tensor imaging (DTI) and correlating this with autopsy findings.

MATERIALS & METHODS
A 26-week fetus whose antenatal ultrasound demonstrated ventriculomegaly and possible Dandy Walker malformations was referred for MR imaging. In utero MR imaging showed cobblestone cortex with abnormal sulcation, ventriculomegaly, a dorsal pontomesencephalic kink, hypoplastic pons and cerebellar dysplasia. A diagnosis of CMD was made and the pregnancy was terminated. On the postmortem MR imaging of fixed brain, the cortical band, which was of same signal intensity as the cortex and was scattered parallel to the surface of the cortex. The cerebellar vermis was hypoplastic and there was hemorrhage around and within the dysplasic cerebellar hemispheres. The brainstem findings were similar to in utero MR findings. On diffusion tensor imaging, increased anisotropy, medium diffusivity and radially oriented tracts were seen extending beyond the cortical band into the cerebral mantle. Deep to this layer, there was a zone of lower anisotropy, low ADC, and tangentially oriented tracts. The normal subplate, as defined by a zone of low anisotropy and medium diffusivity was not identifiable. The corticospinal tracts were not identifiable. Autopsy confirmed the extensive leptomeningeal glioneuronal heterotopia obliterating the subarachnoid space. The cortex was thick and disorganized. Normal lamination of the cerebrum was absent. Clusters of neurons were seen within the cerebral mantle, arranged in clumps, distributed parallel to the cortical surface. Radial glia were seen extending from the periventricular zone and into the obliterated subarachnoid space between clusters of neurons.

CONCLUSION
Cobblestone cortex can be identified with in utero MR imaging. However, higher resolution postmortem MR imaging, including DTI, detected the second bead-like band of neuronal heterotopia and also demonstrated the disruption of normal laminar organization of the cerebrum, which was confirmed on autopsy.

KEY WORDS: Congenital muscular dystrophy, fetal, postmortem

Paper 209 Starting at 4:03 PM, Ending at 4:11 PM
Alterations in Regional Oxygen Saturation (StO2) and Cerebral Blood Volume in NICU Babies

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Massachusetts General Hospital
Boston, MA

PURPOSE
To determine if bedside quantitative frequency domain (FD) near-infrared spectroscopy (NIRS) provides useful information in the assessment of neonatal brain injury.

MATERIALS & METHODS
We used a FD NIRS system with: • Parallel acquisition of 4 detector channels at 1.0, 1.5, 2.0, 2.5 cm. • 8 wavelengths: 635, 670, 691, 752, 758, 782, 811, 831 nm. • Modulation frequency: 110 MHz. • Optical power < 3 mW. • Sampling rate ≤ 20 Hz. Frequency-domain multidistance data allows quantitative measurements of hemoglobin concentration in tissue (HbT), oxygen saturation (StO2) and scattering. The 3 cm optical probe was placed on six well defined regions of the head and held in place for 8 seconds for data acquisition. In 60% of the infants we repeated measurements multiple times. Our FD system has four distances and eight wavelengths providing a high redundancy of data which in turn allows us to assess the goodness of each measurement and develop criteria for data quality. We discard data for which R2 < 0.97 for the model fit of the experimental data, P > 0.05 for the Pearson product moment correlation coefficient against the eight measured absorption coefficients and the hemoglobin fit or P > 0.1 and R2 < 0.5 for the linear fit of R2 < 0.97 for the model fit of the experimental data, P > 0.05 for the Pearson product moment correlation coefficient against the eight measured absorption coefficients and the hemoglobin fit or P > 0.1 and R2 < 0.5 for the linear fit of the reduced scattering coefficients versus wavelength. We recruited neonates from the NICU both with known abnormalities on brain MR imaging and those without evidence of brain injury. Normals were recruited from the well baby unit or the community. The study was IRB approved and parental consent was obtained.

RESULTS
Forty-five normal subjects aged 0-50 weeks (cGA 35-90 weeks) were assessed. One had multiple exams over time. Twenty-six NICU babies aged 0.3-18.1 weeks (cGA 29.6-49.1 weeks) were examined. Nine had two to five exams. Sixteen had MR evidence of brain injury within the first few days of life (13 were ≥ 35 weeks and 3 < 35 weeks). Fourteen had no know brain injuries or abnormalities (3 were ≥ 35 weeks and 11 < 35 weeks). One was on ECMO and one had complicated physiology due to gastroshesis. All neonates suffering global HII or focal arterial ischemic stroke had increased StO2 (indicating less oxygen utilized by the brain) and elevated CBV (consistent with hyperemia) if studied in < 14 days. One severely injured neonate imaged after 2 weeks had a transition to low StO2 and CBV. Abnormalities in CBV and StO2 were identified in regions without diffusion weighted imaging abnormalities.

CONCLUSION
FD-NIRS detects increased StO2, CBV in global HII and focal AIS suggesting that rebound hyperperfusion plays a significant role. FD-NIRS detected abnormalities in the
absence of decreased diffusion on MR imaging suggesting that significant neuronal dysfunction can occur in the absence of diffusion weighted imaging changes.

**KEY WORDS:** NIRS, hypoxic ischemic Injury, oxygen saturation

**Paper 210 Starting at 4:11 PM, Ending at 4:19 PM**

**Endogenous Whole Brain Flow (Arterial Spin Labeling) MR Imaging in Neonatal Brain Injury**

Grant, P. E., Krishnamoorthy, K. S., Pienaar, R., Franceschini, M., Kiruluta, A., Alsop, D.

1 Massachusetts General Hospital, Boston, MA, 2Beth Israel Deaconess, Boston, MA

**PURPOSE**

To show that arterial spin labeling (ASL) can be performed routinely at 1.5T and yield useful information in neonates and to determine if rebound hyperperfusion is common in neonatal brain injury.

**MATERIALS & METHODS**

Neonates within 7 days of birth or symptom onset and undergoing clinical MRI evaluation at 1.5T had ASL in addition to routine images. Whole brain ASL was performed with a spatial resolution of 3.75 mm3 and 3 NEX. Inflowing blood was continuously labeling for 1.2 seconds with a 1 second delay prior to image acquisition to allow labeled blood to reach the microvasculature. The imaging acquisition consisted of an interleaved stack of variable density spiral acquisitions and background suppression. Total acquisition time for ASL was 5 minutes. Visual assessments of images were performed by a pediatric neuroradiologist to determine if there were CBF changes in regions of injury or globally compared to normal. ASL CBF was rated as normal if CBF was highest in the deep gray, occipital cortex and periorol and cortex similar to prior SPECT reports. ROI analysis was performed in a subset of cases. This study was approved by our IRB.

**RESULTS**

Thirteen neonates, 35 to 41 weeks gestational age at birth, were imaged within 1-10 days of symptom onset. One study was severely motion degraded. One neonate with brief seizures, normal MRI and follow up had normal CBF. One neonate with choroid plexus bleeds and normal follow up had normal CBF. One neonate with deep venous thrombosis, thalamic and periventricular hemorrhage had low thalamic CBF but diffuse elevation in cortical CBF. One neonate with perinatal depression but normal MRI had diffuse elevation in cortical CBF. One with partial HII and decreased cortical ADCs bilaterally had diffuse elevation in cortical CBF, most marked in areas of ADC decrease. Of the two with profound HII, one had cortical CBF increase and even more marked CBF increases in the VL thalami. One with HII associated with AVM rupture had no ADC abnormality apart from the hematoma but diffuse increase in cortical CBF. Four with arterial ischemic strokes had global increases in cortical CBF but variable CBF in the strokes. One with stroke secondary to group B strep meningitis and patchy global increase in cortical CBF had higher CBF in the regions of ADC decrease. Three cases were quantitatively analyzed to date: CBF ranged from 69 +/- 6 to 92 +/- 36 mL per 100 g per minute in normal-appearing regions and 46 +/- 26 to 230 +/- 69 in regions with decreased diffusion on diffusion-weighted imaging (DWI).

**CONCLUSION**

ASL at 1.5T provides useful additional clinical information in neonatal brain injury with minimal additional time. In this pilot study ASL demonstrated that rebound hyperperfusion is common in neonatal brain injury. Increases in blood flow may affect the entire brain even when injuries are focal. Increases in blood flow can be seen in the absence of DWI abnormalities (ADC decrease).

**Key WORDS:** Arterial spin labeling, hypoxic ischemic injury, neonate

**Paper 211 Starting at 4:19 PM, Ending at 4:27 PM**

**Accuracy of Qualitative Assessment in Determining Brain Stem, Deep Gray and Vermis Involvement in Patients with Hypoxic Ischemic Injury**

Setty, B. N., Krishnamurthy, K., Grant, E. P.

Massachusetts General Hospital Boston, MA

**PURPOSE**

To determine if qualitative assessment accurately detects brain stem, deep gray and vermis involvement in patients with hypoxic ischemic injury (HII).

**MATERIALS & METHODS**

An IRB-approved retrospective study was performed to identify neonates with central pattern of HIE within the first week of life from 2001-2005. An equal number of normal neonates who had MR imaging within the first week of life were selected for comparison. All were studied at 1.5T and diffusion-weighted imaging was performed at b = 1000 s/mm2 with six gradient directions and 3 NEX. Apparent diffusion coefficient (ADC) maps were generated. ADC values were measured in the cerebellar vermis, dorsal brain stem, midbrain, ventrolateral thalamus and the basal ganglia in both the normal neonates and neonates suspected with HII. A free region of interest (ROI) was used to include the entire region of interest and ADC values were measured. A total of 40 ADC ROIs were drawn in each group. The above regions also were assessed qualitatively for decreased diffusion. The mean ADC values in normal neonates were used as a standard of reference to derive statistical significance. Descriptive statistics were used for deriving statistical significance.

**RESULTS**

Eight patients met selection criteria (M: F: 4:4, mean age: 37.87 weeks) for central pattern of HIE (Group I). Group II consisted of eight normal neonates with M: F: 5:3, mean age: 38.5 weeks. The mean ADC values in cerebellar vermis, dorsal brain stem, midbrain, ventrolateral thalamus and the basal ganglia in Group I were 1.13 X10^-3 mm^2/sec, 1.21 X10^-3 mm^2/sec, 1.18 X10^-3 mm^2/sec, 1.03 X10^-3 mm^2/sec and 1.14 X10^-3 mm^2/sec respectively. Based on the mean ADC values alone, 50% (4/8), 75% (6/8), 87.5% (7/8), 100% (8/8) and 100% (8/8) respectively had decreased diffusion in patients of Group II. On qualitative analysis, 37.5% (3/8), 87.5% (7/8), 87.5% (7/8), 100% (8/8) and 62.5% (5/8) patients had decreased diffusion in the cerebellar vermis, dorsal brain...
stem, midbrain, ventrolateral thalamus and the basal ganglia respectively in Group II. Thus the sensitivity and specificity of qualitative analyses were 50% and 75% in the cerebellar vermis, 100% and 50% in dorsal brain stem, 100% and 100% each in the dorsal midbrain and the basal ganglia in patients with hypoxic ischemic injury (HII).

**CONCLUSION**
Qualitative assessment detects involvement of the dorsal midbrain and ventrolateral thalamus more accurately than involvement of the vermis, dorsal midbrain and basal ganglia.

**KEY WORDS:** Hypoxic ischemic injury, diffusion-weighted imaging, apparent diffusion coefficient

**Paper 212 Starting at 4:27 PM, Ending at 4:35 PM**
**Functional MR Imaging of Deaf Infants under Sedation Prior to Cochlear Implantation**

Mecoli, M. D. · Karunanayaka, P. R. · Altaye, M. · Huei, T. · Choo, D. · Arjmand, E. · Egelhoff, J. C. · Schmithorst, V. J. · Holland, S. K.

Cincinnati Children’s Hospital Medical Center
Cincinnati, OH

**PURPOSE**
This study investigates the use of functional MR imaging (fMRI) for the evaluation of central auditory function in hearing-impaired infants prior to cochlear implantation. BOLD activation in primary auditory cortex (A1) is measured in response to auditory stimulation with narrow-band noise tones or stories read by a female speaker. We present MRI volumetric and activation findings for A1 in infants with severe to profound sensorineural hearing loss with normal hearing infants.

**MATERIALS & METHODS**
Subjects included two groups of infants 9-17 months of age with severe to profound sensorineural hearing impairment (HI group, n=10) or normal hearing (NH group, n=15). Infants were sedated with either Nembutal or Propofol for clinical MRI of the brain. MR scanning was performed on a 3T Siemens Trio with EPI using a silent background acquisition. Auditory stimulation was presented through a commercially available MRI compatible audio system (Avotec SS3100) at 10dB above the hearing thresholds of each of the infants. Activation maps were computed for contrasts between the three stimulus conditions (silence-tones-stories) using a general linear model. ROIs were outlined in the left and right Heschl’s gyrus (A1) on high-resolution 3D T1-weighted images under the supervision of a pediatric neuroradiologist. Pixels were counted within the ROIs if their z-value was significant at a level of p≤0.05 and they belong to a cluster of 3 pixels.

**RESULTS**
A1 activation was not significantly different between the NH and HI groups. Both positive and negative activation was detected in both groups at rates that did not differ significantly. A significant correlation was found between hearing threshold and A1 activation in the HI group (Fig 1). Significantly greater activation was detected in A1 during the story task in NH infants sedated with Nembutal (n=5) compared with Propofol (n=10) (p≤0.014).

**CONCLUSION**
In these preliminary results from a study that will ultimately comprise n=30 NH infants and n=60 HI infants, significant levels of both positive and negative activation are detected in A1 in both groups. Hearing and language outcomes will be measure in the HI group 2 years after cochlear implantation. Correlations between these preimplant fMRI results and postimplant outcome measures will be computed to ascertain the predictive value of fMRI in infants with severe to profound sensorineural hearing impairment.

**REFERENCES**

**KEYWORDS:** Primary auditory cortex, functional MR imaging, deaf infant

**Paper 213 Starting at 4:35 PM, Ending at 4:43 PM**
**Pilomyxoid Astrocytoma: Expanding the Imaging Spectrum**

Linscott, L. L. 1 · Osborn, A. G. 1 · Blaser, S. 1 · Castillo, M. 1 · Chin, S. S. 1 · Hedlund, G. L. 4 · Krakenes, J. 2 · Sutton, C. 1 · Hewlett, R. 1 · Chapman, P. 3

1University of Utah School of Medicine, Salt Lake City, UT, 2Hospital for Sick Children, Toronto, ON, CANADA, 3University of North Carolina, Chapel Hill, Chapel Hill, NC, 4Primary Children’s Medical Center, Salt Lake City, UT, 5University of Bergen, Haukeland University Hospital, Bergen, NORWAY, 6Tulane University School of Medicine, New Orleans, LA, 7Red Cross Children’s Hospital, Cape Town, SOUTH AFRICA, 8Inland Imaging, Spokane, WA

**PURPOSE**
Pilomyxoid astrocytoma (PMA) is a recently described “infantile,” more aggressive variant of pilocytic astrocytoma (PA) that has unique clinical, biological and histopathologic characteristics. Only a single small case series has described...
the imaging characteristics of this tumor. We report the largest imaging series to date, redefining and broadening the imaging and clinical spectrum of PMA.

**Materials & Methods**
Images, pathology reports, and clinical information of 19 patients with pathology-confirmed PMA were reviewed retrospectively. CT and MRI findings including location, morphology, signal intensity, and presence and pattern of enhancement were tabulated.

**Results**
Patients ranged in age from 9 months to 24 years with a mean of 7 years at initial diagnosis. Gender ratio was 11:8 (M:F). Tumors varied from 2 to 12 cm in diameter. Ten of 19 (53%) tumors were located in the hypothalamic/chiasmatic/3rd ventricular region. Nearly half (9/19) occurred in atypical locations including the cerebral cortex (4/19), cerebellum (2/19), basal ganglia/thalamus (2/19) and 4th ventricle (one). Nine (47%) cases showed heterogeneous rim enhancement, eight (42%) showed uniform enhancement, and two (11%) cases showed no enhancement at all. Three (16%) cases demonstrated striking intratumoral hemorrhage.

**Conclusion**
Imaging features of PMA are identified in 19 pathologically proved cases. New findings that broaden the spectrum of PMA include (1) Location outside the hypothalamic/chiasmatic region; (2) presence of intratumoral hemorrhage; (3) rim enhancement and (4) tumors occurring in older children and young adults.

**Key Words:** Astrocytoma, pilomyxoid, imaging characteristics

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**Angioplasty and Stenting for Symptomatic Intracranial Atherosclerosis**

**Jhamb, A. · Hurley, M. · Haw, C. · Redekop, G. · Graeb, D. · Heran, M.**

University of British Columbia-Vancouver General Hospital
Vancouver, BC, CANADA

**Purpose**
Anticoagulation or antiplatelet therapy is the standard treatment for symptomatic intracranial atherosclerosis. Angioplasty and stenting is an emerging alternative for patients with refractory symptoms in spite of best medical therapy. We present our experience, looking at clinical and angiographic outcomes and complications, and compare this to published reports of angioplasty alone.

**Materials & Methods**
Thirty-one patients with symptomatic intracranial atherosclerosis underwent angioplasty and stenting of 35 intracranial vessels. Lesions were in the internal carotid artery in eight cases (22.8%), middle cerebral artery in eight cases (22.8%), and vertebrobasilar circulation in 19 cases (54%).

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**Tuesday Afternoon**

3:15 PM – 4:45 PM
Grand Ballroom B

(28d) INTERVENTIONAL: New Devices and Techniques (Scientific Papers 214 – 224)

See also Parallel Sessions
(28a) ADULT BRAIN: fMRI
(28b) SPINE: Spinal Injections and Vertebroplasty
(28c) PEDIATRICS: Developmental/Congenital Malformations and Neonatal Imaging

Moderators: A. Daniel Sasson, MD
Huy M. Do, MD

Paper 214 Starting at 3:15 PM, Ending at 3:23 PM

**Angioplasty and Stenting for Symptomatic Intracranial Atherosclerosis**

Jhamb, A. · Hurley, M. · Haw, C. · Redekop, G. · Graeb, D. · Heran, M.
University of British Columbia-Vancouver General Hospital
Vancouver, BC, CANADA

**Purpose**
Anticoagulation or antiplatelet therapy is the standard treatment for symptomatic intracranial atherosclerosis. Angioplasty and stenting is an emerging alternative for patients with refractory symptoms in spite of best medical therapy. We present our experience, looking at clinical and angiographic outcomes and complications, and compare this to published reports of angioplasty alone.

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Thirty-one patients with symptomatic intracranial atherosclerosis underwent angioplasty and stenting of 35 intracranial vessels. Lesions were in the internal carotid artery in eight cases (22.8%), middle cerebral artery in eight cases (22.8%), and vertebrobasilar circulation in 19 cases (54%).

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Fig 1. Seventeen-year-old male with rim-enhancing cerebellar PMA.

Fig 2. Twenty-four-year-old male with hemorrhagic temporal lobe PMA.
Five patients had simultaneous stenting of the ipsilateral extracranial carotid artery and one had stenting of the vertebral artery origin.

**RESULTS**

Stents were deployed successfully in 32 of the 35 vessels (91.4%). Vessel tortuosity precluded stent delivery in one case, and the procedure was limited to angioplasty alone, with dissection noted and symptomatic recurrent stenosis observed within 6 months. Two procedure-related strokes were observed (5.7%), due to the snowplow effect of perforating vessel occlusion. No in-stent stenosis or recurrent symptoms have been noted in follow up of stented patients (mean duration of follow up was 21 months), although one had symptomatic progression of disease at another intracranial site.

**CONCLUSION**

Percutaneous revascularization for intracranial atherosclerosis can be accomplished using current device technology with relatively low rates of morbidity. Our experience concurs with that reported in the literature and suggests that primary stenting is associated with good clinical and angiographic outcomes. Compared to previously reported complication and restenosis rates with primary angioplasty, stenting appears to be a superior treatment modality.

**KEY WORDS:** Intracranial atherosclerosis, stenting

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**Paper 215 Starting at 3:23 PM, Ending at 3:31 PM**

**Acute Carotid Terminal Occlusion Treated with and without Merci Retriever Device: The Houston Experience**


1University of Texas Health Science Center, Houston, TX, 2Mayo Clinic, Jacksonville, FL

**PURPOSE**

Recanalization of the occluded vessel is considered one of the strongest predictors for good outcome in stroke patients. Carotid terminus occlusion has the worst outcome with 10% recanalization after intravenous tissue plasminogen activator (TPA). Reported recanalization with Merci clot retriever device is 53%. No study to date has compared the use of the Merci device as an adjuvant to other IA therapies. The purpose of this study was to compare the recanalization rates of carotid terminal occlusions in patients treated with the Merci device versus previous IA therapies.

**MATERIALS & METHODS**

We reviewed our prospectively collected stroke registry for consecutive acute carotid terminus occlusions from 1997 to 2006. Patients were divided into two groups: Group 1 - patients treated with local IA lytic or non-Merci mechanical intervention with or without intravenous TPA. Group 2 - similar to group 1 plus Merci clot retriever device. Baseline neurologic deficit (as measured by NIH Stroke Scale), time from symptom onset to recanalization, length of intraarterial therapy (IAT) procedure, successful recanalization (final TICI ≥ 2b), procedure complications, intracranial hemorrhage (ICH), symptomatic intracranial hemorrhage (sICH), mortality and discharge disposition were collected.

**RESULTS**

A total of 39 patients were identified (Table 1).

**CONCLUSION**

In our experience, despite similar stroke severity, patients with acute carotid terminus occlusion treated with the Merci clot retriever device had better recanalization rates without device-related complications. Our recanalization rates are substantially higher than previously reported rates without any prolongation of IAT time. However, improved recanalization did not correlate with better outcome; this may relate to lack of patient selection with preprocedural mismatch criteria.

**KEY WORDS:** Stroke, Merci, terminal ICA

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**Paper 216 Starting at 3:31 PM, Ending at 3:39 PM**

**Interventional Management of Stroke III Trial: An Ongoing Phase III Trial**

Khatri, P. · Broderick, J. · Tomsick, T. · Carrozella, J. · Demchuk, A. · Dillon, C. · Hill, M. · Janis, S. · Jauch, E. · Hyckhorst, K. · Mauldin, P. · Palesch, Y.

1University of Cincinnati, Cincinnati, OH, 2University of Calgary, Calgary, ON, CANADA, 3Medical University of South Carolina, Charleston, SC, 4NINDS, Washington DC, VA

**PURPOSE**

The Interventional Management of Stroke (IMS) I and II pilot trials demonstrated that the combined intravenous (IV) and intraarterial (IA) approach to recanalization may be more effective than standard IV rt-PA (Activase®) alone for moderate-to-large (NIHSSS ≥10) strokes, and with a similar safety profile. Therefore, the primary objective of this NIH-funded, Phase III, randomized, multicenter, open-label clinical trial is to determine whether a combined IV/IA
approach to recanalization is superior to standard IV rt-PA alone when initiated within 3 hours of acute ischemic stroke onset.

**MATERIALS & METHODS**

A projected 900 subjects with moderate-to-large (NIHSSS ≥ 10) ischemic strokes between ages 18-80 years will be enrolled over the next 5 years at 40+ centers in the United States and Canada. Both approaches must have IV treatment initiated within 3 hours of stroke onset. Subjects will be randomized in a 2:1 ratio with more subjects enrolled in the combined IV/IA group. The IV rt-PA alone group will receive the standard full dose [0.9 mg/kg, 90 mg max (10% as bolus)] of rt-PA intravenously over an hour. The combined IV/IA group will receive a lower dose of IV rt-PA (~ 0.6 mg/kg, 60 mg max) over 40 minutes followed by immediate angiography. If a treatable thrombus is not demonstrated, no IA therapy will be administered. If an appropriate thrombus is identified, treatment will continue with either the Concentric Merci® thrombus-removal device, infusion of rt-PA and delivery of low-intensity ultrasound at the site of the occlusion via the EKOS® Micro-Infusion Catheter, or infusion of rt-PA via a standard microcatheter. The choice of IA strategy will be made by the treating neurointerventionalist. IA treatment must begin within 5 hours and be completed within 7 hours of stroke onset. The primary outcome measure is a favorable clinical outcome, defined as a modified Rankin Score (mRS) of 0-2 at 3 months. The primary safety measure is mortality at 3 months and symptomatic ICH within the first 36 hours after onset. Finally, a secondary objective of the IMS III Trial is to determine the cost-effectiveness of the combined IV/IA approach as compared to standard IV rt-PA.

**CONCLUSION**

The IMS III Trial will develop and maintain a network of interventional centers to test the safety, feasibility, and potential efficacy of new FDA-approved catheter devices as part of a combined IV/IA approach to recanalization as the IMS III Study progresses. Trial enrollment began in July of 2007.

**KEY WORDS:** Clinical trial, acute cerebral infarction, revascularization

**Paper 217 Starting at 3:39 PM, Ending at 3:47 PM**

**SPACE: Results and Analysis from the German Trial of Stent-Protected Angioplasty versus Carotid Endarterectomy in Symptomatic Patients**

Jansen, O. · SPACE Collaborative Group

UKSH University of Schleswig-Holstein

Kiel, GERMANY

**PURPOSE**

Carotid endarterectomy is effective in stroke prevention for patients with severe symptomatic carotid artery stenosis. Carotid artery stenting has been used widely as alternative treatment. Since equivalence or superiority has not been convincingly shown for either treatment the SPACE trial aimed to compare these two treatments.

**MATERIALS & METHODS**

Between 2000 and 2006 a total of 1200 patients with symptomatic carotid artery stenosis were randomly assigned within 180 days of transient ischemic attack or moderate stroke (modified Rankin scale score of ≤3) carotid artery stenting (n = 605) or carotid endarterectomy (n = 595). The primary endpoint of this hospital-based study was ipsilateral ischemic stroke or death from time of randomization to 30 days after the procedure. The noninferiority margin was defined as less than 2.5% on the basis of an expected event rate of 5%. Analyses were on an intention-to-treat basis.

**RESULTS**

One thousand one hundred eighty-three patients were included in the analysis. The rate of death or ipsilateral ischemic stroke from randomization to 30 days (pOE) after the procedure was 6.84% with carotid artery stenting and 6.34% with carotid endarterectomy (absolute difference 0.51%, 90% CI -1.89% to 2.91%). The one-sided p value for noninferiority was 0.09. Additional secondary analysis allowed to identify special subgroups who primarily benefit from carotid stenting or are at higher risk with endovascular therapy. The use of protection devices did not show significant reduction of periprocedural complications (p > 0.05). However there was a trend that closed cell design stents showed less complications. While the difference in pOE between both treatment arms was minor the differences inside each arm was severe.

**CONCLUSION**

SPACE failed to prove noninferiority of carotid artery stenting compared with carotid endarterectomy for the periprocedural complication rate. However the difference between both treatments was minor. For interventionalists SPACE showed that the experience of the therapist and the kind of endovascular technique were important factors for the complication rate.

**REFERENCES**


**KEY WORDS:** Carotid stenting, endarterectomy, trial
Tuesday

Paper 218 Starting at 3:47 PM, Ending at 3:55 PM

Initial and Delayed Complications of Carotid Blowout Syndrome in Patients of Head and Neck Cancers Treated by Self-Expandable Stent-Grafts

Chang, F.\textsuperscript{1, 2} · Lirng, J.\textsuperscript{1, 2} · Luo, C.\textsuperscript{1, 2} · Guo, W.\textsuperscript{1, 2} · Wu, H.\textsuperscript{1, 2} · Teng, M.\textsuperscript{1, 2} · Chang, C.\textsuperscript{1, 2}

\textsuperscript{1}Taipei Veterans General Hospital, Taipei, TAIWAN, \textsuperscript{2}National Yang Ming University, School of Medicine, Taipei, TAIWAN

\textbf{Purpose}

Reconstructive management of carotid blowout syndrome in patients with head and neck cancers with stent-grafts was reported to be a temporary management due to its high rebleeding rate and poor long-term stent patency. The purposes of this study were: 1) to evaluate the initial and delayed complications in these patients treated with stent-grafts, 2) to evaluate the management of these complications for improving outcome.

\textbf{Materials & Methods}

Eleven patients of head and neck cancers with carotid blowout syndrome were treated with self-expandable stent-grafts. The diameter of the selected stent-grafts were at least 1 mm larger than the diameter of carotid artery proximal to pathologic lesion. The ends of the stent-graft were deployed more than 1 cm over the margin of pathologic vascular lesion. We evaluated the complications and the follow-up outcomes by assessing the clinical findings, CT A and angiograms.

\textbf{Results}

Immediate hemostasis was achieved in 10 patients. Initial complications included type 1 endoleak in one patient, stroke in one patient and asymptomatic thrombosis of the carotid artery in two patients. The patient of type 1 endoleak was managed successfully by direct percutaneous puncture of the pseudoaneurysm under a temporary balloon occlusion in the proximal carotid artery. The patient of symptomatic stroke failed with intraarterial thrombolytic therapy. Delayed complications included rebleeding in five (1 type 2 endoleak), distal restenosis with/without delayed carotid thrombosis in four, and brain abscess formation in one. Rebleeding was noted in five patients and was managed successfully with a second stent-graft and embolization in four of them. Distal restenosis with delayed carotid thrombosis after follow up of longer than 3-6 months was found in three patients. A patient of distal restenosis was managed successfully by carotid angioplasty and stenting. A patient of septic thrombosis with brain abscesses was treated by antibiotic therapy.

\textbf{Conclusion}

The complications of stent-graft deployment for treating patients with head and neck cancers and carotid blowout syndrome include endoleak, rebleeding, distal restenosis, stent thrombosis and brain abscess formation. Although stent-grafts achieved immediate and initial hemostasis in the majority of our patients, long-term safety, stent patency, and permanency of hemostasis appeared unfavorable. This treatment may be a temporary or emergency rather than a permanent measure. Close clinical and image follow up after the management for early detection of complications is strongly indicated in these patients. Combined percutaneous puncture of recurrent pathologic vascular lesions and application of prophylactic antibiotics can improve the outcome.

\textbf{Key Words:} Carotid blowout syndrome, stent-graft, head and neck cancers

Paper 219 Starting at 3:55 PM, Ending at 4:03 PM

EVE: A Computer-Based Endovascular Training System for Neuroradiology

Rabinov, J. D. · Cotin, S. · Allard, J. · Dequidt, J. · Lenoir, J. · Luboz, V. · Neumann, P. · Wu, X. · Dawson, S.

Massachusetts General Hospital Boston, MA

\textbf{Purpose}

To propose a computer-based neurointerventional simulator to train physicians in aspects of angiographic procedures. Interventional neuroradiology is a growing field of minimally invasive therapies including embolization of aneurysms and arteriovenous malformations (AVMs), carotid angioplasty/stent, acute stroke and embolization for tumor and epistaxis. Treatment is performed using image-guided instrument navigation through a patient’s vasculature. While there are simulators for cervical carotid procedures such as carotid stenting, nearly all training occurs on live patients some of whom are critically ill. The FDA requirement for simulation training in carotid stenting indicates the need to provide experience outside of live patient cases. The goal is to reduce the risks to patients and improve outcomes of angiographic procedures.

\textbf{Materials & Methods}

Development of our neurointerventional simulator includes accurate anatomical and physiologic representation of arterial, parenchymal and venous phases of thoracic, cervical and intracranial vasculature. Our method for segmenting and reconstructing the vascular anatomy consists of a semi-automated translation of data from the patient's CTA or MRA into three-dimensional interactive models. This method reconstructs topologically correct surface representations of vascular structures including bifurcations. The current cerebrovascular model includes 4,000 vessel segments comprised of both arterial and venous distributions and is optimized for real-time collision detection with virtual devices. New algorithms for physics-based modeling of catheter-vascular interactions and haptics for tactile feedback are under development. This will allow for simulation of complete diagnostic and therapeutic procedures. It will include the representation and tracking of three independent endovascular devices.

\textbf{Results}

The approach has been tested against a vascular phantom and clinical data sets. These simulated angiographic studies with X-ray rendering and contrast propagation closely approximate those in actual patients. The results prove that our vascular reconstruction methods are accurate and create a system with sufficient fidelity to permit realistic simulation-based training.
CONCLUSION
We are developing a real-time high-fidelity interventional neuroradiology simulator for physician training. We have defined a set of endovascular simulation components including anatomy, physiology, endovascular device modeling and haptics. It is the first entirely physics-based simulator designed to support patient-specific data sets that will allow practical experience without putting patients at risk.

KEY WORDS: Neurovascular, interventional, simulator

Paper 220 Starting at 4:03 PM, Ending at 4:11 PM
Quantitative Diffusion Analysis of Unresolved Lesions in Posterior Reversible Encephalopathy Syndrome
Liu, X. · Wang, H. · Ekholm, S. · Westesson, P.
University of Rochester School of Medicine & Dentistry Rochester, NY

PURPOSE
To quantitatively analyze apparent diffusion coefficient (ADC) and fractional anisotropy (FA) values of reversible and unresolved lesions in posterior reversible encephalopathy syndrome (PRES). To evaluate diffusion characteristics in predicting unresolved lesions.

MATERIALS & METHODS
Thirteen PRES patients with consecutive MR imaging examinations were enrolled in this study. Visual features of unresolved lesions in diffusion-weighted images and ADC maps were reviewed. ADC and FA values between resolved and unresolved lesions were compared.

RESULTS
There are two kinds unresolved lesions, one is with hyper diffusion-weighted imaging (DWI) intensity and high ADC value (1.1017 ± 0.1727 × 10^{-3} mm²/s), the other is with high DWI and low ADC (0.6907 ± 0.0912 × 10^{-3} mm²/s). The resolved lesions are iso- or slightly high DWI intensity and high ADC value (0.9690 ± 0.157 × 10^{-3} mm²/s). The differences of ADC value among resolved and unresolved lesions are significant by one-way ANOVA, P < 0.01. Discriminant analysis between the resolved and the unresolved lesions could classify 68.7% lesions with high ADC values correctly based on the threshold as ADC value equal to 1.024. There are no significant differences of FA values between the resolved and the unresolved lesions, but there are five lesions which were with normal signal in the follow-up FLAIR image while with significant hypointensity in FA images.

CONCLUSION
More vasogenic edema is the reason of high ADC values in reversible lesions of PRES. Lesions with restricted diffusibility or severe edema (> 1.024 × 10^{-3} mm²/s) are prone to be unresolved injuries. FA may be useful in detecting unresolved lesions.

KEY WORDS: Diffusion tensor imaging, posterior reversible encephalopathy syndrome

Paper 221 Starting at 4:11 PM, Ending at 4:19 PM
Percutaneous Biopsies of the Skull Base
Escobar, W. · Gomez, F.
Universidad del Valle Centro Medico Imbanaco Cali, COLOMBIA

PURPOSE
Various tumors can affect the skull base area. Their histologic diagnosis and treatment is quite complex, requiring in many opportunities major surgical interventions to expose the tumor to obtain a biopsy and subsequently resect the lesion to attempt its complete eradication. Some cases require additional treatment - or can only be treated - with radiation therapy and/or chemotherapy. Knowing the histologic diagnosis before the therapeutic surgical intervention allows for better therapeutic planning. We present a series of cases demonstrating that with the appropriate technique it is possible to perform percutaneous skull base biopsies to obtain a histologic diagnosis. In the case of hypervascular lesions, percutaneous embolization can be performed using the same access pathway.

MATERIALS & METHODS
Between the years 1998 and 2006, 47 percutaneous image-guided biopsies were performed at our center in different regions of the skull base, including the anterior cranial fossa, middle fossa, parasellar region, clivus and infratemporal fossa. To reach the lesions we used different approach routes, including: trans-foramen ovale, trans-orbital, trans-nasal, supra and infrazygomatic. Forty-four procedures were performed under fluoroscopic guidance alone in the angiography suite using tandem technique. Two biopsies were obtained under CT guidance and 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 biopsy 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 47 lesions and diagnosis was possible in 46 cases. Histologic diagnosis included: chordoma, chondrosarcoma, rabdomyosarcoma, carcinoma, metastasis, juvenile nasoangiofibroma, pituitary adenoma, lymphoma, meningioma and schwannoma. Nine hypervascular lesions were encountered and percutaneously embolized at the time of the biopsy.

CONCLUSION
Percutaneous biopsy of the skull base is possible, it is a safe procedure, and allows histologic diagnosis to plan appropriate surgical, radiation or chemotherapy treatment and it is a new development in neuroradiology.

KEY WORDS: Biopsies, skull, base
Paper 222 Starting at 4:19 PM, Ending at 4:27 PM
Therapeutic Implication of Nonaneurysmal Subarachnoid Hemorrhage

Tsai, F. Y.; Nguyen, B. V.; Hasso, A. N.
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Purpose
Major cause of subarachnoid hemorrhage (SAH) is ruptured aneurysm. However, infrequent causes may lead to diagnostic dilemma. Prevalence of these infrequent etiologies in multiethnic population may avoid the unnecessary delay in diagnosis.

Materials & Methods
We retrospectively reviewed all SAH from December 2004 to September 2006. Patients were evaluated and managed by multidisciplinary cardiovascular and neurocritical teams. Among 75 consecutive patients, 39 male and 36 female with average age of 56.6 ± 15.5 years: 36 White (48%), 23 Hispanic (30.8%), 12 Asian (16%), and 4 Black (5%), the etiologies of nonaneurysmal SAH may be categorized as: seven vertebral artery dissection; five dural sinus thrombosis; three basic venous SAH; one postpartum arteriopathy.

Results
Vertebral artery dissection: 4 Hispanic, 2 White, 1 Asian. Dural sinus thrombosis: 2 Hispanic, 1 White, 2 Asian. Basal venous SAH: 1 Asian, 1 Black, 1 White. Postpartum arteriopathy: 1 Hispanic.

Conclusion
We have found that Hispanics and Asians have more frequent incidence of nonaneurysmal SAH. Multislice CT A may be sufficient to evaluate the etiologies of SAH and the characteristic appearance of aneurysm. However, CTA and/or MRA may overlook these unusual etiologies of nonaneurysmal SAH. Delay in diagnosis may lead to poor prognosis. Occasionally, catheter cerebral angiography is still needed to confirm the diagnosis for proper treatment.

Key Words: Subarachnoid hemorrhage, nonaneurysmal

Paper 222 Starting at 4:27 PM, Ending at 4:35 PM
Dangerous Advances in Measurements from Digital Subtraction Angiography: When Is a mm Not a mm?

Fox, A. J.1 · Millar, J.2 · Raymond, J. · Pryor, J. C.4 · Roy, D.3 · Molyneux, A. J.5
1Sunbury Health Sciences Center, Toronto, ON, CANADA, 2Wessex Neurological Center, Southampton General Hospital, Southampton, UNITED KINGDOM, 3Notre Dame Hospital, Montreal, PQ, CANADA, 4Massachusetts General Hospital, Boston, MA, 5Frenchay Hospital, Bristol, UNITED KINGDOM

Purpose
The core lab of a multicenter randomized trial of aneurysm coiling measures mm before/after endovascular therapy. Improved digital subtraction angiography (DSA) now can give mm measurements instead of pixels. Yet software seems to elude mm accuracy.

Materials & Methods
CD images are assessed with PACS using consistent tools for all. Arrays of 10 mm fiducials can translate to mm. New DSAs may now be embedded with mm rather than pixels on the workstation. Of 73 core lab CDs analyzed until abstract submission, 40 comparative readings were done with both embedded mm and external fiducials, 38 with 10 mm and two with 5 mm fiducials.

Results
Twenty-five had 10 mm fiducials adjusting for magnification from the side closest to furthest from the fluoroscope. Adjusted calibration with the PACS caliper of 10 mm fiducials compared to mm from embedded CD data gives a range of 8.2-12.5 “vendor mm” (mean 10.6) for 10 mm on the least magnified side. The more magnified side gives 10.0-16.7 “vendor mm” (mean 13.5) for 10 mm. Thirteen with only one fiducial sees 10 mm fiducials as 8.6-18.5 “vendor mm,” mean 13.0. Two cases with 5 mm fiducials give 3.6 “vendor mm” for both.

Fig 1.10 mm fiducials measure directly as mm from DSA software with a standard PACS caliper. The side nearest the fluoroscope measures “12.0 mm” and furthest “16.0 mm.” The aneurysm measures “22.2 mm” length, “11.3 mm” width, and “7.6 mm” neck region, yet these are not correct mm.

Conclusion
Manufacturers produce mm to read off DSA. For years real mm were unavailable due to differing angiographic table positions, tube-to-intensifier distances, FOV, varying C-arm angles, differential magnification of sides, and others. Yet CD copying of DSA data using embedded vendor software seems to distort calibrations to incorrect mm as read off standard PACS. In reality there is only one mm, though CDs from DSA systems read 8.2 - 18.5 fallacious “vendor mm” from 10 mm, and 5 mm as 3.6 “vendor mm.” Yet 10 mm is 10 mm. This variance could be dangerous for aneurysm treatment. If operators cannot trust mm as mm, then pixel readings could be safer to use as they force hands-on fiducial use for mm translation. A vendor solution is needed for this lack of consistent calibration, or CDs should not automatically carry mm measurements that are untrue mm.

Key Words: Digital subtraction angiography, cerebral aneurysms, measurements
Efficacy of Fusion CTA for Following Treated Aneurysms by Coil Embolization

Graduate School of Biomedical Sciences Hiroshima University
Hiroshima, JAPAN

PURPOSE
According to the advancement of medical technology, we can treat cerebral aneurysms by intervention using various materials; for example Guglielmi detachable coil (GDC). And it is necessary to evaluate the postoperative finding and to follow the treated patients whether or not coil compaction will occur. By only DSA we can evaluate the accurate relationship between the aneurysm and inserted coils, but DSA is very invasive examination for patients. MRA cannot show coils and craniogram cannot show vessels. There is CT examination, but because of metallic artifact we cannot show vessels and coils by CT angiography (CTA). The purpose of this study was to examine whether fusion CT would provide accurate information on the postoperative findings.

MATERIALS & METHODS
Ten patients underwent coil embolization by GDC for cerebral aneurysm. CTA was performed before coil embolization and plain CT was performed after the coil embolization. Two sets of 3-dimensional (3D) imaging were constructed with 3D image analyses software (Virtual Place, Ver. 2.02, AZE, Japan). Only postoperative coil images were fused with preoperative CTA images in order to reduce artifacts due to the coils. We compared the coil locations on these 3D CT (Fusion CT) images to the postoperative DSA.

RESULTS
All 3D fusion images with CTA and coils were constructed successfully. CTA could reveal postoperative findings as well as by DSA. And we could evaluate the cases whose results were neck remnant.

CONCLUSION
Original fusion CTA with coils furnished accurate information for postoperative findings without DSA. So we will be able to evaluate whether coil compaction will occur in the future.

KEY WORDS: Aneurysm, coil embolization, Fusion CTA
Pathophysiology of Brain Attack

Colin P. Derdeyn, MD

LEARNING OBJECTIVES
Upon completion of this presentation, participants will be able to:
1) Define the pathogenesis of acute ischemic stroke.
2) Identify the factors involved in reperfusion injury.

PRESENTATION SUMMARY
This talk will review the complicated pathogenesis of acute ischemic stroke. The following issues will be discussed.

Most ischemic strokes are secondary to thromboembolic arterial occlusion. The most common sources of thromboemboli include the heart (owing to atrial fibrillation in many patients) and atherosclerotic plaque at the common carotid artery bifurcation in the neck (1). When an artery becomes occluded, the brain supplied by that artery may become ischemic, depending on the adequacy of flow through collateral channels. Preexisting hemodynamic impairment from atherosclerotic stenosis or occlusion likely predisposes brain tissue to ischemic injury from any given thromboembolic occlusion (2). The cortical surface of the brain often, but not always, has an abundant network of pial collaterals connecting arterial branches. Penetrating arteries into the white matter do not have the benefit of such a network (3). The survival of brain cells during a period of ischemia is related to several factors. The most important are the duration and depth of the ischemia (4). Most neurons cannot survive even a few minutes of severe ischemia. In a thromboembolic stroke, there is often a great deal of regional variability of the depth of ischemia. Some ischemic areas may remain viable for up to 24 hours (5). These regions of ischemic but viable tissue have been termed the "ischemic penumbra" (6). The improved outcome of patients that have been revascularized in the hours after stroke onset has empirically validated this concept (7).

There are many factors that influence the brain's tolerance to ischemia, including temperature (increased temperature is harmful and hypothermia is protective), plasma glucose levels (hyperglycemia is harmful), and prior ischemic injury (helpful). In addition, there are other factors that influence the outcome of reperfused tissue, including apoptosis and reperfusion-related inflammatory mechanisms. All are areas of active research, as interventions aimed at these mechanisms may improve outcome in patients with ischemic stroke.

REFERENCES

Quantitative Evaluation of Conventional CT Using ASPECTS for Guiding Acute Stroke Therapy

Andrew M. Demchuk, MD, FRCPC

Physiologic Imaging in Acute Stroke

R. Gilberto Gonzalez, MD, PhD
Tuesday Afternoon

4:45 PM - 6:15 PM
Grand Ballroom C-F

(31) Malformations, Phakomatoses and Ischemic/Traumatic Injury (ASPNR) - Audience Response Plus+ (AR+)* Self-Assessment Modules (SAM)**

(230) Common Congenital Malformations
   — Rosalind B. Dietrich, MD

(231) Common Phakomatoses
   — Alice C. Patton, MD

(232) Ischemic/Traumatic Injury to the Pediatric Brain
   — Gilbert Vezina, MD

Moderators: Charles M. Glasier, MD
            Gary L. Hedlund, DO

*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 Self Assessment (SAM) session programming.

**Programming has been reviewed and qualified for Self Assessment Modules (SAM) credit through the American Board of Radiology (ABR).

***Formerly Berlex

Common Congenital Malformations

Rosalind B. Dietrich, MD

Learning Objectives
Upon completion of this presentation, participants will be able to:
1) Diagnose common cerebral malformations.
2) Identify abnormalities seen in children with cerebral malformations that are the more common.
3) Review the appropriate imaging workup for children with suspected cerebral malformations.

Presentation Summary
Congenital central nervous system anomalies occur due to abnormal or arrested development of the brain and/or spine during the intrauterine period. As the brain and spine form within a limited period of time, insults leading to the development of congenital anomalies often affect multiple brain structures. Both prenatal and postnatal multiplanar imaging techniques are extremely useful in demonstrating the spectrum of abnormalities seen in each entity and help diagnose and give prognostic information to treating physicians and parents. This information together with increasing understanding of the genetic origins of many of these entities is giving additional insight into many of the congenital brain and spine anomalies discussed in this session. Disorders of dorsal induction occur between 3-4 weeks of gestation due to failure of neuralation. They demonstrate involvement not only of the brain and/or spine but also of the overlying leptomeninges and bony structures. Cephaloceles (encephaloceles and meningoceles), the three types of Chiari malformations, spinal lipomas and dural sinuses develop during this period. In disorders of ventral induction (occurring between 5-10 weeks of gestation) there is a failure of cleavage of the brain into separate hemispheres and failure of separation of the diencephalon and the telencephalon. Imaging studies show continuity of both gray and white matter across the midline and any associated facial anomalies. Entities include alobar, semilobar, lobar and midhemispheric fusion types of holoprosencephaly and septooptic dysplasia. The cerebellum and brainstem develop concurrently with the cerebral hemispheres. Posterior fossa anomalies include hypoplastic or dysplastic. Hypoplastic anomalies include cystic lesions (Dandy-Walker malformation, Blake's pouch cyst, and mega cisterna magna) or vermian or hemispheric hypoplasia. Dysplastic anomalies include Joubert syndrome, rhombencephalosynapsis and Llermite-Dulcos syndrome. Normal neuronal migration starts in the 8th week of gestation when neuroblasts migrate from the germinal matrix to the cerebral cortex guided by radial glial fibers. Migrational anomalies result from insults occurring between 2 and 5 months of gestation that interfere with the proliferational, migrational or organizational components of this process. They include lissencephaly (agyria/pachygyria), polymicrogyria, heterotopias, cortical dysplasias, schizencephaly and hemimegalencephaly. The corpus callosum develops between 8-20 weeks of gestation. Different parts of the corpus callosum develop sequentially with the posterior genu forming first and then followed by the anterior body, posterior body, splenium, and rostrum. Both dysgenesis and hypoplasia of the corpus callosum may be seen. Imaging studies show characteristic findings and associated anomalies include lipomas, interhemispheric arachnoid cysts, Dandy-Walker and Chiari malformations and encephaloceles.

References
Common Phakomatosis

Alice C. Patton, MD

Learning Objectives
Upon completion of this presentation, participants will be able to:
1) Define the clinical presentation of the common phakomatoses in children.
2) Review the imaging characteristics of the common phakomatoses.
3) Define the scientific basis of the clinical and imaging findings.

Presentation Summary
The presentation will review the clinical and imaging findings of the common phakomatoses, also known as the neurocutaneous syndrome. They include neurofibromatosis and tuberous sclerosis. These are a heterogeneous group of disorders, which may be inherited (through autosomal dominant or recessive means) or occur as a result of spontaneous mutation. The genetic changes result in the loss of ‘suppressor’ activity, and there is therefore unchecked proliferation of normal and abnormal cells. This leads to the characteristic hamartomas and neoplasms in patients with neurofibromatosis and tuberous sclerosis. The pathogenesis of the radiological white matter bands characteristically imaged in tuberous sclerosis, and the intracranial stigmata of Sturge Weber Syndrome will also be discussed.

Ischemic/Traumatic Injury to the Pediatric Brain

Gilbert Vezina, MD

Learning Objectives
Upon completion of this presentation, participants will be able to:
1) Review the imaging features of cerebral injuries in non-accidental head trauma.
2) Diagnose patterns of cerebral infarction in children.

Presentation Summary
Trauma to the head is the most common cause of acquired disability in childhood. The incidence is approximately 200 to 300 per 100,000 population per year in the United States. The majority of injuries are the result of falls from heights, motor vehicle accidents, sports or recreational activities, and assaults (in older children). In children less than two years of age, one-fourth of the injuries are inflicted. The overall mortality of severe head injuries (defined as Glasgow Coma Scale less or equal to 8) is 25-35%. In children below age two, non-accidental trauma accounts for more than 80% of deaths. Biomechanics of head trauma in infants is different than in older children. Infants have much larger heads compared to their body size (the head represents 10% of body weight) and weak neck muscles. As a result, more whiplash of the head will be seen in infants as a result of inertial type injuries than in adults. Further, the infant skull is thin, soft and flexible (as the cranial sutures are not fused); the infant brain is not myelinated and therefore is soft and compressible. As a result, the brain and skull can undergo greater deformity in infants than in adults, leading to a greater incidence of subdural hemorrhages and parenchymal tears. Specific aspects of pediatric CNS trauma - non-accidental trauma, birth trauma, growing skull fractures and cranial burst fractures will be discussed in this presentation. Stroke is an important cause of morbidity in childhood, and its prevalence is increasingly recognized. In many instances the etiology of a pediatric stroke is never found; common causes include underlying metabolic disorders (ex. hyperhomocysteinemia), trauma/spontaneous dissection, previous infections (ex. varicella zoster), cardiac causes (ex cyanotic congenital heart disease), vasculopathies (ex. moyamoya syndrome), coagulopathies (ex. protein C or S deficiency) and vascular malformations. Unlike in the adult situation, in children the majority of the arterial pathology demonstrable with imaging is intracranial rather than at the carotid bifurcation.

Tuesday Afternoon
4:45 PM - 6:15 PM
Columbus I-L

(32) Advanced Imaging Seminar - Techniques for Functional Imaging

(233) BOLD fMRI: State of the Clinical Art
— Andrei I. Holodny, MD

(234) Arterial Spin Labeling (ASL)
— John Detre, MD

(235) Vascular Space Occupancy (VSO)
— Peter C. van Zijl, PhD

Moderators: Timothy P. L. Roberts, PhD Howard A. Rowley, MD

BOLD fMRI: State of the Clinical Art
Andrei I. Holodny, MD

Arterial Spin Labeling
John Detre, MD

Learning Objectives
Upon completion of this presentation, participants will be able to:
1) Interpret the biophysical basis for arterial spin labeled perfusion MRI measurements of cerebral blood flow.
2) Identify the benefits of arterial spin labeled perfusion MRI for imaging regional brain function.
3) Contrast perfusion fMRI and BOLD fMRI.

PRESENTATION SUMMARY
Arterial spin labeling (ASL) uses magnetically labeled arterial blood water as a diffusible tracer for the measurement of cerebral blood flow (CBF). The effects of ASL in the brain are assessed by comparison with images acquired without labeling. With certain assumptions or ancillary measures, these effects can be quantified in classical CBF units of ml/g/min and have been validated against 15O-PET and other established techniques, though ASL provides the benefits of being completely noninvasive and acquired using MRI, which is widely available and provides a variety of other contrasts, including high-resolution structural imaging.

Over the past decade, several technical advances have dramatically improved the quality of ASL perfusion MR imaging. These include high-field, parallel imaging, improved labeling schemes, improved models for CBF quantification, and imaging sequences that allow suppression of static brain signal. Arterial spin labeling has obvious applications in cerebrovascular disorders. Additionally, because CBF is regionally coupled to neural activity and metabolism in the brain, regional changes in ASL also can be used as a surrogate marker for neural function and dysfunction. Arterial spin labeling has demonstrated utility in the differential diagnosis of degenerative disorders, and for studying normal cognition. Perfusion fMRI based on ASL allows quantification of both baseline and activated brain function. This can be important in clinical and pharmacologic fMRI, and for characterizing behavioral states or traits. This approach is complementary to BOLD fMRI, which is primarily sensitive to transient changes in regional brain function evoked by task activation.

Vascular Space Occupancy
Peter C. van Zijl, PhD

Dr. van Zijl is Professor of Radiology at The Johns Hopkins University School of Medicine and serves as Director of the F.M. Kirby Research Center for Functional Brain Imaging at the Kennedy Krieger Institute in Baltimore. He graduated with a PhD in Mathematics and Physics (Physical Chemistry) from the Free University in Amsterdam in 1985. In 1987, he joined NIH and switched from basic NMR to the field of Magnetic Resonance Imaging and Spectroscopy. Dr. van Zijl serves on the editorial boards of Magnetic Resonance in Medicine, Journal of Cerebral Blood Flow and Metabolism, Journal of Magnetic Resonance, and NMR in Biomedicine. He was Chair of the Experimental NMR Conference in 2003. He has previously received an Established investigator award of the American Heart Association. He is a fellow of the International Society of Magnetic Resonance in Medicine and has served on its board from 2002-2005. Dr. van Zijl has about 180 peer-reviewed publications on a variety of topics related to the development of new MRI and MRS technology and to the understanding of MRI contrast. Today he will present one of the latest developments, MRI contrast based on changes in vascular space occupancy or VASO MRI.

LEARNING OBJECTIVES
Upon completion of this presentation, participants will be able to:
1) Describe VASO approach to measure blood volume effects using MRI without contrast agents.
2) Demonstrate possibilities in measuring both blood volume and blood flow using the VASO effect.
3) Analyze uniqueness of VASO for use in functional MRI
4) Illustrate applications of VASO in the clinic.

PRESENTATION SUMMARY
Cerebral blood volume (CBV) is an important physiologic quantity that changes in several neurologic disorders as well as during brain activation. Until recently, the only way to image CBV effects with MR imaging (MRI) was with contrast agents. This has the disadvantage of allowing only a single quantitative measurement at a time scale that is very slow and not useful to assess fast events such as microvascular expansion during brain activation. Recently, we demonstrated that by nulling the blood signal using an MRI inversion recovery approach, it is possible to perform CBV-sensitive functional MRI. This method, dubbed "Vascular Space Occupancy" or "VASO" MRI (1), basically labels the blood black, which can subsequently be used to monitor CBV effects. Functional MRI: During brain stimulation, the microvascular blood volume increases in the region where neuronal activation takes place. Even though activation effects can be measured rapidly using the BOLD effect, this latter phenomenon does not provide a precise spatial localization because the oxygenation changes that it is based on persist downstream from the regions of activity. It will be shown that VASO, which gives a signal change opposite in sign to BOLD (negative vs positive, respectively) can provide more localized assignment of such regions (1). Because BOLD and VASO can be done at a rapid time scale (seconds), their combined application can be used to study the mechanism of physiologic changes during brain activation, which has led to an approach to quantify oxygen extraction fraction of tissue (2) and to a new interpretation of some of the physiologic effects following brain activation (3). Recent developments at 3T have shown that VASO also contains information on blood flow (CBF) (4). Fortunately, CBF and CBV effects can be separated out by measuring signal changes as a function of repetition time (TR), allowing changes in both parameters to be evaluated. Clinical VASO: As changes in CBV occur in many neurologic disorders, we investigated whether VASO has any clinical applications. Data will be shown that VASO may be useful in the detection of stroke, brain hemodynamic changes consequential to carotid stenosis, and for the detection of cancer. Recent developments show that VASO can be used to determine absolute volumes by performing a series of two VASO scans, one without and one with contrast agent (5). This will enhance its clinical importance.

REFERENCES
4. Donahue, et al. MRM 2006;56:1261-1273
Tuesday Afternoon

4:45 PM - 5:45 PM
Columbus G

(33) ELC Lecture B: PACS
Introduction & PACS Migration

— C. Douglas Phillips, MD, FACR
— Richard H. Wiggins, III, MD
**Wednesday Morning**

7:45 AM – 8:45 AM
Grand Ballroom C-F


(38) Spine and Pediatrics Review Session I
— Jacqueline A. Bello, MD

(39) Spine and Pediatrics Review Session II
— Jill V. Hunter, MD, MBBS, FRCR

Moderator: Gilbert Vezina, MD

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

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### Presentation Summary

This session will address congenital and acquired diseases of the pediatric spine. Illustrative examples of spinal disorders in children, ranging in age from the second trimester fetus to adolescence, will be displayed in the appropriate format. There will be a discussion as to differential diagnosis and diagnostic features. A spectrum pediatric spinal diseases will be illustrated and discussed.

### Wednesday Morning

8:45 AM – 9:45 AM
Grand Ballroom C-F

(35) General Session: CNS Infections

(240) Perinatal/Infant Infections
— Robert A. Zimmerman, MD

(241) New Flus and Viruses and Ticks
— Franz J. Wippold, II, MD

(242) Adult CNS Infections
— Doris Goldsher, MD

Moderator: Jay J. Pillai, MD

### Perinatal/Infant Infections

Robert A. Zimmerman, MD

**Learning Objectives**

Upon completion of this presentation, participants will be able to:
1) Summarize a perspective on the overall issue of in utero, perinatal and post-natal CNS infections.
2) Review imaging manifestations of TORCH infections.
3) Identify the role of diffusion imaging and contrast enhancement in post-natal bacterial and viral CNS infections.

**Presentation Summary**

In utero infections of the fetus, TORCH; infections transmitted during labor from infected amniotic fluid (chorioamnionitis), most often gram positive cocci; infections acquired in passage through the birth canal, either HSV II or gram
negative rod; meningoencephalitis, and infections acquired postnatally during infancy, usually bacterial meningitis, are entities examined by CT and MR imaging, both for their imaging findings (common and differential features) and for their clinical correlations. There is a vast array of potential infectious agents, bacterial, viral and parasitic, that are particularly devastating to the fetus, neonate and infant, because of their lack of cellular immune response and the fact that the injury is occurring during the still rapid growth and development of the brain. Not all infections are obvious at the time of birth, so that the neuroradiologist, who examines the older infant or child, must keep an open mind when faced with a differential diagnosis for an injured or destroyed brain, in considering these entities. The clinician also must be aggressive in the serologic testing of these patients in order to establish the specific diagnosis.

New Flus and Viruses and Ticks
Franz J. Wippold, II, MD

LEARNING OBJECTIVES
Upon completion of this presentation, participants will be able to:
1) Identify patterns of infections and to know demographics of the different entities.
2) Formulate differential diagnoses for some of the patterns of involvement.

PRESENTATION SUMMARY
Despite the widespread use of antibiotics in the treatment of bacterial diseases in the past century, viruses remain an elusive, potentially dangerous and life-threatening challenge for physicians. The neuroradiologist is potentially the first health care professional to link the pieces of the clinically elusive puzzle. This presentation will review the imaging manifestations of human and insect-borne viruses with particular attention to imaging patterns of recognition. Additionally, mimicking lesions will be considered in developing a context for differential diagnoses.

REFERENCES

Adult CNS Infections
Doris Goldsher, MD

LEARNING OBJECTIVES
Upon completion of this presentation, participants will be able to:
1) Review the role of imaging as a marker of therapeutic response.
2) Discuss the need for quantitative analysis, image acquisition uniformity, quality assurance and central image reads.
3) Identify the appropriate role of advanced imaging techniques for early clinical trials.
4) Discuss requirements for conventional imaging techniques in late, phase III clinical trials.

PRESENTATION SUMMARY
The imaging features of central nervous system (CNS) infections can be classified by location of the lesion, host response and organism. Their appearance reflects multiple factors including the type of the organism, the mode of spread and the histopathologic changes caused. Improvements in morphologic imaging have made it possible to detect lesions in the brain, spinal cord and the meninges, and to determine their anatomical distribution precisely. Furthermore, advances in imaging technology and the ability to produce diffusion-weighted imaging and MR spectroscopy have enhanced the ability to more accurately characterize infectious processes and to better differentiate them from neoplastic and ischemic pathologies of similar morphologic appearance. Most infections spread to the CNS by hematogenous routes. Direct spread from adjacent structures such as the paranasal sinuses, mastoid air cells and pharynx still occurs. Trauma, surgery, other interventional procedures, tumors, anatomical abnormalities or osteomyelitis disrupting the defense lines of the meninges and the brain, facilitate the invasion of CNS infection. Retrograde axoplasmic flow along cranial or peripheral nerves may enable viral agents to invade the brain. Having effective treatments for many infectious diseases, imaging has an important role and a significant impact on the prognosis and outcome of the various infectious diseases of the CNS.

REFERENCES
Nanomedicine and the Future of Neuroradiology
William S. Ball, Jr., MD

LEARNING OBJECTIVES
Upon completion of this presentation, participants will be able to:
1) Identify the new field of nanomedicine.
2) Analyze the impact nanomedicine may have on healthcare.
3) Interpret the potential interface between nanomedicine and neuroimaging.

PRESENTATION SUMMARY
Nanoscale-science represents a new field representing materials and devices at the nanometer-length scale, i.e., at the level of atoms and molecules. Disease processes typically begin at the subcellular/cellular level long before they become clinically overt. In addition, change in the subcellular/cellular/extra-cellular domains may precede clinical progression or response to therapy. Nanoscience and nanotechnology offer the promise of monitoring cell function and aiding in the early diagnosis and management of disease. For nanomedicine to become a reality, nanotechnology must be developed that can monitor and eventually control vital cell function and physiology, probe the cell without untoward effect on the cell viability or its function, and transmit that information in a form that can be used to make diagnostic and therapeutic decisions. Finally, this technology must prove to be of benefit in the diagnosis and management of specific disease classes, and must be congruent with future directions in therapeutic strategies for the disease. Diseases involving the central nervous system offer a real challenge in medicine, and would particularly benefit from nanomedicine. Neuroimaging at the molecular and cellular levels will play a prominent role in Nanomedicine as this new field unfolds in the future. We as neuroradiologists must begin to explore our future in this exciting new area of science, as we have much to contribute to its safe and effective development.
Etiology and Biomechanics of Lumbar Disk Disease

Helen E. Gruber, PhD

Helen E. Gruber, PhD, a recognized cell biologist in the study of the intervertebral disk, cartilage and bone, has authored 149 peer-reviewed articles and 12 book chapters. She serves on the editorial board of the journal Spine, and Bio technic & Histochemistry, and currently is the Director of Orthopaedic Research Biology, Department of Orthopaedic Surgery at Carolinas Healthcare System, Charlotte, N.C. Contributing author Edward N. Hanley, Jr., M.D., the chair of the Department of Orthopaedic Surgery at Carolinas Healthcare System, Charlotte, N.C., has authored over 167 peer-reviewed major scientific publications on orthopaedics, the spine, and disk degeneration. He has co-authored (with F. T. Wetzel) “Spine Surgery, A Practical Atlas”, McGraw Hill, in 2002. Dr. Hanley is an internationally recognized leader in spine surgery and has served as president of the International Society for the Study of the Lumbar Spine, the Cervical Spine Research Society, the Academy of Orthopaedic Surgeons, and the American Orthopaedic Association. He also routinely serves on committees for the N.I.H. and the F.D.A. He is on peer-review editorial boards of Spine and The Spine Journal. In 2006, he was appointed to the board of trustees for the Journal of Bone and Joint Surgery, the premier journal publishing clinical musculoskeletal papers.

LEARNING OBJECTIVES
Upon completion of this presentation, participants will be able to:
1) Identify the biologic features of disk degeneration and its progression.
2) Differentiate the interventional strategies for disk degeneration.
3) Differentiate the biologic therapies for disk degeneration, including growth factors, gene therapy, and cell therapy.
4) Describe how new imaging systems, such as T1rho, will aid in providing a more physiologic and functional grading system for disk degeneration.

PRESENTATION SUMMARY
Promising new approaches for the biologic treatment of disk degeneration are evolving from a number of current scientific fronts, including an improved understanding of the function of the disk cell in vivo and recognition of the potential value of cell-based therapies for disk degeneration. Biologic approaches to disk therapy are important since current methods of treatment, including fusion, disk spacers and disk replacement, are not physiologic, limit motion, and place excess stress on adjacent spinal segments. Methods which manipulate and modulate disk cell function open exciting and challenging new therapeutic possibilities. In this presentation we provide current perspectives on 1) the biologic features of disk degeneration and its progression, 2) interventional strategies for disk degeneration, and 3) cell-based biologic therapies for disk degeneration, and discuss how new imaging techniques, such as T1rho, will provide a more physiologic and functional disk grading system for use with biologic therapies.
Spinal Instability: Imaging Techniques
Johan W. Van Goethem, MD, PhD

LEARNING OBJECTIVES
Upon completion of this presentation, participants will be able to:
1) Define spinal instability.
2) Distinguish spinal instability as macro- or micro-instability.
3) Identify the appropriate imaging technique accordingly.

PRESENTATION SUMMARY
1) Definition and classification - Although “Spinal instability” is a popular term with 80,000+ hits in Google and over 400 hits in PubMed, the first return in Google “Back.com - FAQs - What is lumbar instability” “hits” the nail on the head. When reading the opinion of more than ten specialists, one gets almost as many different definitions, ranging from the simple and elegant such as “Lumbar instability involves the abnormal movement of two vertebrae on each other” over the simple and maybe not so elegant such as “Means that the spine is not stable and usually needs surgery” to the more complex definitions. Merriam-Webster defines instability as the quality or state of being unstable, where unstable is lacking steadiness: apt to move, sway, or fall (an unstable tower), not being in or able to maintain a state of balance. Britannica defines an unstable equilibrium as one in which the least departures produce forces tending to increase the displacement (e.g., a brick lying on the floor is in stable equilibrium, while a ball bearing balanced on a knife-edge is in unstable equilibrium). Frymoyer defines spinal instability as the loss of spinal motion segment stiffness such that force application to that motion segment produces greater displacements than would be seen in a normal structure, resulting in a painful condition and the potential for progressive deformity. For some this defines “macro-instability.” It can be classified as axial rotational, translational, retrolisthetic, and postsurgical instability syndromes. Micro-instability on the other hand does not involve gross abnormal motion. For some it equals degenerative disk disease.

2) Imaging - 2.1) Macro-instability - Imaging in instability can be either anatomical or functional and/or dynamic. Dynamic examinations involve either flexion/extension or any other movement that provokes the patient's complaints. This usually is performed with X-rays but also can be done on CT or MR imaging either with an axial-loading device or on a stand-up MR machine. Anatomical (static) examinations also can be performed with plain film, CT or MR imaging depending on the underlying pathology. Rotational and retrolisthetic instability usually result from facet joint hypermobility due to degenerative disease but almost always is accompanied by disk and/or ligamentous laxity. Anterolisthesis is the typical example of translational instability. Finally, postsurgical instability is due to excessive ligament, disk or bone removal. 2.2) Micro-instability - According to some micro-instability is equal to degenerative disk disease, internal disk disruption, and/or internal disk derangement. It is hypothesized that disk degeneration causes an increase in the neutral zone. This is defined as the zone within which the spine has minimal internal resistance to movement. An increased neutral zone is associated with micro-instability. In imaging of micro-instability we therefore will focus on the intervertebral disk.
Vascular Malformations of the Spine
In Sup Choi, MD

Learning Objectives
Upon completion of this presentation, participants will be able to:
1) Identify vascular malformations of spinal cord and spine.
2) Review clinical presentations.
3) Review angiographic features.
4) Discuss endovascular management.

Presentation Summary
Classification of spinal vascular malformations: Spinal Cord; Intramedullary Perimedullary. Metameric. Dural; Epidural. Dural; Spine

Evaluation and Treatment of Spinal Column Tumors
Jeffrey A. Stone, MD

Learning Objectives
Upon completion of this presentation, participants will be able to:
1) Cite the natural history of several spinal tumors and role of Interventional Neuroradiology in their treatment.
2) Identify endovascular options for the treatment of spinal neoplasms.
3) Discuss percutaneous options for the treatment of spinal neoplasms.

Presentation Summary
This lecture will cover the role of the radiologist in the treatment of spinal neoplasms. In particular, the percutaneous and endovascular treatment options for several common spine neoplasms will be reviewed as well as strategies for intervention. A brief review of the natural history of spinal neoplasms and the clinical work up of these patients will be included.

Wednesday Afternoon
1:15 PM - 2:45 PM
Grand Ballroom A

(42) Clinical Research in Pediatric Neuroradiology - Pitfalls and Projects (ASPNR)

(252) Imaging as an Indicator of Response: Quality, Reproducibility and Quantitative Analysis
(Presentation of prospective externally funded multi-institutional or multidisciplinary investigations)
— C. Carl Jaffe, MD

Moderators: Nancy K. Rollins, MD, FAAP
William S. Ball, Jr., MD

Imaging as an Indicator of Response: Quality, Reproducibility and Quantitative Analysis
C. Carl Jaffe, MD

Dr. Jaffe is a Branch Chief in the Cancer Imaging Program, Division of Cancer Treatment and Diagnosis, National Cancer Institute (NCI) and is Emeritus Professor of Medicine, Yale University School of Medicine. He holds an undergraduate degree from the Massachusetts Institute of Technology and medical degree from Columbia College of Physicians and Surgeons and is board certified in diagnostic radiology and nuclear medicine. His career focus has been computer applications in diagnostic imaging and he has been a visiting scientist at the Office of High Performance Computing and Communications at the National Library of Medicine and a Visiting Professor in Applied Physics, Delft University of Technology, the Netherlands. He founded the Center for Advanced Instructional Media at the Yale School of Medicine which received the prestigious Pirelli International Award in 2005 for communication of Science and Technology entirely carried out on the Internet. He has been a Board Member on the Whitaker Foundation, Chairman of the Board of Scientific Counselors National Library of Medicine and 2nd Vice President of the Radiological Society of North America. He has a variety of grant awards including a NIH Research Career Development Award, James Picker Foundation Scholar, and investigator initiated grants from the National Institutes of Health. He has published or edited 8 books and more than 180 monographs and scientific journal articles. His current focus and responsibility at NCI is oncologic clinical trials, response assessment and the role of imaging as a biomarker.
LEARNING OBJECTIVES
Upon completion of this presentation, participants will be able to:
1) Discuss the role of imaging as a marker of therapeutic response.
2) Review the need for quantitative analysis, image acquisition uniformity, quality assurance and central image reads.
3) Identify appropriate role of advanced imaging techniques for early clinical trials.
4) Review requirements for conventional imaging techniques in late, phase III clinical trials.

PRESENTATION SUMMARY
The importance of imaging in clinical trials has increased recently in importance - moving beyond simple prognostic staging to measurement of therapeutic response. Imaging now contributes significantly to FDA "accelerated approval" processes for therapeutic drug evaluation. This policy, existing since the mid-1990s, temporarily accepts alternative endpoints to survival in trials of therapies for life-threatening illnesses. Thus imaging has moved from merely its usual correlative role in trials, to the more critical role of measurement of response rate (RR), progression-free survival (PFS) and time to progression (TTP). This will have important effects on trial design, with Bayesian and cross-over trials becoming more attractive. With new therapy treatments such as TMZ and new molecular entities, imaging could potentially provide pivotal data for therapeutic management. Particularly in neural tumors, however, reliable, reproducible and predictive response data have been problematic with the all too evident shortcomings of RECIST and even the McDonald criteria as cases in point. Approaches to more effective use of anatomical measures (WHO, RECIST, area, and volumetrics) will be illustrated while also addressing ways to approach using more advanced imaging techniques, such as dynamic and molecular imaging.

REFERENCES

Wednesday Afternoon
1:15 PM – 2:45 PM
Columbus G
(43) ELC Workshop E: Advanced Web Design
(253) Advanced Web Design
— Dale A. Charletta, MD

Advanced Web Design
Dale A. Charletta, MD

Wednesday Afternoon
3:15 PM – 4:45 PM
Grand Ballroom C-F
(44a) SPINE: Neoplasms and Other
(Scientific Papers 254 – 264)

See also Parallel Sessions
(44b) ADULT BRAIN: Cerebrovascular Occlusive Disease I
(44c) PEDIATRICS: Cerebrovascular Diseases, Degenerative, Demyelinating, Metabolic Disease
(44d) INTERVENTIONAL: Aneurysms I

Moderators: Gregroy W. Petermann, MD
Eric D. Schwartz, MD
Spinal Cord Tumors

Ganglioglioma: 50% had long segment involvement, canal intramedullary tumors with histologic findings.

Intramedullary spinal tumors are rare neoplasms (4-10%) of the central nervous system and include ependymoma, astrocytoma, hemangioblastoma, and ganglioglioma. Preoperative diagnosis can significantly affect surgical planning with the expectation of attempted gross total resection of ependymomas vs biopsy/subtotal resection of astrocytomas for example. Radiographic diagnosis is often equivocal with overlapping imaging features such as location within the cord, the border characteristics of the tumor, presence of hemorrhage, cysts/syrinx, and enhancement pattern. To evaluate and correlate the MR imaging (MRI) characteristics of intramedullary tumors with histologic findings.

Materials & Methods
We identified 140 patients with primary spinal cord neoplasms treated at our institution during a 10-year period (1996-2005). Thirty-eight patients with available preoperative MRI were included in this study. There were 20 males and 18 females; age 2 to 63 years. All patients underwent resection or biopsy with pathologic tissue diagnosis. The MRI characteristics of the tumors were analyzed retrospectively by two neuroradiologists blinded to the diagnoses for location/central vs eccentric within the cord; well defined vs ill-defined/infiltrative borders; presence of cysts, enhancement, hemosiderin, T1 and T2 signal characteristics and presence of canal expansion. The MRI characteristics were correlated with the histologic findings.

Results
There were 22 ependymomas: (5 myxopapillary, 15 grade II, and 2 grade III); eight astrocytomas: (3 pilocytic, 4 grade II, 1 grade III); six hemangioblastomas, and two gangliogliomas. Ages: astrocytoma: 2-43 years (mean 16 years); ependymoma 10-63 years (mean 35 years); hemangioblastomas: 34-58 years (mean 46 years); and ganglioglioma: 9-14 years (mean 12 years). Well defined borders: 88% ependymomas, 20% astrocytomas; presence of hemosiderin: 53% ependymomas, 0% infiltrating astrocytomas, 33% pilocytic astrocytoma; homogenous enhancement: 53% ependymomas, 20% astrocytomas; central location: 71% gr 2/3 ependymomas, 40% astrocytomas; cyst: 50% ependymoma and 45% astrocytoma, holocord syrinx (47% ependymomas, 40% infiltrating astrocytomas, 0% pilocytic astrocytomas). Pilocytic astrocytomas: 100% homogenous enhancement and well defined borders, 33% associated hemosiderin (in adult patient), no associated syrinx. Grade1 myxopapillary ependymomas: 100% had well defined borders with homogenous enhancement and were found in the cauda equina. Hemangioblastomas: 100% had enhancing nodules, 67% had multiple nodules (all who had Von Hippel Lindau). Ganglioglioma: 50% had long segment involvement, canal expansion, and heterogenous enhancement, 50% had solid focal enhancement without canal expansion.

Conclusion
Careful evaluation of the MRI characteristics of intramedullary tumors may suggest the correct diagnoses. Well defined borders and the presence of hemosiderin are characteristics most typical of ependymomas when compared to astrocytomas. Well defined homogeneously enhancing tumors in a pediatric patient without hemosiderin or holocord syrinx would favor a pilocytic astrocytoma. Patients with von Hippel Lindau often have multiple cord hemangioblastomas. Gangliogliomas may not always present as a classic long-segment tumor with extensive cyst and canal expansion and may have features that overlap with pilocytic astrocytoma.

Key Words: Spinal tumors

Melanotic Schwannoma of the Lumbar Spine with Multiple Recurrences

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Purpose
To present the clinical and radiographic features of a rare case of biopsy-proved melanotic schwannoma. This schwannoma cell type can display unusual but characteristic MR findings as well as variable clinical behavior. Our case demonstrates multiple epidural and paraspinal recurrences across segmental levels.

Materials & Methods
The patient presented at 25 years of age with back pain eventually radiating to the left hip and knee. Subsequent onset of lower extremity weakness and provocation of pain with Valsalva maneuver prompted MR imaging. This revealed a left L3 nerve sheath tumor, but with the unusual signal characteristics of both T1 and T2 shortening. Subsequent gross total resection yielded melanotic schwannoma, a rare and clinically heterogeneous type of tumor thought to arise from a common neural crest progenitor of both melanocytes and Schwann cells. Despite the expectation of cure, follow-up imaging over the next 22 months showed a recurrent paravertebral mass at the L3 level along the lateral aspect of the original operative bed. This subsequently was resected with a portion of the distal L3 root. Two years later, another recurrence was demonstrated despite interval radiation therapy. This second recurrence extended from the operative bed superiorly within the epidural space to the L2 level, extending through the L2 neural foramen. Additionally, there was a synchronous tumor focus identified within the paraspinal muscles at L4-5. Aggressive resection of both lesions then was performed, as maximum radiation therapy had already been given.

Results
MR imaging of the spine demonstrated a transforaminal location of the original lesion, consistent with a nerve sheath tumor. The tumor demonstrated pronounced T1 and T2 shortening resulting from the paramagnetic nature of melanin. This T1 shortening initially had been incorrectly attributed to hemorrhage or mineralization. Recurrences of this tumor initially manifested as subtle regions of enhance-
ment along the residual spinal nerve roots and the margins of the operative bed. These eventually evolved into masses with melanotic signal characteristics similar to the initial tumor.

**CONCLUSION**
Melanotic schwannoma, though rare, can be prospectively diagnosed in cases of nerve sheath tumors that exhibit paired T1 and T2 shortening. It is an important tumor subtype to recognize due to its variable clinical course, with occasional locally aggressive behavior or frank transformation into malignancy. Once this lesion has been diagnosed, more frequent follow-up intervals and lower diagnostic thresholds may be appropriate than with conventional schwannomas, given our observed pattern of locally and multiply recurrent disease.

**KEY WORDS:** Schwannoma, melanotic, tumor

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**Paper 256 Starting at 3:31 PM, Ending at 3:39 PM**

**Multidetector CT Evaluation of Spinal Bone Tumors**

Debnam, J. M. · Rhines, L. D. · Ketonen, L. · Hunter, G. J. · Edeiken, B. S. · Hamberg, L. M.
The University of Texas M.D. Anderson Cancer Center Houston, TX

**PURPOSE**
We report on our clinical experience utilizing multidetector CT (MDCT) imaging of the spine for diagnosis, preoperative evaluation, and to provide detailed assessment of the surgical results in patients with spinal bone tumors.

**MATERIALS & METHODS**
Twenty-five spinal bone tumors in 24 patients (11 female, 13 male, mean age 53.9 years) were identified in whom MDCT imaging had been performed for presurgical (n = 16) and recurrent (n = 9) lesions. Imaging included reformations in the sagittal, coronal, and angled axial planes as well as 3D volume-rendered series. Primary tumors included the following: chordoma (n = 7), chondrosarcoma (n = 5), giant cell tumor (n = 4), osteoblastoma (n = 3), osteosarcoma (n = 2), aneurysmal bone cyst (n = 2), hemangioblastoma (n = 1), and osteoid osteoma (n = 1). Surgical resection was performed in 18 patients and follow-up MDCT imaging in 11 patients.

**RESULTS**
MDCT complemented MR imaging for diagnostic purposes in the initial assessment of the spinal bone tumors. The extent of bony destruction caused by the tumor and evaluation of adjacent levels allowed accurate surgical planning. Postoperatively, hardware position was well demonstrated and the reduction of streak artifact improved evaluation of the spine for signs of tumor recurrence.

**CONCLUSION**
MDCT imaging is an integral component of spinal bone tumor evaluation.

**KEY WORDS:** MDCT, spine, neoplasms

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**Paper 257 Starting at 3:39 PM, Ending at 3:47 PM**

**Multidetector CT Evaluation of the Spine in Patients with Neurofibromatosis Type 1**

Debnam, J. M. · Ketonen, L. · Slopis, J. M. · McCutcheon, I. E. · Hamberg, L. M. · Hunter, G. J.
The University of Texas M.D. Anderson Cancer Center Houston, TX

**PURPOSE**
We report on our clinical experience utilizing multidetector CT (MDCT) imaging of the spine for diagnosis, preoperative evaluation, and to provide a detailed assessment of the surgical results in patients with abnormalities related to neurofibromatosis Type 1.

**MATERIALS & METHODS**
Nineteen abnormalities in 16 patients (mean age 36 years; female 11, male 5) with neurofibromatosis Type 1 were identified in whom MDCT imaging was performed for diagnostic (n = 9) and preoperative (n = 7) evaluation. Imaging included reformations in the sagittal, coronal, and angled axial planes as well as three-dimensional (3D) volume rendered series. The types of abnormalities included the following: spinal dysplasia (n = 3), abnormal spinal curvature - both uncorrected (n = 4) and previously corrected (n = 4), and benign (n = 6) and malignant (n = 2) nerve sheath tumors. Postoperative follow-up MDCT imaging was obtained in all seven patients.

**RESULTS**
Spinal dysplasia and abnormal spinal curvature were well evaluated with the 3D volume rendered series. In patients in whom prior correction of scoliosis was performed, MDCT with multiplanar reformations as well as the 3D volume rendered series with translucent display provided accurate assessment of surgical hardware. The extent of bony destruction caused by benign and malignant nerve sheath tumors and evaluation of adjacent levels assisted in surgical planning. Postoperatively, the location of surgical hardware was well visualized and the reduction of artifact related to the hardware improved evaluation of the spine for signs of tumor recurrence.

**CONCLUSION**
MDCT of the spine is a valuable tool in the evaluation of abnormalities associated with neurofibromatosis Type 1.

**KEY WORDS:** Spine, neurofibromatosis, multidetector CT
Paper 258 Starting at 3:47 PM, Ending at 3:55 PM
Distinguishing Benign and Malignant Osseous Lesions of the Spine by Maximum Standard Uptake Values Obtained from 18FDG-PET Scans from Patients with Known or Suspected Malignancies

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1 Memorial Sloan-Kettering Cancer Center, New York, NY, 2 Harlem Hospital, New York, NY

PURPOSE
To correlate standard uptake values (SUV) of osseous lesions on 18FDG-PET in patients that have undergone CT-guided biopsy of the spine.

MATERIALS & METHODS
We retrospectively reviewed 18FDG-PET imaging studies of 132 consecutive patients that underwent a CT-guided biopsy of an osseous spine lesion. Whole body PET scans were done within 45 days of the biopsy. Fifteen patients were excluded from the study (SUV could be obtained - 11, inadequate biopsy - 3, interim radiation therapy - 1). SUVs for the lesions that were biopsied were correlated with the final pathology, malignant vs nonmalignant.

RESULTS
Of the 117 patients evaluated 89 patients had lesions that were malignant (76%) while 28 patients had spine lesions that were negative for malignancy (24%). The SUVs of the lesions biopsied ranged from 0 to 23.0.

CONCLUSION
Of all the osseous lesions of the spine that underwent CT-guided biopsy, those with an SUV > 3.5 on 18 FDG-PET were significantly more likely to be malignant.

KEY WORDS: Neoplasm, spine, FDG-PET

Paper 259 Starting at 3:55 PM, Ending at 4:03 PM
Clinical Application Study of MR Perfusion Imaging and Diffusion Tensor Imaging in Tumor-Like Lesions of Cervical Spinal Cord

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PURPOSE
To evaluate the application of MR perfusion-weighted imaging (PWI) and diffusion tensor imaging (DTI) in the diagnosis of tumor-like lesions in cervical spinal cord.

MATERIALS & METHODS
Cervical dynamic susceptibility contrast (DSC)-GRE-PWI and cervical DTI(EPI sequence TR/TE = 10000/85, b-value 1000s/mm², 25 directions; field of view was 20, slice thickness 4 and gap 0) scans were performed on 11 patients with GE 1.5T MR scanners with 8-channel neurovascular coils. One patient repeated cervical MR PWI; and two patients repeated cervical DTI examination. Trace apparent diffusion coefficient (trace ADC) and fractional anisotropy (FA), of DTI and relative cerebral blood volume (rCBV) in the PWI were calculated by Functool on a GE workstation.

RESULTS
There are five patients whose lesions were with increased rCBV comparing with the contralateral side, including one patient was with ependymoma, one with meningioma; one with sarcoidosis, two patients with astrocytoma. Mean rCBV ratio between lesion and contralateral side is 1.82 ± 0.35. There are six patients whose cervical spinal cord lesions were with decreased rCBV comparing with the contralateral side. One patient was with radiation injury for medulloblastoma which was confirmed by progressive decreased perfusion of a follow-up PWI examination; two patients with enhancing demyelinating lesions; three patients were with myelomalacia including one was because of postcervical meningioma resection; the other two were sequela of demyelinating disease. There is only one pathology confirmed astrocytoma with increased FA than contralateral side; for other lesions, mean FA value of other lesions (0.29 ± 0.03) were lower than the contralateral side (0.56 ± 0.11), paired t test, P < 0.01.

CONCLUSION
Combining cervical PWI and DTI could supply more information, including perfusion and anisotropy abnormality of tumor-like lesions in the cervical spinal cord; which are important for clinical diagnosis and further treatment.

KEY WORDS: Diffusion tensor imaging, perfusion-weighted imaging, tumor

Paper 260 Starting at 4:03 PM, Ending at 4:11 PM
Long-Term Follow Up of Spinal Cord Ependymoma

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Hôpital Erasme Brussels, BELGIUM

PURPOSE
To report our experience of long-term follow-up MR imaging (MRI) studies in spinal cord ependymomas after surgical partial or complete removal. To discuss imaging strategy and diagnostic challenges.

MATERIALS & METHODS
We reviewed 66 patients with a spinal cord ependymoma who underwent surgery and for whom a long-term follow up was available. Histology confirmed 57 ependymomas of grade II, two grade II with higher index of proliferation, two tannocytic ependymomas and five myxopapillary ependymomas. A first follow up MRI usually was obtained within 24 to 48 hours after surgery including T1, T2 and Gd T1-weighted images. Later on, a control examination was obtained once a year unless residual tumor or tumor recurrence was observed. Systematic analysis of those images was made and compared with the clinical outcome of the patient. The evolution of associated syringomyelia also was recorded.
RESULTS
In 53 patients, a complete tumor removal was described at surgery. Follow-up MRI (3 months to 16 years) showed indeed complete and permanent removal in 27 patients. No contrast enhancement was ever observed. In 13 patients contrast enhancement was observed on the early postoperative MRI that disappeared eventually on the follow-up MRI (3 months to 4 years). In nine cases, a small but persistent contrast uptake was present and considered as being scar tissue. In four cases with complete removal, tumor recurrence was seen in one case of myxopapillary ependymoma 3 years after surgery, one case with a higher index proliferation grade II had an early recurrence and was reoperated four times in 8 years. Two grade II recurred: one as early as 1 year after surgery and one after 18 years! In 13 patients, a subtotal resection could be achieved only: two myxo-papillary and 11 grade II ependymomas. The complex long-term follow up will be discussed (10 years): some patients remained stable whilst others had several recurrent surgeries.

CONCLUSION
Ependymomas usually benefit from a complete resection. Still, it is necessary to be cautious and we recommend regular follow up because late tumor recurrence may occur as late as 18 years. Gd enhancement can be seen on early postoperative MRI and disappear eventually. Some limited areas of enhancement can be seen and are stable: a nontumoral but sequellar scar tissue is therefore considered.

KEY WORDS: Ependymoma, spinal cord

Paper 261 Starting at 4:11 PM, Ending at 4:19 PM
Multidetector CT-Guided Lumbar Puncture in Cancer Patients
Debnam, J. M. · Schellingerhout, D. · Kumar, A. J. · Ketone, L. · Hamberg, L. · Hunter, G. J.
The University of Texas M.D. Anderson Cancer Center Houston, TX

PURPOSE
To describe the technique and evaluate outcomes of multidetector CT (MDCT)-guided lumbar punctures for diagnostic and therapeutic purposes in cancer patients.

MATERIALS & METHODS
Between 8/25/05 and 12/5/06, 18 MDCT-guided lumbar punctures were requested in 16 cancer patients (11 female, 5 male, mean age 52.9 years). All of these procedures were performed to collect cerebrospinal fluid for laboratory analysis and in addition for six patients, the instillation of intrathecal chemotherapy. Indications for the procedures included difficulty gaining access with a previous fluoroscopically guided attempt (n = 3) and the need for sedation in patients who were unable to tolerate the procedure due to lack of adequate pain control (n = 11) or altered mental status (n = 4). Medical records were reviewed retrospectively to assess the technical approach, diagnostic outcome and complications.

RESULTS
Procedures were performed under conscious sedation or with general anesthesia when requested. Patients were placed in the prone or lateral decubitus position for image guidance during the procedure. MDCT provided guidance for access of the lumbar thecal sac with a spinal needle in 16 out of 18 attempts (88.8%). In the two failures, no access could be obtained in one patient despite two attempts due to severe degenerative changes and scoliosis. In another case, CSF failed to return leading to inability to obtain a diagnostic sample. Contrast was instilled into the thecal sac to confirm needle position so that intrathecal chemotherapy could be administered. There were no immediate or delayed complications from the procedures.

CONCLUSION
MDCT-guided lumbar puncture is an effective and safe procedure with a high diagnostic accuracy and low complication rate and is effective in the appropriate clinical setting.

KEY WORDS: Multidetector CT, lumbar puncture

Paper 262 Starting at 4:19 PM, Ending at 4:27 PM
Cerebrospinal Fluid Flow in the Chiari I Malformation Modeled with Computational Flow Dynamics
Roldan, A. · Wentland, A. · Wieben, O. · Osswald, T. · Faroud, M. · Haughton, V.
University of Wisconsin Madison, WI

PURPOSE
Cerebrospinal fluid (CSF) flow abnormalities are theoretically the cause of syringomyelia and some neurologic signs and symptoms in Chiari I. The pathogenesis of neurologic changes secondary to CSF flow abnormalities has not been explained adequately. CSF flow in presence of tonsilar ectopia has been characterized for specific axial levels but not in 3D. Critical differences in CSF flow between symptomatic and asymptomatic Chiari I patients have not been defined. The purpose of this study was to study CSF velocities and CSF pressures throughout the foramen magnum and upper cervical spinal canal with a computational flow analysis program.

MATERIALS & METHODS
3D models of the subarachnoid space of the upper cervical spine and foramen magnum in normal subjects and patients with a symptomatic Chiari I malformation were created by acquiring high-resolution 3D MR images (VIPR) and converting image data to a 3D model (MIMICS). Flow was modeled in the subarachnoid space using the Boundary Element Method (BEM). The elements were selected to provide a value for the CSF flow throughout the space. Velocities for the inlet in the model were assumed by referencing CSF flow data in PC MR CSF flow images. Velocities and pressures were calculated for each of the internal points in the numerical simulation. Velocities obtained using BEM were compared to actual CSF velocity data in normal subjects and in patients.

RESULTS
With the implemented numerical technique, models were successfully created for the subarachnoid space in normal subjects and Chiari I. In models for the normal subarachnoid space, inhomogeneities in velocity were identified (Fig 1). The model shows lower velocities at the anterior part of the
CONCLUSION
The BEM models show that the variation in CSF velocities through the subarachnoid space are determined largely by the anatomy of the subarachnoid space. With BEM, the strategy for measuring CSF flow in patients may be optimized. With BEM, critical differences in CSF flow between symptomatic and asymptomatic patients may potentially be defined.

KEY WORDS: Chiari I malformation, CSF dynamics, syringomyelia

Paper 263 Starting at 4:27 PM, Ending at 4:35 PM
Development of Molecular Imaging Agents for the Assessment of Neural Transport with Scintigraphic and Optical Imaging Modalities

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The University of Texas M. D. Anderson Cancer Center Houston, TX

PURPOSE
To develop an agent for the molecular imaging of retrograde axonal transport in nerve tissue. Such an agent holds promise for the spatial and temporal study of neuropathies in human patients. We labeled a fragment of tetanus toxin protein with radionuclides and optical tracers and used these agents to demonstrate retrograde axonal transport in animals.

MATERIALS & METHODS
A His-tagged recombinant tetanotoxin fragment (TTF) was produced in E.coli, purified, and labeled with $^{68}$Indium-DOTA for radioscintigraphic studies and with Alexa$^{488}$ or Alexa$^{546}$ for optical imaging studies. $^{111}$Indium-DOTA-TTF was injected into the soleus muscle of C57bl mice, and imaging performed on XSpect SPECT-CT system (GammaMedica). Optical in vivo imaging was performed with IVIS 200 (Xenogen). Intravitral fluorescence microscopy was performed with the Cell-Vizio system (Mauna Kea) using a S-300-5.0 ProFlex fiberoptic probe. Histologic validation of tissue distribution was performed with laser scanning confocal fluorescence microscope FV 1000 (Olympus) and by means of biodistribution studies using tissue sampling and well-type gamma counting (Packard).

RESULTS
SPECT-CT images of $^{68}$Indium-DOTA-TTF demonstrated time-dependent propagation of the radiotracer along the ipsilateral sciatic nerve. Tissue sampling analysis demonstrated that at 24 hours after injection, $6.97 \pm 4.6\%$ID/g (mean $\pm$ SD) was localized in the ipsilateral sciatic nerve, which was 363 fold higher than in the contralateral noninjected side. In vivo optical imaging also demonstrated the uptake of TTF-Alexa$^{488}$ in the sciatic nerve, while the microscopy studies in vivo and in excised nerve segments confirmed the compound uptake in nerve fascicles of the sciatic nerve. Pharmacokinetic 2-compartment modeling yielded $t_{1/2}=1.1$ h and $t_{1/2}=95.7$ h (75.3% and 24.7% contribution respectively).

CONCLUSION
Both the radionuclide and fluorophore-labeled agents are taken up into motor nerve endings after intramuscular injection, and are retrogradely transported in axons. This process can be monitored with multimodality imaging and is potentially useful for the spatial and temporal study of neuropathies and their response to treatment.

KEY WORDS: Axonal transport, molecular imaging

Paper 264 Starting at 4:35 PM, Ending at 4:43 PM
IDEAL (0) ASSIST (2)
Weiss, K. · Cornelius, R. · Weiss, J. · Sun, D.
University of Cincinnati Cincinnati, OH

PURPOSE
Develop and test a rapid automated MR total spine screening technique providing improved tissue contrast through optimized fat-water separation.

MATERIALS & METHODS
IRB approval and informed consent was obtained. IDEAL (iterative decomposition of water and fat with echo asymmetric and least-squares estimation) sequencing was incorporated into the automated spine survey iterative scan technique (ASSIST) protocol to provide rapid assessment of both vertebral morphology and marrow composition throughout the entire spine. The spine, from skull base to sacrum, was imaged in the sagittal plane in two automated contiguous 35 cm FOV stations providing 70 cm coverage, utilizing out-of-phase FGRE (TE = 2.2 at 1.5T, TE = 3.3 msec at 3.0T) and FSE (T1- and/or T2-weighted) IDEAL sequencing. For IDEAL sequences, decomposed fat and water images, composite chemical shift corrected images, and F% images were generated and reviewed. A total of 12 subjects were studied, one twice at 3.0T and one at both 1.5T and 3.0T for a total of
14 spine studies (8 at 1.5T and 6 at 3.0T). Images were evaluated independently by two neuroradiologists and run through ASSIST analysis software for automated vertebral numbering. Studies were compared to conventional imaging sequences where available.

**RESULTS**

In all 12 subjects/14 spine studies, neuroradiologist and computer ASSIST labeling of all vertebrae were concordant. In all cases, IDEAL provided uniform fat and water separation throughout the entire 70 cm FOV imaged. Two subjects demonstrated breast metastases (Fig 1) and one had a large presumptive schwannoma. All subjects demonstrated some degree of degenerative disk disease with associated Modic Type I or II changes at multiple levels. GRE ASSIST afforded subminute submillimeter in-plane resolution of the entire spine with high contrast between disks and vertebrae at both 1.5 and 3.0T. In all cases, marrow signal abnormalities could be characterized particularly well with IDEAL-derived images and parametric maps.

**CONCLUSION**

IDEAL ASSIST is a promising MR imaging technique affording a rapid automated high-resolution, high-contrast survey of the entire spine with optimized tissue characterization.

**KEY WORDS:** MR imaging, technique

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**Wednesday Afternoon**

**3:15 PM – 4:45 PM**

**Columbus I-L**

(44b) ADULT BRAIN:
Cerebrovascular Occlusive Disease I
(Scientific Papers 265 – 275)

See also Parallel Sessions
(44a) SPINE: Neoplasms and Other
(44c) PEDIATRICS: Cerebrovascular Diseases,
Degenerative, Demyelinating, Metabolic Disease
(44d) INTERVENTIONAL: Aneurysms I

Moderators: Mark E. Mullins, MD, PhD
Jerrold Boxerman, MD

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**Paper 265 Starting at 3:15 PM, Ending at 3:23 PM**

**Estimation of the Local Arterial Input Function in Cerebral Perfusion Imaging Provides Additional Clinical Information**

Shimony, J. S.1 · Lee, J. J.1 · Brethorst, L. G.1 · Vo, K. D.1 · Lee, J. M.1 · Derdeyn, C. P.1 · Snyder, A. Z.1 · Videen, T. O.1 · Markham, J.1 · Lin, W.2 · Powers, W. J.1

1Washington University School of Medicine, St. Louis, MO,
2University of North Carolina School of Medicine, Chapel Hill, NC

**PURPOSE**

Most current methods of measuring cerebral perfusion using dynamic susceptibility contrast (DSC) rely on measuring a single arterial input function (AIF), which can be difficult to estimate using MR imaging (MRI) due to saturation of the signal. Using a single AIF cannot account for the different delay and dispersion that occur before the contrast bolus arrive at different parts of the brain, especially in patients with chronic hemodynamic impairment or acute stroke. We developed a tissue perfusion model that estimates a local AIF for each pixel of the brain. The purpose of the current study was to apply this model to patients with both chronic and acute hemodynamic impairment and to assess for additional clinical information that can be obtained using this technique.

**MATERIALS & METHODS**

Model Description: Tracer kinetic perfusion models express the tissue concentration as the cerebral blood flow times the pixel impulse residue curve convolved with the AIF. The residue curve was approximated as an exponential with the mean transit time (MTT) as the decay constant. The AIF was modeled as a gamma-variate function (GV) arriving at t₀. These expressions were substituted into the tissue concentra-
tion equation and the convolution was performed analytically. The posterior probabilities for the model parameters were computed for each pixel given the time series data using Bayesian probability theory and Metropolis-Hastings Markov chain Monte Carlo simulation with simulated annealing. Regions of interest were selected in both the ipsi- and contra-lateral sides of the brain to evaluate the degree of asymmetry between the perfusion parameters. Patient Selection: The patients with chronic hemodynamic impairment were scanned as part of the St. Louis Carotid Occlusion Study. Perfusion measurements were performed in 19 patients using both PET and DSC MRI within the same day. Acute stroke patients were scanned twice with the first scan performed in under 3 hours from the time of presentation as part of a clinical trial investigating the use of tPA.

RESULTS
In addition to providing the standard set of perfusion parameters (CBF, CBV, and MTT) the current method provided additional perfusion parameters related to the local AIF. Key among these were the time of arrival (t₀), AIF rise parameter (alpha), and the AIF decay parameter (beta). In the chronically affected patients the results of the standard parameters were similar to those obtained using standard techniques. The local AIF parameters in several patients indicated greater left-right asymmetry than that seen with the standard parameters, providing greater contrast to noise. In the small sample of stroke patients the local AIF parameters provided additional information on the stroke core and penumbra that was not available using the standard measures. Additionally, the CBF and MTT results were subtly different between the two methods, indicating differences in the estimated stroke size between the two methods.

CONCLUSION
Using a more complex tissue perfusion model with local AIF estimation provides additional information in both acute and chronic hemodynamic impairment.

KEY WORDS: Perfusion imaging, cerebral hemodynamic impairment, stroke

We wish to thank the Berlex/MIR Fellowship for support of this project.

Paper 266 Starting at 3:23 PM, Ending at 3:31 PM
Quantitative Assessment of Core/Penumbra Mismatch in Acute Stroke: CT and MR Perfusion Imaging are Highly Correlated (when Coverage Is Sufficient!)

Schaefer, P. W. · Barak, E. R. · Kamalian, S. · Rezai Gharai, L. · Gonzalez, R. G. · Lev, M. H.
Massachusetts General Hospital
Boston, MA

PURPOSE
CT cerebral blood volume(CBV) maps, similar to MR diffusion-weighted images(DWI), can be used to operationally define infarct core and CT mean transit time(MTT) maps, similar to MR MTT maps, can be used to operationally define salvageable penumbra. Three inclusion criteria for major clinical trials aimed at extending the time window for IV thrombolysis beyond 3 hours are: (1)MTT lesion size >2 cm (~2 ml), (2)core lesion size <1/3 of the MCA territory (~100 ml), and (3)core/penumbra mismatch >20%. We therefore sought to determine (1) the correlation between quantitative CT and MR measurement of mismatch, and (2) whether the difference between these measurements would alter the decision to enroll patients in trials based on the above criteria.

MATERIALS & METHODS
Forty-eight patients with acute MCA stroke who were first imaged within a mean of 3.8 hours of stroke onset (range 0.48-8.35 hours) and who underwent CT perfusion(CTP) and MR DWI/perfusion-weighted imaging(PWI) within 3 hours of each other were included. The DWI and MR-MTT abnormalities were visually segmented using a semi-automated commercial analysis program by raters blinded to the CTP findings. The CT-CBV and CT-MTT lesions were automatically segmented using a relative CBV threshold of 0.66 and a relative MTT threshold of 1.50 on commercially available software. CTP slab thickness was 1 cm in four cases, 2 cm in 14, 4 cm in 25, and 8 cm in five. Percent mismatch was defined as (MTT- DWI)/MTT volume x100. Correlation coefficients were calculated.

RESULTS
Mean DWI lesion volume was 48.6(0-247) cc and mean CT-CBV lesion volume was 23.0(0-156) cc, R²=0.66(p <0.001). Mean CT-MTT lesion volume was 78cc(0.2-306) and mean MR-MTT lesion volume was 141.5cc(0.4-388), R²=0.66(p <0.001). Mean DWI/MMT mismatch was 68.7%(2.5-97.6) and mean CT-CBV/MMT mismatch was 81.1%(11.2-100), R²=0.60 (p <0.001). For patients with a 4-8 cm CTP slab, R=0.74(p <0.001); for those with a 1-2 cm slab, R=0.33(p =0.18). In 46/48(95.8%) cases, MRP and CTP agreed for determining MTT lesion size < or >2 cms. In 1/48, CTP underestimated lesion size due to inadequate coverage and in 1/48, CTP overestimated lesion size due to spurious software measurements. In 46/48(95.8%) cases, MRI and CTP agreed for determining < or >20% mismatch. In 1/48, CTP overestimated mismatch size due to spurious MTT software measurements and in 1/48, CTP overestimated mismatch size because a CBV lesion was not detected. In 44/48(92%) cases, MRI and CTP agreed for determining < or >100ccs. In 7 cases DWI was >100cc. In 4/7, CT-CBV lesion size was <100ccs. This difference was attributable to coverage, and would not have occurred had the “whole brain” CTA source images been used to estimate core.

CONCLUSION
Although MR is currently the imaging method of choice for determining mismatch, CT may be more practical to perform in acute stroke patients. Criteria for inclusion in clinical trials based on mismatch are highly correlated for MR and CTP imaging, when CTP coverage is sufficient to include the majority of the ischemic region. This is typically the case with newer generation scanners and with current CTP imaging protocols.

KEY WORDS: Stroke, MR and CT perfusion imaging
Paper 267 Starting at 3:31 PM, Ending at 3:39 PM
Penumbra Stroke System: A New Generation of Mechanical Devices for the Treatment of Acute Stroke Due to Large Vessel Occlusive Disease

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PURPOSE
Safe and reliable recanalization at the site of primary occlusion has remained an elusive goal in acute ischemic stroke. The Penumbra™ Stroke System is a new generation of mechanical devices designed to reduce clot burden in acute stroke due to large vessel occlusive disease. This system has two revascularization options, first with thrombus debulking and aspiration, followed by direct thrombus extraction if clots remain. Reported herein is the first clinical experience with the Penumbra Stroke System in patients with acute stroke.

MATERIALS & METHODS
A total of 23 patients were enrolled in this Phase 1, prospective, single arm, multicenter international trial. Main inclusion criteria were a deficit measurable on the National Institute of Health Stroke Scale (NIHSS), presentation within 8 hours of symptom onset and an angiographic occlusion (TIMI grade 0 or 1) of a treatable intracranial vessel. The primary endpoint was incidence of recanalization of the target vessel (TIMI grade 2 or 3). Secondary endpoints were good clinical outcome as defined by a 4-point improvement on the NIHSS or a modified Rankin Score (mRS) of < 2 at 24 hours and all cause mortality at 30-day follow up.

RESULTS
Of 23 patients enrolled, 21 target vessels in 20 patients were treated by the Penumbra Stroke System. Three patients were not treated due to problems with endovascular access. The occluded target vessels were: internal carotid artery (7), middle cerebral artery M1 segment (5), and basilar artery (9). Mean age was 58 years, and mean baseline NIHSS score was 20 (range 16 to 38). All treated vessels were revascularized successfully by the Penumbra Stroke System to TIMI 2 or 3 (100%). There were two procedure-, device-related adverse events: groin hematoma and a subarachnoid hemorrhage from a vessel perforation. Both events were without further clinical consequences. Of 20 patients who participated in 30-day follow up, nine (45%) have a > 4 point NIHSS improvement or an mRS of ≤ 2. All cause mortality at 30 days was 45% (9/20), which is lower than expected of this high risk stroke cohort, where 70% had either a baseline NIHSS score > 20 or a basilar occlusion.

CONCLUSION
Early clinical experience suggests that the Penumbra Stroke System allows safe recanalization in high risk patients experiencing ischemic stroke secondary to large vessel occlusive disease.

KEY WORDS: Acute ischemic stroke, endovascular therapy, Penumbra System

Paper 268 Starting at 3:39 PM, Ending at 3:47 PM
Susceptibility-Weighted Imaging: Clinical Utility for Hyperacute Cerebral Ischemia

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PURPOSE
Susceptibility-weighted imaging (SWI) uses phase to enhance contrast caused by susceptibility difference. The phase image itself is used to separate the dominant spectral information. The image feature is contrast caused by susceptibility difference between deoxygenated blood (deoxy-Hb) and the surrounding tissue (oxy-Hb) (1). Early detection of arterial occlusion and perfusion abnormality is necessary for effective therapy of hyperacute cerebral ischemia. We attempted to assess the clinical role of SWI in hyperacute ischemic stroke (HIS) during 24 hours from onset.

MATERIALS & METHODS
We studied 62 patients who had suffered from HIS caused by occlusion of intracranial major arteries. MR examinations were performed with a clinical whole-body imager operating at 1.5T. 3D FLASH SWI parameters were as follows: 48/40/20 ms (TR/TE/flip); field of view, 23 cm; matrix size, 320; axial sections, 1.6 mm thick; and scan time, 5 minutes 32 seconds. Minimum intensity projection was performed to display the processed data. All patients underwent diffusion-weighted imaging (DWI), MR angiography (MRA) and Gd perfusion study.

RESULTS
We have found two major findings on SWI in patients with HIS; those are increased vessel contrast (IVC) and intrararterial low signal (IAL). IVC is remarkable hypointensity in the draining veins within perfusion abnormality. IVC was detected in 77.4%. IVC was detected not only in the cortical veins but medullary veins. The area with IVC agreed with an area with perfusion impairment confirmed by Gd-perfusion study in all patients. IAL was markedly hypointense dot-like signal in the occluded artery due to T2* effect representing emboli or thrombi. IAL was seen in 69.4%. IAL agreed with lack of TOF MRA and FLAIR intraarterial signal (IAS); however, in some cases, IAL is superior to FLAIR IAS for the detection of acute thrombus itself due to susceptibility effect.

CONCLUSION
IVC suggests a relative increase of intravenous paramagnetic deoxyHb and a relative reduction of oxyHb due to the impaired oxygenation (misery perfusion state). SWI can detect not only an area of perfusion impairment but also occluded artery. SWI provides important adjunct information for HIS. IVC is a useful finding to assess acute misery perfusion state without contrast media and a reliable indicator for determining whether a patient should undergo Gd-perfusion study.

REFERENCES

KEY WORDS: Susceptibility-weighted imaging, MR imaging, cerebral infarct
Visual Estimation of MR Imaging Core/Penumbra Mismatch - Versus Quantitative Measurement - Unnecessarily Excludes Patients from Thrombolytic Clinical Trials

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PURPOSE
Diffusion-weighted imaging (DWI) has been used to estimate infarct core, and MR perfusion-weighted mean transit time (MTT) imaging to estimate salvageable ischemic penumbr a. Two important inclusion criteria for enrollment of acute stroke patients into clinical trials aimed at extending the time window for IV thrombolysis beyond 3 hours are: 1) DWI lesion volume <1/3rd MCA territory (~100 ml), and 2) DWI/MTT lesion volume mismatch >20%. We sought to determine: 1) how well visual estimation of infarct and mismatch size compares with quantitative measurement, and 2) how often the differences between these two would alter the selection of patients for thrombolysis clinical trials.

MATERIALS & METHODS
Sixty-nine patients with acute MCA stroke who underwent MR diffusion and perfusion imaging within 9 hours of onset were evaluated. For quantitative measurement, visually detected DWI and MTT abnormalities were manually segmented using a semiautomated commercial analysis program. Volumes and percent mismatches were calculated. For qualitative assessment, two experienced vascular neuroradiologists, blinded to the quantitative results, graded the infarct size as > or < 1/3rd of the MCA territory (~100 ccs), and the percent mismatch as > or <20%.

RESULTS
Mean quantitative DWI stroke volume was 48 cc (range 0-322). In 63/69 (91.3%) cases, the qualitative estimation of DWI stroke size agreed with the quantitative measurement. In 6/69 (8.7%), the radiologists incorrectly estimated the strokes to be >1/3rd of the MCA territory (DWI quantitative volume range 70.5 - 87.2 ccs). Mean quantitative DWI/MTT mismatch was 58% (range 0-100). In 51/69 (73.9%), the qualitative estimation of mismatch agreed with the quantitative measurement. In 18/69 (26.1%), the radiologists incorrectly estimated that the mismatch was <20% (quantitative mismatch range 22.8 - 66.3%). In 17 of these 18, however, would the clinical decision for trial enrollment have been affected (one case had a DWI lesion volume > 100cc). Mean quantitative MTT stroke volume was 127 cc (range 0.17-417). Overall, 22/69 (31.9%) patients would have been incorrectly excluded from thrombolysis clinical trial enrollment based on visual estimation alone.

CONCLUSION
Visual estimation of admission DWI/MTT images in acute stroke patients, compared to quantitative measurement, leads to overestimation of infarct size and/or underestimation of mismatch size in some cases. Overall, 31.9% of patients in this cohort would have been excluded unnecessarily from thrombolysis clinical trials, had a visual, rather than a quantitative selection process been used. Automated quantitative segmentation tools may therefore be desirable to optimize patient selection for entry into acute stroke trials.

KEY WORDS: Stroke, MR diffusion and perfusion

Venous Thrombosis as a Mechanism of Exacerbation in Venous and Combined Venous Lymphatic Vascular Malformations of the Orbit

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PURPOSE
To describe venous thrombosis as a mechanism of clinical change in venous and combined venous lymphatic vascular malformations of the orbit.

MATERIALS & METHODS
Design: Retrospective, interventional case series. Participants: 11 patients with episodes of thrombosis of purely venous (n = 6) and combined venous lymphatic malformations (n = 5). Intervention: Surgical excision of lesion in selected patients. Main Outcome Measures: Age at presentation, gender, disease onset, symptoms and signs, investigatory findings (imaging and pathology reports), management, and outcome.

RESULTS
Of the six patients with purely venous malformations (Group A), three were male and three female, and of the five with combined venous lymphatic malformations (Group B), one was male and four female. In Group A and in Group B, the mean age at presentation was 59 ± 11.22 years (range 45-71 years) and 10.8 ± 11.7 years (range 1.5-26 years), respectively. The pattern of onset was acute in all cases. In Group A, the most common sign and symptom was pain (n = 6), while in Group B were proptosis (n = 5), periorbital swelling (n = 5), and echymosis (n = 4).

CONCLUSION
Clinically the 2 groups behave differently. Group A presents with pain and upon follow up usually there is spontaneous resolution of the thrombus with no need for intervention, while in Group B there is a tendency for rebleeding where early intervention is advised. Finally when requesting imaging (CT angiography, MR gadolinium) for such lesions early versus late phases should be employed because in late phases the thrombus is better delineated, while can be easily missed in early phases.

KEY WORDS: Orbit, thrombosis, venous malformation
Assessing the Effect of Clot Location and Burden on Outcome in Patients with Anterior Circulation Infarction Treated with Intraarterial Therapy


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PURPOSE

Acute stroke patients with tandem internal carotid and middle cerebral artery occlusions treated with intravenous thrombolytic agents have lower recanalization rates and worse clinical outcomes. Our purpose was to assess the effect of clot location and burden on recanalization rates and outcome in acute anterior circulation stroke patients treated with intraarterial recanalization.

MATERIALS & METHODS

We retrospectively analyzed the imaging and clinical outcome of 43 patients with pretreatment CT angiography (CTA) demonstrating anterior circulation large vessel thrombus who were treated with intraarterial therapy between 2004 and 2006. The CTA was analyzed for vessel occlusion in seven vascular segments: ICA infra-ophthalmic (ICA-IO), ICA supra-ophthalmic (ICA-SO), M1 proximal half, M1 distal half, M2 superior division, M2 inferior division, and A1. Each segment was graded as either occluded (score =1) or not occluded (score =0). We added the score in all seven segments to determine total clot burden. Noncontrast CT and CTA source images (CTA-SI) were graded for parenchymal hypodensity using ASPECT scores. Images also were graded for the presence or absence of the anterior communicating and posterior communicating arteries. Pial collateral vessels were graded as being < opposite side or >/= opposite side. Postprocedure angiograms were graded for recanalization on the Mori scale (0-1: no recanalization, 2: partial recanalization, 3-4: complete recanalization). Outcome was dichotomized by the modified Rankin score (mRS) at 3 months into good outcome (mRS 0-2) and poor outcome (mRS 3-6).

RESULTS

Thirty-two of 43 (74%) patients had poor and 11 (26%) patients had good clinical outcome. All 13 patients with ICA occlusions also had MCA occlusions (tandem ICA/MCA occlusion, TIM). Thirty patients had isolated MCA occlusions; 11 with proximal M1, 16 with distal M1 and three with isolated M2 occlusions. Patients with TIM occlusions had significantly worse outcomes compared to patients with isolated MCA occlusions (p=0.03); only 1/13 (7.7%) patients with a TIM occlusion versus 10/30 (33%) patients with MCA occlusions had a good outcome. Patients with TIM occlusions also had significantly lower ASPECT scores (3.1) on CTA-SI versus patients with MCA occlusions (5.2) (p=0.007). There was no significant difference in NCCT ASPECT scores or recanalization rates between these two populations. There was no difference in outcomes in patients with proximal versus distal M1 or M2 occlusions. Patients with a good outcome had a significantly lower average clot burden score (3.1) versus patients with poor outcome (4.17) (p=0.02); 0/11 patients with a clot burden >4 had a good outcome and 11/32 (34%) patients with a clot burden <=4 had a good outcome (p=0.0003). Presence of the anterior communicating and/or posterior communicating arteries did not correlate with outcome. Eighty-two percent (9/11) of patients with good outcome and 41% (13/32) of patients with poor outcome had pial collateral vessels >/= opposite side (p=0.01).

CONCLUSION

In patients with anterior circulation ischemic stroke treated with intraarterial therapy, those with TIM occlusions have worse outcomes than isolated MCA occlusions. This difference may be attributed to increased size of infarct prior to treatment as seen on CTA-SI. Clot burden and degree of pial vessel collateralization also are associated with outcome. This information may be important for selecting which patients will benefit most from intraarterial recanalization.

KEY WORDS: Anterior circulation stroke, CT angiography, intraarterial therapy

Comparison of Volumetric Segmentation to Visual Scoring for Assessment of White Matter Ischemic Disease

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PURPOSE

White matter hyperintensities (WMH) on T2-weighted images commonly are seen in the elderly and have been associated with both atherosclerosis risk factors as well as cognitive decline in several prospective multicenter studies but its characterization has been problematic. Early studies have used visual grading of WMH severity while more recent studies have added forms of semiautomatic volumetric analysis. The purpose of this study is to examine the correlation between a novel segmentation technique and an established visual semiquantitative scoring system.

MATERIALS & METHODS

One thousand twenty-eight subjects (mean age 72 years) enrolled in the Atherosclerosis Risk in Communities (ARIC) study from Jackson, MS and Forsyth, NC received brain MR scans at 1.5T including axial 3 mm contiguous FLAIR and 5 mm contiguous T2, PD, and T1-weighted images. WMH was graded visually by neuroradiologists on the PD images using a 0 to 9 scale using standards initially developed as apart of the Cardiovascular Health Study (CHS) study. A semiautomated volumetric analysis of the FLAIR images applying a novel statistically based segmentation to the image intensity histogram also was performed to yield a total WMH volume. Blinded interreader test cases also were included and the two scoring methods were correlated using a kappa analysis. Segmentation maps were reviewed in apparent discrepant cases and subjects with infarcts and other lesions.
RESULTS
A kappa value of 0.85 was found when correlating the visual scoring versus volumetric segmentation. For the visual scoring of the interreader test cases (24 pairs) there was 100% agreement within one, with a weighted kappa of .84 while for the volumetric analysis the kappa was 0.98.

CONCLUSION
Overall agreement between the visual scoring and volumetric analysis was very good. These results help to validate this statistically driven segmentation technique compared to the traditional visual scoring for estimating severity of ischemic white matter disease. On the other hand the results also lend credibility to the visual scoring techniques and particularly the standards used in earlier studies. Strengths of the volumetric technique include lower interreader variability, greater precision, decreased operator training, and the creation of 3D maps of the spatial distribution of disease which can be subject to group analysis. A potential weakness however is the specificity of the segmentation to exclude FLAIR hyperintensities other than leukoaraiosis. Examples will be shown comparing the visual versus volumetric analysis in cases of infarcts and other lesions.

REFERENCES

KEY WORDS: White matter, ischemia, segmentation

Paper 273 Starting at 4:19 PM, Ending at 4:27 PM

CT Angiography Source Image Hypoattenuation Predicts Clinical Outcome in Posterior Circulation Strokes Treated with Intraarterial Therapy


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PURPOSE
Posterior circulation infarction is associated with a high mortality rate. Intraarterial therapy (IAT) is used to treat vertebral and basilar occlusions in an attempt to improve survival. CT angiography (CTA) source image (CTA-SI) hypoattenuation is thought to represent infarct core and CTA-SI ASPECT scores have improved prediction of final infarct size and clinical outcome in anterior circulation strokes. However, little is known with respect to pretreatment imaging correlation with outcome in posterior circulation strokes. Our purpose was to correlate the degree of parenchymal hypoattenuation on initial CTA-SI, using a novel score, with clinical outcome, in patients with vertebral and basilar emboli, treated with IAT.

MATERIALS & METHODS
We retrospectively analyzed the imaging and outcome of 16 patients with pretreatment CT angiograms (CTA) showing vertebral and/or basilar artery occlusions who underwent IAT from 2003-2006. We graded CTA-SI for parenchymal hypoattenuation in eight regions bilaterally: medulla, midbrain, pons, thalamus, cerebellum, occipital lobe, inferior parietal lobe, medial temporal lobe. Each side of a region was graded on a scale of 0-2: 0: no hypoattenuation, 1: <50% involvement, 2: >50% involvement). On the CTA, we also assessed clot location, presence or absence of vessel hyperdensity, presence or absence of vascular calcification, and collateralization(presence of absence of posterior communicating arteries). Degree of recanalization was assessed on digital subtraction angiography following thrombolysis. Outcome was dichotomized into death during hospitalization versus survival and was also characterized by the modified Rankin score(mRS) at 3 months.

RESULTS
Nine women and seven men with an average age of 68 years (47-86) were treated. Mean time from symptom onset to CTA was 5.2 hours (0.7-15.8), and to procedure conclusion was 10.2 hours (3.5-19). Four patients had basilar, two had vertebral, and 10 had combined vertebral and basilar artery occlusions. Eleven patients had complete, four had partial and one had no recanalization. Mean NIHSS on admission was 28 (11-40). When examining all eight regions, the seven surviving patients(44%) had a mean CTA-SI score of 3.29 (1-7) and the nine deceased patients had a significantly higher mean CTA-SI score of 9.1 (5-14) (p=0.0003). The total CTA-SI score highly correlated with mRS at 3 months (r² =0.78, p=0.0007). When examining just brainstem/diencephalon, surviving patients had a mean CTA-SI score of 2.86 (1-6) while deceased patients had a significantly higher mean CTA-SI score of 7.89 (5-11) (p =.0002). The brainstem/diencephalon score also highly correlated with mRS at 3 months (r²=0.79, p=0.0005). Furthermore, the admission NIHSS correlated strongly with survival (p=0.006) and mRS at 3 months (r² = 0.73, p=0.002). No other variables examined (age, sex, time to treatment, clot location, presence of vessel hyperdensity, presence of collaterals, presence of calcification) correlated with outcome.

CONCLUSION
The degree of hypoattenuation on pretreatment CTA-SI correlates highly with outcome in patients with posterior circulation stroke treated with IAT. The strength of this correlation increases by examining just the brainstem/diencephalon(medulla, pons, midbrain, thalamus). In spite of recanalization, patients with a brainstem/diencephalon score of >6 died, while those with a score of <5 survived, with a follow-up mRS of 1-4. This information may be important for selecting which patients will benefit most from intraarterial recanalization.

KEY WORDS: Posterior circulation stroke, CT angiography, intraarterial therapy
Utility of CT Angiography and CT Perfusion in Diagnosing Brain Death

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PURPOSE
To assess the utility of CT angiography and CT perfusion as an ancillary test for the diagnosis of brain death.

MATERIALS & METHODS
Five patients with suspected brain death but with confounding factors that prohibited clinical diagnosis were included in this study. All patients had both CT angiography and CT perfusion performed. CT angiography was performed with both early and delayed imaging following contrast injection. All patients also had Technicium-99m HMPAO brain death scintigraphy or cerebral angiography performed to confirm the diagnosis of brain death.

RESULTS
On early phase CT angiography, contrast filling of the carotid and vertebral arteries terminated before the skull base in all patients. On the delayed phase, two patients demonstrated minor filling of the proximal MCA branches, but no cortical MCA arterial filling. CT perfusion demonstrated reduced cerebral blood volume (CBV) and cerebral blood flow (CBF). CBV and CBF levels were below the reversible ischemic threshold in all cases at all imaged levels.

CONCLUSION
CT angiography and CT perfusion are acceptable ancillary tests for the diagnosis of brain death.

KEY WORDS: Brain death, CT angiography, CT perfusion

MR Imaging Evaluation of Hyperacute Brainstem Stroke and Correlation with Pathologic Findings in an Animal Model

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PURPOSE
The purpose of our study was to evaluate early MR imaging findings of brainstem stroke and correlate these with pathologic changes in an animal model.

MATERIALS & METHODS
After Institutional Animal Care and Use Committee approval, selective basilar artery (BA) occlusion was created in seven New Zealand White rabbits (male and female; 4.0-4.5 kg) by injection of preformed thrombus through microcatheter positioned into the distal vertebral artery. MR imaging of the brain and MR angiography (MRA) were performed on all animals prior to BA occlusion, as well as repeatedly during the period of ischemia. BA occlusion was maintained for 3 hours in four animals, and for 6 hours in three animals. Each animal was euthanized at the end of the experiment. Brains were removed, stained for 30 min with 1.5% 2, 3, 5-triphenyltetrazolium chloride, and fixed in 4% paraformaldehyde. An area of core and penumbra were identified based on triphenyltetrazolium staining, hematoxylin and eosin staining, and electron microscopy.

RESULTS
Brainstem stroke was induced in all animals based on pathologic changes. The BA remained occluded in all animals throughout the experiments, as confirmed by control digital subtraction angiography as well as MRA. Significant mitochondrial damage, based on electron microscopy findings, was detected as early as 3 hours after BA occlusion (Fig 1). The earliest MR imaging changes with positive diffusion-weighting imaging signal were detected at 4.5 hours of ischemia with definite findings at 6 hours (Fig 2).

CONCLUSION
A reproducible model of brainstem stroke can be induced in a rabbit model using selective endovascular occlusion of the BA. Significant pathologic changes of the brainstem
parenchyma can be detected in this model as early as 3 hours after ischemia, significantly earlier than acute stroke is indicated on MR imaging.

**Key Words:** Brainstem stroke, animal model

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**Wednesday Afternoon**

**3:15 PM – 4:45 PM**
**Grand Ballroom A**

(44c) PEDIATRICS: Cerebrovascular Diseases, Degenerative, Demyelinating, Metabolic Disease

(Scientific Papers 276 – 286)

*See also Parallel Sessions*

(44a) SPINE: Neoplasms and Other
(44b) ADULT BRAIN: Cerebrovascular Occlusive Disease I
(44d) INTERVENTIONAL: Aneurysms I

**Moderators:** Evelyn M. Sklar, MD
Paul D. Griffiths, MD

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**Paper 276 Starting at 3:15 PM, Ending at 3:23 PM**

**Intracranial Arterial Aneurysms in the Pediatric Population**

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**Purpose**

To determine the anatomical, pathologic, and clinical characteristics of intracranial arterial aneurysms in the pediatric population.

**Materials & Methods**

Patients under the age of 19 years with intracranial arterial aneurysms presenting to three tertiary referral hospitals in central and southern Ohio between January 1993 and November 2006 were identified retrospectively. The institutions included one regional children’s hospital in central Ohio and two hospitals in southern Ohio (1 regional children’s hospital and 1 regional cerebrovascular-trauma center). Patients were identified by searching radiology reporting data bases, neurosurgery clinic registries and neuroangiography log books. In each case medical records were reviewed for epidemiologic, anatomical, pathologic, and clinical characteristics of the aneurysm.

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**Results**

Seventy-one intracranial arterial aneurysms were identified in 58 patients with a median age of 10.5 years (range 8 months-18 years). There were 15 aneurysms in patients under the age of 5 (Group A), 13 in patients 5-10 years of age (Group B) and 36 in patients 11-18 years of age (Group C). There were 16 aneurysms in the posterior circulation (all intradural) and 55 aneurysms in the anterior circulation (36 intradural and 19 extradural). Posterior circulation aneurysms affected the basilar artery (n = 3), posterior cerebral artery (n = 5), vertebral artery (3), superior cerebellar artery (2), posterior inferior cerebellar artery (1), anterior inferior cerebellar artery (1), arteriovenous malformation (AVM) nidus (1). Anterior circulation aneurysms affected the petrous internal carotid artery (ICA) (n = 7), cavernous ICA (11), ophthalmic artery (1), terminal ICA (3), anterior communicating artery (5), middle cerebral artery (17), anterior cerebral artery (8), posterior communicating artery (2), middle meningeal artery (1). Five were mycotic, 16 traumatic, one related to vasculitis, two neoplastic, four flow-related secondary to AVM, and 43 idiopathic. The most common type was idiopathic in all age groups (A, B, C). Known or potential risk factors were present in 10 of the idiopathic aneurysms including tuberous sclerosis (n = 2), neurofibromatosis-1 (n = 1), autosomal dominant polycystic kidney disease (1), sickle cell disease with moyamoya and hypertension (1 patient with 5 aneurysms), hypertension alone (1), end stage renal disease with hypertension and cystinosis (1), growth hormone deficiency (1), cutis marmorata telangiectasia congenita (1) and congenital absence of the internal carotid artery (1). In patients with idiopathic aneurysms the most common clinical presentation was subarachnoid hemorrhage (SAH) (9/43). One patient with an idiopathic aneurysm suffered SAH due to rupture of a de novo intracranial aneurysm 6 years after therapeutic carotid occlusion was performed for treatment of the index aneurysm.

**Conclusion**

Our results indicate that the majority of pediatric intracranial arterial aneurysms are idiopathic anterior circulation lesions, without clinically manifest risk factors. The single most common parent artery affected is the middle cerebral artery. Pediatric patients with idiopathic intracranial aneurysms most commonly present with SAH and have a risk of developing de novo intracranial aneurysms.

**Key Words:** Pediatric intracranial aneurysm, aneurysm

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**Paper 277 Starting at 3:23 PM, Ending at 3:31 PM**

**Incidence and Topographic Distribution of Brain Lesions in Pediatric Cerebral Venous Thrombosis**

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**Purpose**

Cerebral venous thrombosis (CVT) is a rare disorder in children and neonates are most commonly affected. In this study, our purpose was to evaluate the incidence and the topographic distribution of brain lesions associated with CVT and to correlate the topographic distribution of brain lesions with known normal venous drainage and anatomy.
Materials & Methods
Brain CT/CTV and/or MRI/MRV of 73 consecutive patients with CVT were evaluated by two neuroradiologists retrospectively. The patients with known trauma, previous surgical procedure, known brain tumor, cerebral vascular malformation, cerebral arteriovenous fistula, recent history of arterial infarction, hypoxic ischemia, germinal matrix hemorrhage and history of sickle cell disease were excluded from the study to eliminate for possible other causes of cerebral edema or hemorrhage. The patients were divided into three groups according to their age (newborn: within 1 month; infant: 1-12 months; older children: 1-16 years). The site of CVT, the location and the size (the largest diameter of parenchymal edema/hemorrhage was measured and classified as < 1 cm, small; 1-3 cm, medium; > 3 cm, large) of brain lesions and the presence of hemorrhage was recorded. The overall incidence of brain lesions in all patients with CVT was calculated. The incidence of brain lesions also was calculated for each group of patients separately.

Results
Thirty-six newborns, 10 infants, and 27 older children with CVT were included. The most common locations for CVT were the transverse sinus, the superior sagittal sinus and the straight sinus. Overall 39 of 73 (53%) children with CVT had brain parenchymal lesions. Twenty-three of 36 (64%) newborns, 4 of 10 (40%) infants and 12 of 27 (44%) older children had brain lesions. The most common locations were the frontal and parietal lobes. The topographic distribution of lesions correlated with the corresponding venous drainage territory in 18 of 23 (78%) newborns, all infants and all older children. Newborns had smaller lesions compared to the infants and the older children. In 21 of 23 (91%) newborns brain lesions were hemorrhagic while only in one of four (25%) infants and four of 12 (33%) older children brain lesions were hemorrhagic.

Conclusion
The topographic distribution of brain lesions associated with CVT correlates with the territory of dural venous sinus in children. This suggests that CVT is not well tolerated in children and warrants prompt diagnosis to prevent potential brain injury.

Key Words: Cerebral venous thrombosis, pediatric

Paper 278 Starting at 3:31 PM, Ending at 3:39 PM
De novo Development of a True Pial Arteriovenous Malformation: Case Report and Literature Review
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Purpose
Arteriovenous malformations traditionally are thought to represent congenital lesions. We present a rare case of documented de novo arteriovenous malformation development (AVM) in a pediatric patient, imaged by MR and conventional angiography. The literature on this very rare phenomenon is reviewed.

Materials & Methods
MR and conventional angiographic imaging findings are presented of a rare case of de novo AVM.

Results
A 6-year-old female initially presented with seizures and developmental delay, and MR imaging (MRI) was performed. This demonstrated a diffuse migration abnormality consistent with extensive band heterotopia. No other abnormality was noted. The patient was otherwise asymptomatic. A follow-up MRI was performed 4 years later, for evaluation of behavioral changes, and increasing seizures with associated aphasia. This revealed the interval development of an irregular tangle of flow voids along the margin of the left occipital horn in the left posterior parietal-occipital lobe consistent with an arteriovenous malformation (Fig, arrow). No associated abnormalities were identified. On subsequent catheter angiography a left parietal-occipital AVM was demonstrated (nidal dimension - 3.5 cm), supplied by left middle cerebral and posterior cerebral arteries with venous drainage into the thalamostriate venous system and left transverse sinus. A PubMed search for de novo AVM resulted in four previous case reports of this phenomenon (1-4). Of these, only one prior case clearly documents de novo development without other potential inciting factors or pre-existing angiographic abnormalities. This patient did have a prior history of head trauma, however (3).
CONCLUSION
This case clearly documents de novo development of a true pial AVM. Review of the literature demonstrates that this has been reported very rarely. Our case supports the notion that AVMs may develop spontaneously and challenges the idea that all AVMs are congenital lesions.

REFERENCES

KEY WORDS: Arteriovenous malformation, de novo

Paper 279 Starting at 3:39 PM, Ending at 3:47 PM
Pediatric Intracranial Aneurysms: Two Decade Single Institution Experience
Hetts, S. W. · Narvid, J. · Sanai, N. · Gupta, N. · Lawton, M. · Fullerton, H. · Dowd, C. · Higashida, R. · Halbach, V.
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PURPOSE
To characterize the clinical, radiologic, treatment, and outcome data associated with patients under 19 years old diagnosed with intracranial aneurysms at a single tertiary care institution over a 25-year period.

MATERIALS & METHODS
Retrospective and prospective medical record, MR imaging, and intracranial angiogram review from all pediatric patients examined at our university hospital over the last 25 years.

RESULTS
Between 1981 and 2006, our institution diagnosed and treated 67 patients (mean age = 12 years, 36 female and 31 male) with intracranial aneurysms. At the time of initial presentation, patients reported headache (30 patients, 45%), cranial neuropathies (11, 16%), nausea/vomiting (10, 15%), vision changes (9, 13%), trauma (9, 13%), incidental (5, 7%), seizure (3, 4%), and sensory changes (2, 3%). There were a total of 82 aneurysms, 17% of which measured greater than 25 mm. Twenty-nine fusiform aneurysms (35%) occurred in 23 patients. Thirty-four saccular aneurysms (41%) occurred in 31 patients. Eleven infectious aneurysms (13%) occurred in six patients. Ten traumatic aneurysms (12%) occurred in nine patients. Overall, subarachnoid hemorrhage occurred in 19 patients (28%). A total of 67 patients underwent treatment of their aneurysms including 14 patients managed conservatively with close follow-up and serial imaging. Sixteen patients underwent coiling. Thirteen patients underwent endovascular balloon occlusion. Sixteen patients underwent surgical clipping. Aneurysms in eight patients were trapped and/or bypassed. Overall mortality was 1.4%. Morbidity included 6% infarction and 1.4% new onset seizure disorder.

CONCLUSION
Intracranial aneurysms in children have a different distribution of locations and causes than in adult patients. The natural history of such lesions is incompletely understood. Management of pediatric aneurysms is in evolution and close collaboration between pediatric neurology, neurosurgery, and interventional neuroradiology is advocated.

KEY WORDS: Pediatric, aneurysm

Paper 280 Starting at 3:47 PM, Ending at 3:55 PM
Bilateral Cavernous Internal Carotid Aneurysms in a Child with Juvenile Paget’s Disease and Osteoprotegerin Deficiency
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Albuquerque, NM

PURPOSE
Juvenile Paget’s disease or familial hyperphosphatasia is a rare, autosomal recessive disorder that represents a distinct clinical condition, not simply a juvenile-onset form of Paget’s disease. Osteoprotegerin deficiency leads to marked osteoclast activation and greatly accelerated bony remodeling. The osteoprotegerin/RANKL/RANK system is central to regulation of osteoclast activity and bone turnover. It is becoming apparent that this system also has a role in the immune and vascular systems. We report a case of a child with a severe form of this condition and bilateral cavernous internal carotid aneurysms.

MATERIALS & METHODS
An 11-year-old boy presented with the chief complaint of difficulties looking straight with both eyes. He had been diagnosed at birth with juvenile Paget’s disease, and later testing showed complete absence of osteoprotegerin. Conventional noncontrast CT and CT angiography of the head were obtained. Subsequently a conventional angiogram was performed.

RESULTS
Bilateral cavernous internal carotid aneurysms were demonstrated on all studies, with fusiform dilatation extending superiorly. There was remodeling and smooth thinning of the sphenoid bone, and ground-glass changes of the skull. This patient was shown previously to have a homozygous deletion of a gene on chromosome 8q that encodes osteoprotegerin.

CONCLUSION
Juvenile Paget’s disease is a rare disorder characterized by severe clinical manifestations. Although a relationship between juvenile Paget’s disease and cerebral aneurysms has not been reported previously, there are numerous pieces of evidence suggesting a role of osteoprotegerin in vascular disease. A link between these diseases and osteoprotegerin deficiency may allow for new insights involving the etiologies of these syndromes.

KEY WORDS: Aneurysm, pediatric, metabolic disorder
Identification of Dural Arteriovenous Fistula by Fetal MR Imaging

Glenn, O. A. · Barkovich, A. J. · Goldstein, R. B.
University of California San Francisco
San Francisco, CA

PURPOSE
To describe the appearance of dural arteriovenous fistulas on fetal MR imaging (MRI).

MATERIALS & METHODS
Five cases of suspected vascular anomalies, excluding vein of Galen malformations, imaged by fetal MRI were identified over a 5-year period. Three cases were performed at our institution, and two cases were from outside institutions. Fetal MRI was performed using SSFSE T2-weighted images, and fast gradient T1-weighted images.

RESULTS
Fetal MRIs were performed between 23 weeks and 36 weeks gestation (median age 26 weeks). Patients were referred for fetal MRI because of sonographic findings of suspected posterior fossa brain tumor, subdural hematoma, and Dandy-Walker malformation. The two outside cases were performed for evaluation of posterior fossa cysts. The third case with posterior fossa cyst and suspected Dandy-Walker malformation also had right-sided heart failure and hydrocephalus. In all cases, fetal MRI demonstrated T2 hypointense collection in the posterior fossa, with apparent subdural location. In three cases, a more focal ovoid or bilobed T2 hypointense mass was seen. There was increased signal on T1-weighted images. The extraaxial mass resulted in compression of the cerebellum and brainstem. There was obstructive hydrocephalus, cerebral parenchymal thinning and T2 hyperintensity in the third case. Multiple vessels were seen at the skull base on both T1- and T2-weighted images in the third case, and a follow-up ultrasound demonstrated slow flow in the posterior fossa collection consistent with a dilated dural venous sac. The pregnancy was terminated in one case, with autopsy confirmation of a dilated dural venous sac. Postnatal MRI in the second case demonstrated a posterior fossa hematoma consistent with a thrombosed dural venous sac with dilated precentral cerebellar and supravermian veins; ultrasound 1 month later showed resolution of hematoma. The infant is developing normally. The third case was noted to have a bruit at birth and underwent conventional angiography which demonstrated multiple feeding vessels. Followup on the two outside cases is not available.

CONCLUSION
Congenital dural arteriovenous fistula should be considered in the differential diagnosis of an apparent posterior fossa cyst/mass on prenatal ultrasound. In our cases, fetal MRI demonstrated an extraaxial collection of blood which appeared subdural in location and represented a dilated venous sac, which was often thrombosed. The presence of multiple adjacent vessels on fetal MRI or prenatal ultrasound and/or the presence of heart failure is further suggestive of the diagnosis. Accurate prenatal diagnosis is important for planning of delivery and immediate postnatal care.

KEY WORDS: Fetal MR imaging, vascular, fistula

Paper 282 Starting at 4:03 PM, Ending at 4:11 PM

Prenatal Diagnosis of Torcular Herophili Thrombosis with MR Imaging: Report of a Case with Positive Outcome and Review of the Literature

Hardin, V. · Spampinato, M. V. · Davis, M. · Chang, E. · Rumbold, Z.
Medical University of South Carolina
Charleston, SC

PURPOSE
To our knowledge, five cases of fetal thrombosis of torcular Herophili have been reported, with varied outcomes. Our hypothesis was that fetal MR imaging features may be used to predict the outcome.

MATERIALS & METHODS
Imaging and clinical features of the cases reported in literature and our case were analyzed.

RESULTS
A transabdominal ultrasound performed at 22 weeks of gestation revealed a large well-defined hypoechoic area encompassing the posterior fossa and the posterior third of the supratentorial compartment with a possible small internal calcification. Color Doppler did not reveal any vascular flow within or around the mass. This was followed by fetal MR imaging that demonstrated a large extradural T2-hypointense mass centered at torcular Herophili. There was a small area of very low signal corresponding to calcification, the findings were interpreted as thrombosis of torcular Herophili. It was decided to follow the pregnancy without any intervention. A follow-up MR imaging at 35 weeks of gestation showed prominent interval decrease in thrombus size and no parenchymal injury. A neurologically intact newborn was delivered. Imaging at 1 year of age revealed a small calcification in the torcular and a small developmental venous anomaly in the posterior fossa. Three of the reported cases were imaged only with ultrasound. A single reported case with fetal MR imaging and fetal outcome showed central iso to hyperintensity of the thrombus on T2-weighted images and T1 hyperintensity, suggestive of subacute clot, which increased in size on follow-up imaging. In the case we encountered, the thrombus demonstrated diffuse T2 hypointensity of the clot and its decrease in size on follow-up MR imaging. In the other reported case with good outcome, the signal of the thrombus was initially iso to hyper-
CONCLUSION
Isolated fetal thrombosis of the torcular Herophili in absence of parenchymal infarcts and intracranial hemorrhage can have a benign prognosis and may not require any intervention, especially if it is of uniformly low T2 signal and remains stable or decreases in size on follow-up studies.

KEY WORDS: Fetal MR imaging, venous thrombosis, torcular of Herophili

Paper 283 Starting at 4:11 PM, Ending at 4:19 PM
Neuroimaging Findings in a Newly Discovered GJA12 Mutation with Recessive Hypomyelinating Leukodystrophy in Saudi Family

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1Riyadh Military Hospital, Riyadh, SAUDI ARABIA, 2National Neurological Institute C Besta, Milano, ITALY

PURPOSE
To highlight the neuroimaging findings in a newly discovered hypomyelinating white matter leukodystrophy secondary to gene mutation in one Saudi family.

MATERIALS & METHODS
We report three children from one family; two males and one female. They all presented with pendular nystagmus, slowly progressing spasticity and developmental delay. All had normal cognitive function. All patients had brain MR imaging (1.5T GE-Hispeed, Milwaukee, WI) utilizing the following:
Ax T1 TR600 msec - TE 15 msec, 5 mm slices with 1 mm gap matrix 192 X 220 FOV24, Ax T2 TR 3000 - TE 20/120 msec matrix 162 X 220 FOV 24, Ax inversion recovery TR 4150 msec, TE 41, TI 300, 5 mm thickness, 2 mm slice inter-gap, FOV 22, matrix 256 X 256, diffusion-weighted images TR 9999, TE 96, FOV 28, matrix 128 X 128 1 nex B value 1000 5 mm slices 0 gap.

RESULTS
The predominant neuroimaging feature is the involvement of the medulla, cerebellar white matter, brain stem, cerebral peduncles and the corticospinal tracts in the posterior limb of the internal capsule. The supratentorial subcortical arcuate fibers, and the lobar white matter was found to be involved bilaterally and symmetrically in two patients, with relative sparing of the white matter in the corona radiate. One patient showed asymmetrical involvement of the supratentorial white matter more on the LT side with a focal cystic vaculation also seen in the occipital subcortical white matter in addition to the involvement of the putamen, caudate and the medial thalamic nuclei. Laboratory investigation did not reveal any abnormality. Molecular neurogenetics analysis showed specific type of homozygous GJA12 mutation down stream from position C281 hardbound a 706 G > A transition. The 706G > A mutation was homozygous in the affected three patients.

CONCLUSION
Accordingly the three children were labeled as GJA12 mutation with recessive hypomyelinating leukodystrophy under the category of Pelizaeus-Merzbacher disease-like disorder (PMLD) with absent mutation in the proteolipid protein. The disorder might be distinguished from the classical neuroimaging abnormality described in Pelizaeus-Merzbacher disease caused by proteolipid protein duplication by the absence of myelination along the corticospinal tract in affected areas together with the presence of GJA12 gene mutation. MR spectroscopy was not currently available.

KEY WORDS: Recessive, hypomyelinating, leukodystrophy
later for a repeat MRI/MRSI exam. Peripheral VLCFA levels (in particular, hexacosanoic acid, C26) were measured within 24 hours of the MRSI examination.

RESULTS
Initial covariate selection showed that the only covariates that might explain changes in C26 were the following: splenium of the corpus callosum NAA/Cr, optic radiation NAA/Cr, and posterior white matter NAA/Cho. In each region, lower metabolite ratios (suggesting lower NAA levels) corresponded to increased C26 levels. Each model showed a p-value less than 0.05. No other metabolite ratio in any gray or other white matter region showed any relationship to C26. The Figure shows the correlation between NAA/Cr in the splenium of the corpus callosum and C26. In the serial studies, optic radiation NAA/Cho increased with age in patients whose C26 levels were stable over time, but was lower (or decreased) in patients whose C26 levels increased with time. In the posterior white matter, Cho/Cr levels also increased in patients whose C26 levels increased over the 1-year time period (p < 0.05).

CONCLUSION
These results indicate that failure to control VLCFA levels leads to reduced levels of NAA (suggesting neuroaxonal damage or dysfunction) in the key brain regions commonly involved in ALD - the splenium of the corpus callosum, and posterior white matter regions. It appears that LO has an ongoing, positive effect on brain metabolism in asymptomatic ALD boys when it successfully lowers VLCFA levels. Proton MRSI may have a role in monitoring therapeutic response to LO in boys with ALD.

KEY WORDS: Spectroscopy, brain, Adrenoleukodystrophy

Hypomyelination and Congenital Cataract: Neuroimaging Features of a Novel Inherited White Matter Disorder
Rossi, A.1 · Biancheri, R.1 · Zara, F.1 · Bruno, C.1 · Uziel, G.2 · van der Knaap, M. S.3 · Minetti, C.1 · Tortori-Donati, P.1 1G. Gaslini Children’s Research Hospital, Genoa, ITALY, 2C. Besta National Neurological Institute, Milan, ITALY, 3Free University Hospital, Amsterdam, THE NETHERLANDS

PURPOSE
To describe the neuroimaging features of hypomyelination and congenital cataract (HCC), a newly described autosomal recessive white matter disease caused by deficiency of hyccin, a membrane protein implicated in both central and peripheral myelination.

MATERIALS & METHODS
A systematic analysis of patients with unclassified leukoencephalopathies seen at our institutions revealed 10 children with congenital cataract, slowly progressive neurologic impairment, and diffuse white matter abnormalities on neuroimaging. Psychomotor developmental delay was evident after the first year of life. Neurologic examination showed pyramidal and cerebellar signs. Mental retardation ranged from mild to moderate. Peripheral neuropathy was demonstrated by neurophysiologic studies in nine children. The available neuroimaging studies (MR imaging in nine cases, CT in one) were reviewed retrospectively.

RESULTS
In all patients, neuroimaging studies revealed diffuse involvement of the supratentorial white matter associated with preservation of both cortical and deep gray matter structures. Supratentorial white matter hypomyelination was detected in all cases; four patients also had evidence of superimposed increased water content in the periventricular and central white matter with a frontal-to-parietal gradient of severity (Fig 1). Deep cerebellar white matter hypomyelination was found in six patients. Older patients had evidence of white matter bulk loss and gliosis. Proton MR spectroscopy showed increases in myoinositol and choline and reduced N-acetylaspartate (NAA); a prominent lipid peak was found in one case. Sural nerve biopsy revealed hypomyelinated nerve fibers. Mutations in the DRCTN2/A gene on chromosome 7, causing complete or severe deficiency of hyccin, were demonstrated in all cases.
CONCLUSION
HCC is characterized by a combined pattern of primary myelin deficiency and secondary neurodegenerative changes that is reflected in a composite MR imaging picture with associated hypomyelination, gliosis, and increased white matter water content, progressively evolving to white matter gliosis and bulk loss. Proton MR spectroscopy findings indicate a combination of gliosis and decreased neuronal population; increased lipids could be due to unstable myelin formation with liberation of lipid components. In the proper clinical setting, recognition of suggestive neuroimaging findings should prompt genetic investigations.

KEY WORDS: Hypomyelination, congenital cataract

Paper 286 Starting at 4:35 PM, Ending at 4:43 PM
Patent Foramen Ovale Leads to a Typical Cerebral Lesion Pattern in MRI of Stroke Patients

Alfke, K. · Plötz, B. · Rohr, A. · Börsch, K. · Stingele, R. · Jansen, O.
University Hospital Schleswig-Holstein
Kiel, GERMANY

PURPOSE
Patent foramen ovale (PFO) is associated with ischemic stroke in younger patients. In combination with atrial septal aneurysm it is a significant risk factor for paradoxical embolization. We assessed the hypothesis that in stroke patients PFO is associated with a typical distribution of lesions in cerebral MRI with mainly bifrontal subcortical lesions.

MATERIALS & METHODS
In this retrospective case-control study T2-weighted MRI images of 162 stroke patients were evaluated. Between 1999 and 2003 81 stroke patients with PFO were identified with transcranial Doppler and injection of contrast agent (bubble-test). Controls were 81 age-matched stroke patients without PFO (negative bubble test). Mean age was 46 years (19-85 years). In MRI images lesions were characterized by their location. The following location categories were rated for small lacunar lesions: subcortical frontal or parietal white matter, peritrigonal white matter, deep paraventricular white matter, basal ganglia. Lesions could be located uni- or bilaterally. Additionally larger territorial infarcts were rated.

RESULTS
Chi-square test showed that bilateral frontal or predominantly frontal subcortical lacunar lesions are significantly associated with PFO (p<0.0001). 43 patients with PFO (53%), but only 19 control-patients (23%) showed this frontal dominance. Odds ratio is 3.7 for having a PFO when MRI shows this pattern of subcortical lesions in a stroke patient. No patient of the PFO-group but 6% of the control group had parietal dominance. Distribution of lacunar lesions in other locations like basal ganglia or deep paraventricular white matter showed no significant difference for the two groups.

CONCLUSION
In conclusion a pattern of bifrontal subcortical lacunar lesions in MRI is significantly associated with PFO in stroke patients. Lesions are probably caused by paradoxical embolization and form a characteristic pattern, typical for PFO. Therefore MRI might help to identify patients with PFO who need recurrent event prevention.

KEY WORDS: Patent foramen ovale, stroke, pattern of embolic stroke

Wednesday Afternoon
3:15 PM – 4:45 PM
Grand Ballroom B

(44d) INTERVENTIONAL: Aneurysms I
(Scientific Papers 287 – 297)

See also Parallel Sessions
(44a) SPINE: Neoplasms and Other
(44b) ADULT BRAIN: Cerebrovascular Occlusive Disease I
(44c) PEDIATRICS: Cerebrovascular Diseases, Degenerative, Demyelinating, Metabolic Disease

Moderators: Roland R. Lee, MD
Mahesh V. Jayaraman, MD

Paper 287 Starting at 3:15 PM, Ending at 3:23 PM
Endovascular Treatment of Distal Cervical and Intracranial Dissections with the Neuroform Stent

Ansari, S. A. · Lassig, J. P. · Nicol, E. · Thompson, B. G. · Gemmete, J. J. · Gandhi, D.
University of Michigan Health System
Ann Arbor, MI

PURPOSE
Endovascular stent placement/stent angioplasty is the primary intervention for cervical arterial dissections in symptomatic patients refractory to medical management or with contraindications to anticoagulation. Unfortunately, the advancement of traditional coronary balloon-expanding stents into the distal cervical and intracranial vasculature can be technically challenging or potentially traumatic. Several patients at our institution have been treated alternatively using the flexible and self-expanding intracranial Neuroform stent when tortuous dissected segments of the distal internal carotid and vertebral-basilar arteries were encountered. We studied this unique population to evaluate a relatively novel treatment approach.

MATERIALS & METHODS
Upon retrospective review, a subset of eight patients with distal internal carotid and vertebral-basilar artery dissections were treated using at least one intracranial Neuroform stent at our institution from August 2005 to November 2006. A
total of 15 stents were utilized in eight interventional procedures. Three dissecting/pseudoaneurysms were treated simultaneously via stent-assisted coil embolization. Seven patients were followed with digital subtraction angiography (DSA) or cross-sectional imaging (CTA/MRA) as well as clinical assessment for a mean of 6.5 months. Improvement in dissection-related stenosis was calculated postprocedure and on follow-up imaging. Long-term procedural integrity, technical and clinical outcomes were assessed.

RESULTS
All patients (4 male and 4 females; mean age 50 years) were symptomatic from their dissections. Presenting symptoms included neck pain/headache, transient ischemic attacks/hemispheric infarcts, subarachnoid hemorrhages, and basilar artery thrombosis. Spontaneous (n = 4) or traumatic/iatrogenic (n = 4) etiologies were responsible for dissections involving the internal carotid (n = 2), vertebral (n = 5), and vertebral-basilar (n = 1) arteries. Dissections were treated with single (n = 4), overlapping (n = 2), or tandem (n = 2) Neuroform stents. Following stent placement, technical success was achieved in all patients with no significant residual stenosis or flow limitation. Dissection-related mean stenosis improved from 74 ± 18% preprocedure to 19 ± 22% postprocedure (p < .0002) with further reduction in five patients to 9 ± 13% (p < .002) on follow-up imaging. Stent-assisted coil embolization of large dissecting/pseudoaneurysms (n = 3) required retreatment of a neck remnant in a single patient. Small dissecting/pseudoaneurysms (n = 5) underwent stent-induced spontaneous thrombosis. There were no procedure-related complications. Mortality (n = 1) was limited to the sequelae of basilar artery thrombosis despite successful recanalization and reconstruction of a dissected vertebral artery. One patient developed delayed in-stent stenosis on follow-up imaging, but remained asymptomatic. Nearly all patients (n = 7) reported clinical improvement or resolution of their symptoms with no recurrent transient ischemic attacks, infarcts, or subarachnoid hemorrhages.

CONCLUSION
In certain cases of arterial dissections affecting tortuous or redundant vasculature, the dedicated intracranial Neuroform stent appears to be a safe and technically effective option in the endovascular management of distal cervical and intracranial dissections.

KEY WORDS: Dissection, Neuroform stent

Paper 288 Starting at 3:23 PM, Ending at 3:31 PM

In-Stent Stenosis of Neuroform: Incidence and Relationship with Follow-up Angiographic Result of Aneurysm Coil Embolization

Lee, D. · Morsi, H. · Diaz, O. · Arat, A. · Mawad, M. E.

Baylor College of Medicine
Houston, TX

PURPOSE
In-stent stenosis of Neuroform placed for the stent-assisted aneurysm coil embolization has been reported not infrequently. The mechanism of the stenosis is not well understood and it might not share the same mechanism with the in-stent restenosis in atherosclerotic lesions. The purposes of this study are to evaluate the single center experience of in-stent stenosis and to see possible implication of the phenomenon in the follow-up angiographic result of coiling.

MATERIALS & METHODS
A total of 26 index intracranial or cavernous carotid aneurysms (mean maximal diameter; 10.5 mm, range: 4-20 mm) in 26 patients (meaw age: 54.9) undergoing Neuroform (Boston Scientific) stent-assisted coiling (bare coils in 11, bioactive coils in 8, and Hydrocoils in 7) and six-month follow-up angiography were evaluated retrospectively. Initial embolization result according to the Montreal classification was class I in six, II in five, and III in 15. Follow-up angiographic findings were analyzed in terms of aneurysm occlusion classification and occurrence of in-stent stenosis.

RESULTS
There were four cases (15.4%) of variable degree (16-52%) of in-stent restenosis. Flow-limiting stenosis was noted in one patient (3.9%). Angiographic occlusion status on 6-month follow-up was “improved” in seven, “unchanged” in 13, and “worse” in six. All the patients with in-stent stenosis showed improvement of occlusion on follow-up angiogram while six of the remaining aneurysms showed worsening of the occlusion status.

<table>
<thead>
<tr>
<th>Presence of In-stent Stenosis, Embolization and Follow-up Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>In-stent stenosis</td>
</tr>
<tr>
<td>-------------------</td>
</tr>
<tr>
<td>Yes</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>No</td>
</tr>
<tr>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

CONCLUSION
Neuroform in-stent stenosis did occur even though the frequency was low. There was a trend of improvement of the angiographic occlusion status on follow-up in patients with in-stent stenosis.

KEY WORDS: Neuroform stent, intracranial aneurysm, restenosis

Paper 289 Starting at 3:31 PM, Ending at 3:39 PM

Micrusphere Spherical Coil-Assisted Placement of the Neuroform Stent for Treatment of Wide-Necked Intracranial Aneurysms

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New Brunswick, NJ

PURPOSE
The Neuroform stent (Boston Scientific) has expanded the range of wide-necked intracranial aneurysms amenable to endovascular therapy. However, in some patients a small error in exact deployment of the stent could result in the stent prolapsing into the aneurysm neck or missing the entire
neck. In addition, it can be technically challenging to maneuver a microcatheter through the interstices of the Neuroform stent to deploy coils into the aneurysm. Our purpose was to evaluate a novel technique that may reduce some of these limitations.

**Materials & Methods**

We selected patients with both ruptured and unruptured wide-necked aneurysms who required Neuroform stent placement for this technique. During the first stage of the procedure, a Micrusphere Spherical (Micrus Corporation) framing coil is deployed but not detached within the aneurysm through a microcatheter. This framing coil acts as a scaffold for deployment of the stent. Using a second catheter, a Neuroform stent is deployed across the neck of the aneurysm. A secondary benefit of this technique is that it allows the coil deployment microcatheter to be “jailed” inside the aneurysm by the stent and the aneurysm to be subsequently packed with coils. Each patient was followed clinically and most were reassessed via repeat imaging.

**Results**

Sixteen patients were treated over a 21-month period. All patients were successfully coiled, and in 14/16 (88%) patients the stent was adequately placed. In one patient a stent could not be deployed secondary to vessel tortuosity. In a second catheter, a Neuroform stent was deployed across the neck of the aneurysm. Both patients were asymptomatic. Although the Neuroform stent deployed slightly proximally or distally with respect to the aneurysm neck in three patients, the presence of the Spherical framing coil prevented the stent from prolapsing into the neck and allowed technical success. One patient had minimal postprocedural subarachnoid hemorrhage but was asymptomatic. A patient who was noncompliant with Plavix therapy had delayed left ICA occlusion 3 months following embolization with mild right hand weakness. One patient had a small pontine infarct 8 days after coiling an embolized right PICA aneurysm, but his symptoms improved. One patient had temporary ICA occlusion from vasospasm during stent placement, but was asymptomatic. In up to 18 months of follow up, four patients had partial aneurysm refilling.

**Summary results**

<table>
<thead>
<tr>
<th>Patient</th>
<th>Age</th>
<th>Gender</th>
<th>Aneurysm location</th>
<th>Aneurysm size (mm)</th>
<th>Neck size (mm)</th>
<th>C GL Ratio</th>
<th>Neuroform Stent</th>
<th>Spherical Coil</th>
<th>H &amp; H Grade</th>
<th>% Occlusion</th>
<th>Immediate Complications</th>
<th>Follow-Up Complications</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>48</td>
<td>F</td>
<td>Ophthalmic</td>
<td>9x6</td>
<td>1.5</td>
<td>62±6x8</td>
<td>Trans.</td>
<td>Neuroform</td>
<td>&gt;90%</td>
<td>None</td>
<td>None</td>
<td>None</td>
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<tr>
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<td>9x7</td>
<td>1.3</td>
<td>62±6x8</td>
<td>Trans.</td>
<td>Neuroform</td>
<td>&gt;95%</td>
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<td>None</td>
<td>None</td>
</tr>
<tr>
<td>3</td>
<td>33</td>
<td>M</td>
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<td>11x9</td>
<td>1.8</td>
<td>62±6x8</td>
<td>Trans.</td>
<td>Neuroform</td>
<td>&gt;95%</td>
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<td>None</td>
<td>None</td>
</tr>
<tr>
<td>4</td>
<td>58</td>
<td>F</td>
<td>Basilar tip</td>
<td>6x6</td>
<td>1.0</td>
<td>3.5±6x9</td>
<td>Trans.</td>
<td>Neuroform</td>
<td>&gt;95%</td>
<td>None</td>
<td>None</td>
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<td>5</td>
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<td>M</td>
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<td>Grade 1</td>
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<tr>
<td>6</td>
<td>58</td>
<td>F</td>
<td>Basilar tip</td>
<td>5x9</td>
<td>4.3</td>
<td>3.5±6x9</td>
<td>Trans.</td>
<td>Neuroform</td>
<td>&gt;95%</td>
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<td>None</td>
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<td>7</td>
<td>67</td>
<td>F</td>
<td>Posterior</td>
<td>17x11</td>
<td>7.4</td>
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<td>Trans.</td>
<td>Neuroform</td>
<td>&gt;95%</td>
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<tr>
<td>8</td>
<td>65</td>
<td>F</td>
<td>PICA</td>
<td>6x8</td>
<td>8.0</td>
<td>62±6x8</td>
<td>Trans.</td>
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<td>9</td>
<td>44</td>
<td>F</td>
<td>Superior hypophyseal</td>
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<td>5.4</td>
<td>62±6x8</td>
<td>Trans.</td>
<td>Neuroform</td>
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</tr>
<tr>
<td>10</td>
<td>49</td>
<td>M</td>
<td>Posterior</td>
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<td>6.6</td>
<td>62±6x8</td>
<td>Trans.</td>
<td>Neuroform</td>
<td>&gt;95%</td>
<td>None</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>11</td>
<td>55</td>
<td>M</td>
<td>Posterior</td>
<td>9x6</td>
<td>6.0</td>
<td>62±6x8</td>
<td>Trans.</td>
<td>Neuroform</td>
<td>&gt;75%</td>
<td>None</td>
<td>Late pontine infarct 8 days after coiling on left</td>
<td>Left hand numbness and left hand numbness</td>
</tr>
<tr>
<td>12</td>
<td>67</td>
<td>F</td>
<td>Superior hypophyseal</td>
<td>9x6</td>
<td>6.3</td>
<td>62±6x8</td>
<td>Trans.</td>
<td>Grade 1</td>
<td>&gt;90%</td>
<td>None</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>13</td>
<td>58</td>
<td>F</td>
<td>Ophthalmic</td>
<td>11x7</td>
<td>7.8</td>
<td>62±6x8</td>
<td>Trans.</td>
<td>Neuroform</td>
<td>&gt;95%</td>
<td>None</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>14</td>
<td>48</td>
<td>F</td>
<td>Posterior</td>
<td>3x7</td>
<td>5.6</td>
<td>62±6x8</td>
<td>Trans.</td>
<td>Grade 1</td>
<td>&gt;90%</td>
<td>None</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>15</td>
<td>63</td>
<td>F</td>
<td>Cavernous ICA</td>
<td>9x5</td>
<td>5.0</td>
<td>1.8±6x8</td>
<td>Undetachable coil</td>
<td>Grade 1</td>
<td>&gt;90%</td>
<td>None</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>16</td>
<td>48</td>
<td>M</td>
<td>Posterior</td>
<td>18x16</td>
<td>11.1</td>
<td>62±6x8</td>
<td>Trans.</td>
<td>Grade 1</td>
<td>&gt;90%</td>
<td>None</td>
<td>Temporary occlusion at treatment site</td>
<td>None</td>
</tr>
</tbody>
</table>

**Conclusion**

Spherical coil assisted Neuroform stent placement is technically feasible and safe. It provides an endovascular therapeutic option in patients with complicated anatomy in which slight stent malposition may result in prolapse of the stent into the aneurysm neck and provides greater stability of the microcatheter within the aneurysm.

**Key Words:** Aneurysm, subarachnoid hemorrhage, stent

**Paper 290 Starting at 3:39 PM, Ending at 3:47 PM**

**Contrast-Enhanced MR Angiography Follow Up of Intracranial Aneurysms Treated with “Neuroform” Endovascular Stent-Assisted Coiling**

Al Azri, F. · Santos, M. · Lesiuk, H. · Miller, W. · Goyal, M. · Lum, C.

1University of Ottawa, Ottawa, ON, CANADA, 2University of Calgary, Calgary, AB, CANADA

**Purpose**

Several studies have demonstrated the use of contrast-enhanced MR angiography (CEMRA) to follow up coiled intracranial aneurysms. To our knowledge, no study has been reported using CEMRA to follow up intracranial aneurysms treated with endovascular stent-assisted coiling. This study investigates feasibility of a combined CEMRA to follow up patients with intracranial aneurysms treated with stent-assisted coiling.
shown that this device can safely and effectively be utilized.

Previously, endovascular treatment of wide-necked aneurysms in diameter was limited. There are limited reports in the paper.

A retrospective review of all patients treated with stent-assisted coiling using Neuroform stent was performed. CEMRA of patients who lost inclusion criteria were reviewed by two experienced interventional neuroradiologists. The CEMRA studies were assessed for quality of the study, petency of parent vessel with stent, obliteration of the coiled cerebral aneurysm. The study quality of categorization was good, poor (but diagnostic quality) and nondiagnostic. The parent vessel was categorized into patent (normal), mild stenosis, moderate stenosis and severe stenosis. Obliteration of aneurysm was categorized into: complete obliteration, residual neck filling with no aneurysm sac filling, and filling of aneurysm sac.

**RESULTS**

A total of 19 CEMRA and DSA studies in 18 patients were found. The interval between DSA and CEMRA ranged between 2-209 days (average 105.2 days). The quality of CEMRA studies were diagnostic in all patients, the majority were good quality category. Consensus was reached between the two readers as the CEMRA and DSA have good correlation in all studies. The technical quality of the CEMRAs: 18 (94.7%) studies were good and one (5.3%) was poor but diagnostic. Patency of the parent vessel by CEMRA: normal one (5.3%), apparent mild stenosis 12 (63.2%), and apparent moderate stenosis four (21.0%), and severe stenosis two (10.5%). Aneurysm obliteration by DSA: complete five (26.3%), neck filling six (31.6%), and aneurysm sac filling eight (42.1%). Aneurysm obliteration by CEMRA: complete eight (42.1%), neck filling five (26.3%) and aneurysm sac filling six (31.6%). Only one patient showed more filling of aneurysm sac than the conventional angiogram and did not require recoiling. Three patients showed less filling on CEMRA than conventional angiogram, which could be due to ongoing thrombosis.

**CONCLUSION**

CEMRA may show apparent narrowing of the parent vessel(s). This may be artifactual from the stent. In spite of this, most cases evaluated by CEMRA were felt to be diagnostic. CEMRA is a promising method for following aneurysms treated with stent-assisted coiling.

**KEY WORDS:** CEMRA, Neuroform stent, coiling

**Paper 291 Starting at 3:47 PM, Ending at 3:55 PM**

Neuroform Stent Placement for Aneurysm Treatment Involving Small Cerebral Vessels: Long-Term Outcomes

Turk, A. S. · Ahmed, A. · Niemann, D. · Aagaard-Kienitz, B. · Strother, C.

University of Wisconsin

Madison, WI

**PRACTICE**

Previously, endovascular treatment of wide-necked aneurysms involving small vessels measuring less than 2 mm in diameter was limited. There are limited reports in the literature addressing stent placement in small distal cerebral vessels. Recent experience with the Neuroform stent has shown that this device can safely and effectively be utilized to treat aneurysms in vessels of this caliber. We report long-term clinical and angiographic results in a series of patients with distal aneurysms arising from small cerebral vessels.

**MATERIALS & METHODS**

We report eight cases of Neuroform stent placement into cerebral vessels measuring less than 2 mm in diameter (range 1.1 mm-1.8 mm). All patients received Plavix 75 mg and Aspirin 325 mg daily at least 5 days prior and 3 months after treatment with Aspirin continued indefinitely. All stents were placed for aneurysm treatment in conjunction with coiling. Lesion locations and numbers were as follows: ACOM region (5), Pericallosal A2-A3 (1), MCA M1-M2 (1), and MCA M3-M4 (1). Clinical follow up ranges from 10 months to 26 months. Imaging follow up was performed with MRI/MRA or DSA.

**RESULTS**

All procedures were performed successfully without immediate or delayed complication. A small amount of intraprocedural thrombus developed during two cases and immediately resolved with 10 mg of intraarterial Reopro. Follow up to 26 months demonstrate durable results with patent stented portion of the vessels. There were no clinical neurologic symptoms related to the treated vessel territory at follow up.

**CONCLUSION**

Development of newer low profile endovascular devices allows access and ability to treat lesions farther out in the smaller cerebral vessels. We have safely and successfully treated eight aneurysms located on vessels smaller than 2 mm in diameter with Neuroform stents with good long-term results. Increased procedural thrombus formation was noted but resolved with ReoPro. Further follow up and more experience is necessary to further determine long-term results and we will update our information as data become available.

**KEY WORDS:** Stent, aneurysm, small vessel

**Paper 292 Starting at 3:55 PM, Ending at 4:03 PM**

Preliminary Results of the ATENA Study Regarding the Endovascular Treatment of Unruptured Intracranial Aneurysms

Pierot, L. · Spelle, L. · for The ATENA Study Group

1Hopital Maison-Blanche, REIMS, FRANCE, 2Fondation Rothschild, PARIS, FRANCE

**PURPOSE**

To present the methodology and the first results of the French registry regarding the endovascular treatment of unruptured intracranial aneurysms (ATENA study).

**MATERIALS & METHODS**

The diagnostic and therapeutic management of unruptured intracranial aneurysms is still a matter of debates. The French Society of Neuroradiology has decided to conduct a registry to precisely evaluate the clinical and anatomical results of the endovascular treatment of unruptured intracranial aneurysms. The main objective is to evaluate the clinical results of the treatment, singularly the rate of complications, and the morbimortality at 1 month.
RESULTS
Six hundred sixty-five patients were included in the period of study. Technical and methodological difficulties are presented. The percentage of technical and clinical complications is presented. The morbimortality at 1 month is analyzed.

CONCLUSION
ATENA study will provide the first precise evaluation of the results of the endovascular treatment of unruptured intracranial aneurysms which is necessary to establish the appropriate rules for the management of patients harboring such lesions.

KEY WORDS: Unruptured aneurysms, endovascular treatment

Paper 293 Starting at 4:03 PM, Ending at 4:11 PM
Effect of Stenting Rotational Positions on Hemodynamics in a Cerebral Aneurysm

Nakayama, T. · Ohta, M. · Rufenacht, D. A. · Takahashi, A. 1
1Tohoku University, Miyagi, JAPAN, 2Geneva University Hospital, Geneva, SWITZERLAND, 3Tohoku University School of Medicine, Miyagi, JAPAN

PURPOSE
The effect of the stenting on the flow reduction in the cerebral aneurysm has been calculated only by computational flow analyses with an idealized model of stent by CAD and a realistic aneurysm from medical images. Nowadays, the computational method to simulate blood flow in a realistic cerebral aneurysm with a realistic stent data has been developed by Nakayama et al. In this study, we report the effect of the flow reduction due to the various arrangements of the stent on the cerebral aneurysm.

MATERIALS & METHODS
Three-dimensional (3D) RA (BV 3000, PMS) image was used for the reconstruction of cerebral aneurysm. Then the 3D geometry of blood vessel was restructured on the PC workstation. The stent for the cerebral arterial aneurysm was used for the Microfocus X-ray Television System (SMX-100CT, Shimadzu Corporation). The 3D reconstructions of the stent were performed with software packages of Mimics 7.0 and Magics 8.0 (Materialise Corporation). After the individual reconstruction, the stent shape was arranged and merged in the shape of the cerebral aneurysm. The stent was set up only on the neck portion. After the set up, three stent positions of rotation were constructed. The first position of the stent strut was in the center of neck of cerebral aneurysm called as 0 (degree). The other positions were rotated clockwise at -10 (degree) [called as -10(degree)] and 20 (degree) [called as 20(degree)] from the first position, respectively. The computational simulation was performed with the commercial solver of Fluent (Fluent Corporation).

RESULTS
The inflow zone and the flow rate undergo changes in the neck area and the maximum velocity is decreased at the neck. The maximum speed on the neck of 20 (degree) is faster higher than that for 0 (degree). The WSS of -10, 0 and 20 (degree) are 0.35 (Pa), 0.45 (Pa), and 0.75 (Pa), respectively. The inflow velocity at the neck of 20 (degree) is higher and the maximum WSS were higher than those of 0 (degree). The inflow area is moved to the vicinity of the center on the neck by the stenting.

CONCLUSION
A computational fluid dynamics study for blood flow is performed with a real cerebral aneurysm including a real stent shape based on micro-CT. The results indicate the flow rate and WSS in the aneurysm are changed by the stenting position.

KEY WORDS: Cerebral aneurysm, stent, micro-CT

Paper 294 Starting at 4:11 PM, Ending at 4:19 PM
Large Aneurysms Causing Focal Neurologic Deficit: Treatment and Evolution

Tampieri, D. · Cortes, M. · Melanson, D.
Montreal Neurological Hospital
Montreal, PQ, CANADA

PURPOSE
The aim of this presentation is to report our experience with the treatment of giant and large unruptured symptomatic intracranial aneurysms using endovascular techniques. This review includes aneurysms in subarachnoid location excluding intracavernous aneurysms.

MATERIALS & METHODS
A group of five patients presenting with progressive neurologic deficit in three cases, Parkinson in one case and left III cranial nerve palsy in one case came to our observation. The symptoms were caused by giant or large unruptured intracranial aneurysms in different locations. All the aneurysms were intracranial in the subarachnoid space (Table 1). In three cases coiling with adjunctive techniques was performed while in two patients the lesion was treated with parent artery occlusion. The patients were evaluated at follow up with MR imaging and MR angiography at 6 months, 1- and 2-year intervals and angiogram at 12 months.

RESULTS
The initial clinical condition resolved in all patients. At the latest clinical follow up 1 to 2 years after the endovascular procedures the patients did not have any symptoms recurrence. MR imaging demonstrated a complete resolution of the edema caused by the unruptured aneurysms in four cases, the resolution of the edema was accompanied by resolution of the clinical symptoms. In two cases (FC and EN) the aneurysms partly recanalized without recurrent symptoms and they were retreaded. No complications occurred during or immediately following the endovascular procedures.
**CONCLUSION**

Endovascular treatment of giant and large symptomatic aneurysms is a safe and valuable method for the resolution of the clinical symptoms. In spite of the recanalization observed the patients persist asymptomatic, probably due to the beneficial removal of the pounding effect of the pulsatile blood on the aneurysmal wall. Parent artery occlusion is an efficient treatment modality without risks of recanalization.

**KEY WORDS:** Aneurysm, interventional, MR imaging

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**Paper 295 Starting at 4:19 PM, Ending at 4:27 PM**

**Natural History and Management of Dissecting Pseudoaneurysms of the Cervical Cerebral Arteries**

Wyse, G. · Urrutia, V. · Aldrich, E. · Nyqust, P. · Sasson, D. · Gailloud, P. · Tamargo, R. · Wityk, R. · Murphy, K.

The Johns Hopkins Medical Institutions

**PURPOSE**

Between 6% and 30% of cervical artery dissections develop a dissecting pseudoaneurysm. The natural history and management of pseudoaneurysms are not clear. Recent case reports describe successful endovascular interventions, but two small case series suggest pseudoaneurysms follow a benign course.

**MATERIALS & METHODS**

We conducted a retrospective study of 36 patients seen at the Johns Hopkins Hospital over the past 8 years with a diagnosis of cervical artery pseudoaneurysm, reviewing radiologic and clinical features from diagnosis through follow up. Endpoints assessed included aneurysm rupture, aneurysmal enlargement, TIA/stroke from aneurysm-to-artery embolism, and new neurologic symptoms due to mass effect. All patients were initially treated medically with either antiplatelet therapy (n = 35) or anticoagulation (n = 1). Follow up on medical therapy was defined as the time from first radiologic diagnosis of pseudoaneurysm to time of last clinical assessment. For 7/36 patients who underwent surgical/endovascular intervention, medical follow up was censored at the time of intervention. For assessment of change in aneurysm size, follow up was from radiologic diagnosis until last radiologic study.

**RESULTS**

Among 36 patients, 33 had a single pseudoaneurysm and three had two aneurysms each (total 39 aneurysms). Average age was 47.5 years (range 27-76); 56% were men; 81% were white. Pseudoaneurysm location was 32/39 in the carotid arteries and 7/39 in the vertebral arteries. Etiology: 64% found during follow up after a dissection; 28% incidental radiologic findings; 5% consequences of trauma; 3% detected because of mass effect. Size: 14 (36%) small (< 5 mm); 10 (26%) medium (6-10 mm); 7 (18%) large (11-15 mm); 8 (20%) giant (≥ 16 mm). The average follow up on medical therapy was 25 months (range 2-84 months). No patient had aneurysmal rupture, but 2/36 (7%) patients had strokes possibly related to the pseudoaneurysm. Both of these two patients had giant pseudoaneurysms (size 16 mm). Follow up radiologic studies were obtained in 37/39 pseudoaneurysms with a mean follow-up time of 15.4 months. Among these pseudoaneurysms, 30/37 (81%) were unchanged, 3/37 (8%) closed off, 3/37 (8%) decreased in size, and only 1/37 (3%) increased in size. The subject with increasing aneurysm size was also one of the two patients with ischemia noted above. In our series 7/39 (19%) pseudoaneurysms underwent treatment including stent, coiling or surgery. A year after aneurysm coiling, one of these pseudoaneurysms had recanalized and caused an ischemic stroke.

**CONCLUSION**

Management of pseudoaneurysms is controversial. In our series, most patients did well with antiplatelet agents alone, with six (16%) decreasing in size or disappearing, and only one (3%) enlarging. However, two (7%) patients had ischemic events possibly related to the pseudoaneurysm while on medical therapy; both had giant-sized aneurysms. In contrast, one of seven (14%) patients treated with surgical/endovascular intervention had a delayed ischemic stroke.

**KEY WORDS:** Dissection, pseudoaneurysm, cervical artery

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**Paper 296 Starting at 4:27 PM, Ending at 4:35 PM**

**Ultrathin Gold and Vitronectin Coating on Platinum Show Enhanced Neointimal Response Compared with Platinum in a Rat Aneurysm Model**

Morris, P. · Berry, J. · Geer, C. · Mattern, C. · Whitlow, C. · Yazdani, S. · Lalli, J. · Claus, R. · Challa, V.

¹Wake Forest University, Winston-Salem, NC, ²Nanosonic Inc., Blacksburg, VA

**PURPOSE**

Designs for “bioactive” aneurysm coils involve coating of the platinum coil with replacement and reduction of the platinum content. This change alters the physical properties of the coils and, in some designs, reduces fluoroscopic conspicuity. In this study we hypothesize that extremely thin coatings of gold and/or vitronectin on platinum coils would demonstrate enhanced neointimal response compared with bare platinum coils in a rat aneurysm model.

**MATERIALS & METHODS**

Five groups of three rats were studied with use of the ligated carotid artery stump as an aneurysm model: control group (sham surgery with no coil placed), control with placement of platinum coil, platinum coil with gold coating, platinum coil with vitronectin coating, and platinum coil with gold and vitronectin layered coating. Two weeks postimplantation the implantation sites were harvested and stained with H&E. Slides were evaluated blindly by a pathologist and ranked ordered for degree of endothelial response. Quantitative
evaluation of the endothelial response was performed blind-
ly using a ratio of the area of endothelial response to the
overall lumen size.

**RESULTS**

Rat carotid arteries implanted with platinum coated with
gold, vitronectin, or both showed a greater neointimal
response within the lumen compared with the control
groups.

**CONCLUSION**

This study shows that in a rat aneurysm model, coils treated
with ultrathin coatings of gold and/or vitronectin provoke a
histologic response and degree of luminal occlusion greater
than that seen with plain platinum.

**KEY WORDS:** Gold, vitronectin, platinum

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**Paper 297 Starting at 4:35 PM, Ending at 4:43 PM**

**Relationship between Aneurysm Size and Position of the
Origin of Right Common Carotid Artery (RCCA): a Retrospective Study**

Ding, Y. · Kadirvel, R. · Dai, D. · Lewis, D. A. · Cloft, H. J.
· Kallmes, D. F.

Mayo Clinic
Rochester, MN

**PURPOSE**

In the elastase-induced aneurysm model in rabbits, the
height of the resultant aneurysm can be controlled by the
position of the right common carotid artery (RCCA) ligation
suture, with lower suture position yielding aneurysms of
lesser height. This study classifies the position of origin of
RCCA relative to surrounding bony structures and explores
the relationship between aneurysm size and the position of
the RCCA origin.

**MATERIALS & METHODS**

Fifty-four elastase-induced aneurysms created using a mod-
ified technique in which the proximal RCCA was ligated and
cut rather than simply ligated. The position of the origin of
RCCA was evaluated by comparing its position with the
location of first posterior rib on the right side. Two types of
position of origin of RCCA were classified: Type 1, high
position, in which the RCCA origin was at the level of the
first posterior rib or above, which rendered surgical exposure
relatively easy for RCCA ligation near its origin; Type 2, low
position, the origin was below the first posterior rib and
where exposure of the RCCA origin was difficult (Figures 1-
2). The relative frequency of Types 1 and 2 RCCA position
was calculated. Aneurysm sizes in each type were measured
and compared using the student’s t test.

**RESULTS**

The prevalence rates of Type 1 and 2 were 81.5% and 18.5%,
respectively. Mean aneurysm neck diameter, width, height,
and volume in Type 1 was 2.9 ± .8 mm, 2.9 ± 1.0 mm, 6.5 ±
2.0 mm, and 47.1 ± 39.7 mm³, respectively. In Type 2, the
mean aneurysm neck size, width, height and volume was 2.9
± 1.1 mm, 3.3 ± 1.0 mm, 8.2 ± 1.7 mm, and 82.9 ± 69.2 mm³,
respectively. Aneurysm height and volume in Type 2 were
larger than that in Type 1 (p = .02, and p = .03, respectively).
There was no significant difference of aneurysm neck diam-
eter and width between these two types (p > .05).

**Figure 1**

Figure 1. DSA image, showing smaller aneurysm created
with higher position of origin of RCCA (right arrow).

**Figure 2**

Figure 2. DSA image, showing bigger aneurysm created with
lower position of origin of RCCA (right arrow).

**CONCLUSION**

Under most situations the origin of RCCA is accessible for
ligation to create model aneurysms, which is important to
control aneurysm size, especially to create small aneurysms.

**KEY WORDS:** Aneurysm model, size, rabbits

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**Wednesday Afternoon**

**3:15 PM – 4:45 PM**

**Columbus G**

(45) ELC Workshop D: Adobe Photoshop and Elements

— Richard M. Berger, MD
Review of Pediatric Intracranial Neoplastic Diseases

**Learning Objectives**
Upon completion of this presentation, participants will be able to:
1) Review common pediatric intracranial neoplastic diseases.
2) Distinguish pediatric intracranial neoplastic disease from that which affects adults.
3) Review MR imaging techniques used for diagnosis and treatment of pediatric brain tumors.

**Presentation Summary**
The most common type of solid tumor among children is the pediatric brain tumor, which is the second most frequent childhood malignancy after leukemia, and the leading cause of death from solid tumors in this population (1). About 9% of the brain tumors reported to the Central Brain Tumor Registry of the United States (CBTRUS) between 1998 and 2002 occurred in persons younger than 20 (2). Our ability to reach an accurate preoperative diagnosis of the pediatric brain tumor hinges largely on magnetic resonance imaging, which is the ideal modality for defining tumor extent, developing an effective treatment plan, and implementing image-guided therapies involving surgery, radiotherapy, and chemotherapy. It is also the central modality for tumor follow up including tumor response, progression, and treatment effects. Using advanced MR techniques such as MR perfusion imaging, MR diffusion imaging, and MR spectroscopy, further characterizes the hemodynamics, cellularity, and metabolism of any suspected malignancies (3). The role of MR imaging in the diagnosis and treatment of pediatric intracranial neoplastic diseases will be reviewed. Emphasis on unique features of pediatric brain tumors that are distinct from adults will be addressed. Types and features of common pediatric intracranial neoplastic diseases will be included.

**References**

Clinical Impact on the Developing Brain from Treatment of Childhood Malignancy

**Naomi Winick, MD**

Dr. Winick attended Indiana University and received a Bachelor’s degree prior to attending Northwestern University Medical School. She did her internship and residency at Babies Hospital - Columbia Presbyterian in New York and her Pediatric Hematology-Oncology Fellowship at Memorial Sloan-Kettering Cancer Center. She left New York in 1983 and has been at The University of Texas Southwestern Medical Center since 1983. She serves as the Director of Clinical Oncology for Children’s Medical Center/University of Texas Southwestern and has had a variety of positions, dominantly related to Acute Lymphoblastic Leukemia (ALL), in both the Pediatric Oncology Group and the current Children’s Oncology Group (COG). She is now the vice-chair of Clinical Trials for the ALL Committee of the Children’s Oncology Group and the study chair for AALL06N1, a study funded through the Best Pharmaceuticals for Children Act. This trial will facilitate a detailed prospective evaluation of potential changes in neuro-cognitive function over time among a large number of children randomized to two different methotrexate doses and schedules, both with and without rescue, on two frontline randomized therapeutic trials for children and adolescents with ALL.

**Learning Objectives**
Upon completion of this presentation, participants will be able to:
1) Discuss the neurologic toxicities/neurocognitive outcomes associated with diagnosis and treatment of medulloblastoma and acute leukemia (ALL) in childhood.
2) Illustrate the shortcomings of CT/MR imaging in predicting neurologic outcome.
**Presentation Summary**

Neurocognitive outcome has been studied in survivors of medulloblastoma and ALL, diagnosed during childhood. This presentation will describe neurologic outcome in both groups, but the primary focus will be on survivors of ALL for pragmatic reasons. Approximately 30% of all pediatric brain tumors are medulloblastomas, commonly found in the posterior fossa. Though overall survival for children with medulloblastoma has improved, with almost 70% surviving long-term, therapy commonly mandates surgical resection, whole neuraxis radiation and chemotherapy. Surgery to excise posterior fossa tumors and whole brain radiation, have clearly been associated with highly significant neurodevelopmental, neurocognitive and, neuroendocrine dysfunction. However, curative treatment regimes that avoid these modalities are few and have yet to be validated. In contrast, 80% of children with ALL enjoy a better prognosis and have been treated successfully with a variety of regimens, most commonly without cranial radiation. Some include high dose methotrexate with leucovorin rescue, some only lower escalating dose MTX without leucovorin rescue and some standard, not high, risk patients, have been treated without parenteral MTX, with a projected EFS of > 85%. Additionally, the number of doses of intrathecal therapy varies greatly, with a recent randomized trial suggesting that the prolonged delivery of intrathecal medication does not enhance disease-free survival. Prior studies of MTX-related neurotoxicity have focused on diffuse white matter loss and gliosis, which is seen most often in the posterior white matter and centrum semiovale. To date, there has been no correlation established between white matter abnormalities as seen on MR imaging and type or severity of neurocognitive dysfunction. This lack of correlation may be related to the insensitivity of routine MR images to the detection of injury in regions within the brain that are important in cognition. If neuroimaging could accurately predict dysfunction, prior to the evolution of irreversible damage, it would provide a critical new tool; enabling clinicians and families to make rational decisions about the relative risks and benefits of continued therapies, taking into account, time on treatment and the patients initial risk classification. Furthermore, if toxicity correlates with damage to a defined neuroanatomical region, it will provide unparalleled insight into the pathophysiology of encephalopathy and possibly, aid in preventive or therapeutic interventions.

**References**


**Imaging of Treatment Effects**

**Fred H. Laningham, MD**

**Learning Objectives**

Upon completion of this presentation, participants will be able to:

1. Identify typical MR findings associated with acute and chronic adverse effects of therapy in pediatric oncology patients.
2. Illustrate the importance of properly protocolling MR exams to include key sequences in specific clinical scenarios.

**Presentation Summary**

Conventional and advanced imaging techniques play an important role in identifying noxious effects of cancer therapy on the central nervous system in children. This talk will discuss relevant magnetic resonance imaging findings of the brain and spine in children while undergoing therapy for hematological disorders and solid tumors. Treatment-related complications with acute clinical manifestations include posterior reversible encephalopathy syndrome (PRES), acute methotrexate toxicity, dural venous sinus thrombosis (cortical vein thrombosis), and transient white matter injuries. These and other complications will be illustrated while elucidating predisposing factors and pathologic mechanisms. The impact that neuroimaging can have in altering therapy in such patients will be highlighted. Adverse effects of treatment which affect children chronically, such as secondary malignancies, intracranial vasculopathy, and parenchymal damage will be discussed. The review will also include results and ongoing projects of the “Late Effects” research being conducted in Memphis.
Designing Stroke Trials in the 21st Century - Opportunities and Limitations

Gary M. Nesbit, MD

IMS II: Final Data and IMS III: An Update

Pooja Khatri, MD

The Multi-MerCI Trial

Reza Jahan, MD

The MR Rescue Trial

Chelsea Kidwell, MD

Dr. Kidwell is Associate Professor of Neurology at Georgetown University and is Medical Director of the Georgetown University Stroke Center and the Washington Hospital Stroke Center. Dr. Kidwell received her MD at the University of Arizona College of Medicine. She completed her neurology residency as well as fellowship training in stroke and vascular neurology at UCLA. Her active research interests include advancing novel treatments for acute stroke, developing innovative approaches to secondary stroke prevention, and employing neuroimaging techniques to understand stroke pathophysiology and optimize acute therapies. Dr. Kidwell currently serves as the Principal Investigator of the NIH-funded MR and Recanalization of Stroke Clots Using Embolectomy (MR RESCUE) trial. Dr. Kidwell has authored or co-authored over 40 peer-reviewed publications, 20 invited chapters and reviews, and over 100 abstracts.

LEARNING OBJECTIVES
Upon completion of this presentation, participants will be able to:
1) Identify the role or diffusion and perfusion MRI to identify acute stroke patients for recanalization therapies.
2) Analyze the rationale, objectives, and design of the MR RESCUE clinical trial.

PRESENTATION SUMMARY
The Magnetic Resonance and Recanalization of Stroke Clots Using Embolectomy (MR RESCUE) trial is an NIH-funded, multicenter, randomized, controlled, blinded-outcome, phase II trial of mechanical embolectomy versus standard medical management in acute ischemic stroke patients. The primary hypothesis of MR RESCUE is that patients who demonstrate a pretreatment penumbral pattern as calculated from diffusion- and perfusion-weighted MR imaging (MRI) will have a better outcome than those without a pretreatment penumbral pattern. The primary outcome measure is long-term neurologic outcome as measured on the day 90 modified Rankin Scale. All patients enrolled in MR RESCUE undergo a preenrollment multimodal MR scan. The raw MRI data are processed in real-time, prior to randomization, with the specially designed RescueOnSite software to generate a penumbral pattern code, which identifies the patient as having a penumbral or nonpenumbral MRI pattern. The fully automated RescueOnSite software recognizes the diffusion- and perfusion-weighted imaging sequences then sorts and processes them to generate multiple diffusion and perfusion maps. The maps then are coregistered and a voxel-by-voxel analysis is performed to determine penumbral status. Randomization into MR RESCUE is stratified by penumbral pattern so that an equal number of penumbral and nonpenumbral patients are enrolled in the two arms: mechanical embolectomy and medical management. MR RESCUE is unique in that it is the only trial specifically designed to validate MRI as a selection tool for endovascular intervention in acute stroke patients. Recruitment is ongoing with 19 sites active and 30 sites planned.
**Ultra-high Field MRI: Imaging and Safety Issues**

William G. Bradley, Jr., MD, PhD, FACR

**LEARNING OBJECTIVES**

Upon completion of this presentation, participants will be able to:

1) Compare the current advantages and disadvantages of 3T vs 1.5 T MRI for the spine.
2) Identify the potential advantages of 3T over 1.5T MRI of the spine for faster or higher resolution imaging.

**PRESENTATION SUMMARY**

The purpose of this talk is to discuss the imaging and safety issues associated with “ultrahigh field” MR imaging (MRI). This is inherently a comparison of “high field” (1.5T) and “ultrahigh field” (3T) MRI. As in the brain and other body parts, 3T MRI of the spine benefits from twice the signal to noise of 1.5T MRI. This can be traded off for higher spatial resolution, thinner slices, or faster scanning, the latter assuming parallel imaging and phased-array coils are used. Just as high field MRI produced higher quality images and earlier diagnoses compared to low and mid field MRI in the past, so ultrahigh field MRI should be superior to high field. In addition to higher signal to noise, the degree of T1-weighting is increased at 3T vs 1.5T for a given TR since T1 increases with field strength for tissue. Thus contrast enhancement is increased for a given dose of gadolinium. On the negative side, there is greater chance of RF heating at 3T. Since long echo-train T2-weighted fast spin-echo is used so ubiquitously for spine imaging, adjustments must be made compared to 1.5T to avoid exceeding specific absorption rate (SAR) limits. This can include decreasing the flip angle of the refocusing pulse from 180° to 125° or simply increasing the echo sampling time or decreasing the echo train length. As the wavelength approaches the dimension of the body (as it does at 3T), dielectric effects become more pronounced. These lead to local areas of higher or lower signal intensity due to the peaks or valleys of standing waves. If these pose a problem diagnostically, they can be reduced with dielectric pads. As with the comparison of high field to low/mid field, chemical shift and motion artifacts are greater at 3T than at 1.5T. Thus it is even more important to phase encode superior-inferior and to place sat pulses over the bowel anterior to the aorta. Finally it is important to consider ultrahigh field spine imaging in the context of other ultrahigh field imaging applications. With further improvements in coil technology and parallel imaging, there is no doubt that 3T will become the new standard for all MR applications. Considering how long one keeps a magnet, do you really want to be left with the equivalent of a “midfield” 1.5T system 5 years from now?

**Diffusion Tensor Imaging of the Spine**

Meng Law, MD

**PRESENTATION SUMMARY**

Clinical diffusion-weighted imaging (DWI) and diffusion tensor imaging (DTI) of the human spinal cord remains technically difficult. The small size of the spinal cord necessitates the employment of small voxel sizes for spatial resolution, at the expense of signal-to-noise. Images may be
degraded as a result of macroscopic motion related to CSF pulsation, patient breathing/swallowing, or gross patient motion. Local field inhomogeneity also contributes to image degradation (1, 2). Echo-planar DTI can be performed in a reasonable amount of time for clinical use, and single-shot techniques may limit the adverse effect of in-plane bulk motion to some extent. New techniques utilizing parallel imaging (3), as well as pulse-triggering or cardiac gating, should further minimize image degradation. In the analysis of DTI maps, care must be taken to avoid including CSF in the ROIs, which would produce a misleading change in DTI metrics (decreased FA and increased MD). We review the challenges with performing in vivo DTI of the human cord and demonstrate how different sequences and sequence parameters can be optimized to obtain high quality reproducible DTI datasets. In turn, the potential clinical applications of in vivo DTI will be reviewed. Diffusion tensor imaging (DTI) has shown promise in the evaluation of white matter tract integrity, and has been shown able to detect changes in spondylosis affecting the spinal cord (4, 5), typically consisting of decreased fractional anisotropy (FA) and increased mean diffusivity (MD). These changes in FA and MD may not be sufficient to differentiate between potentially reversible edema and irreversible gliosis in patients with spondylosis. However, the evaluation of major (E1) and minor (E2, E3) eigenvalues, from which FA is calculated, may assist in identifying subgroups of patients. We compared diffusion tensor metrics in the white matter tracts of the cervical spinal cord in patients with severe multilevel spondylosis with normal volunteers and demonstrated increased minor eigenvalues, with preservation of the major eigenvalue. In the spinal cord, the minor eigenvalues typically correspond to transverse diffusion, perpendicular to the longitudinal axis of the spinal cord. Animal studies have suggested that increases in the minor eigenvalues occur in the setting of demyelination, increased axonal diameter, and additional factors including protein integrity (6). The increased transverse diffusion seen in the normal appearing spinal cord of patients with cervical spondylosis suggests possible microscopic demyelination and axonal compromise. Evaluation of the spinal cord has become increasingly important in both the diagnosis and follow up of MS, as changes in the spinal cord function of MS patients have been shown to correlate with clinical disability (7). The mechanism by which MS affects the normal-appearing spinal cord is unknown, and may relate to Wallerian degeneration, a primary ischemic/vasculitic process, or early local demyelination. Changes in MS patients recently have been detected in the cervical spinal cord, using a sagittal DTI technique and evaluating large regions of interest using histogram analysis (8, 9). However, it is generally accepted that lesions in primary demyelination have a predilection for the posterior columns of the spinal cord; therefore, analysis of DTI metrics in different regions of the spinal cord may demonstrate spatial differences. Bot, et al. have investigated the spinal cords of postmortem MS patients using high-field MR imaging with histopathologic correlation (10). At histopathology, they demonstrated significant axonal loss, increase in axonal diameter, and decreased myelin density in NASC of MS patients. In general, FA is significantly lower in the NASC of MS patients in the lateral, posterior and central cord compared with controls (11). Measurement of DTI metrics in the cervical spinal cord may prove useful in aiding the diagnosis of MS, correlating with clinical disability, as well as monitoring disease progression and therapeutic effect. DTI shows promise in the evaluation of spinal cord pathology. Besides MS and spinal canal stenosis, it has potential applications in other disorders affecting the cord such as amyotrophic lateral sclerosis (ALS), spinal cord mass lesions, spinal cord trauma, vascular lesions of the cord and evaluating recovery from cord pathology or injury (2, 12). Improvements in coil technology coupled with optimization of pulse sequences and parallel imaging techniques will make DTI more accessible and reproducible in clinical practice.

REFERENCES

1. Maier SE, Mamata H. Diffusion tensor imaging of the spinal cord. *Ann NY Acad Science* 2005;1064:50-60

Ultrashort TE MR Imaging of the Spine

Graeme M. Bydder, MB, ChB

Dr. Bydder’s field of study is as follows: Takaka, New Zealand (NZ) 1948 - 1956; Primary School, Nelson College and Shirley Boys High School, NZ 1957 – 1961; High School, University of Canterbury, Christchurch, NZ, B.Sc.
Wednesday Afternoon

4:45 PM – 6:15 PM
Columbus I-L

(49) Advanced Imaging Seminar – Perfusion

(310) Perfusion Imaging: State of the Art
   — James M. Provenzale, MD

(311) Permeability Imaging
   — Daniel P. Barbioriak, MD

(312) Vascular Reactivity
   — David J. Mikulis, MD

Moderators: Timothy P. L. Roberts, PhD
Howard A. Rowley, MD

Perfusion Imaging: State of the Art
James M. Provenzale, MD

Learning Objectives
Upon completion of this presentation, participants should be able to:
2. Explain how the scoring system devised by Fryback and Thornbury can be used to assess individual articles for potential impact on clinical decision-making.
3. Provide recommendations on the design of future studies in order to allow them to show impact on clinical decision-making.

Presentation Summary
The goal of this presentation is to provide the audience with the results of a meta-analysis of the medical literature intended to assess the role of CT and MR perfusion-weighted imaging (PWI) in medical decision-making. This study was funded by the American Society of Neuroradiology. It allowed the speaker and colleagues to study the degree to which a role for PWI in medical decision-making in patients with cerebral ischemia and brain tumors could be supported by published articles. The speaker and his colleagues evaluated 660 articles that dealt with PWI in brain diseases and identified 65 articles in which, at some level, a potential impact of PWI on decision-making could reasonably be claimed. Forty-eight of these articles dealt with cerebral ischemia (of which almost all evaluated thrombolytic therapy) and 17 dealt with brain tumors. Few PWI articles had the classic study designs usually found in articles that are standardly categorized using Fryback and Thornbury criteria. Most articles were not designed to study an outcome, such as a clinical endpoint or to show how patient outcome was improved by the diagnostic information provided. Thus, the Fryback and Thornbury criteria did not lend themselves to optimal use. Our review team then developed a novel scoring system that was designed to be more flexible than the Fryback classification and that provided a more specific set of descriptors of the clinical import of the PWI component of the studies. Review of the PWI literature on cerebral ischemia showed that the vast majority of articles examined the effect on thrombolytic therapy on clinical outcome or on subsequent imaging findings (e.g., ultimate infarct size). However, very few articles could be viewed as showing a direct influence of the use of PWI on patient management. Essentially no attempt was made to analyze how patients might have been treated if PWI data were lacking. With regard to PWI for assessment of malignant tumors, an effect on clinical decision-making is even less strong than for cerebral ischemia because no therapy for such brain tumors has been developed. The two applications of tumor PWI for which the greatest support was provided by our review of the medical literature were 1) distinction of tumors from other mass lesions and 2) determination of tumor grade. Even though these uses of PWI are valuable, our review of the medical literature did not show a clear impact of PWI on decision-making. Future trials that use PWI for assessment of cerebral ischemia or brain tumors should be specifically oriented to assess the impact on clinical decision-making. One possibility would be to (either prospectively or retrospectively) determine what clinical decisions would be made without PWI and whether they differ from decisions that
would have been made had PWI data been available. If the decisions substantially differed based on whether PWI data were available or unavailable, then it would be safe to assume that PWI played a substantial role in determining therapy. Another method would be to randomly assign patients to a group in which PWI is performed (and used in triaging patients to a therapeutic regimen) or a group in which PWI is not performed. However, it is clear that such a paradigm would not likely be prospectively performed in future studies of intravascular infusion of thrombolytic agents. Many treating physicians believe that the accumulated evidence of the importance of a DWI-PWI mismatch is well enough established (despite its limitations) that it would be unethical to randomize patients to not undergo PWI. However, one might be able to apply this paradigm to other forms of therapy, such as mechanical clot disruption.

**Permeability Imaging**

*Daniel P. Barboriak, MD*

**Learning Objectives**

Upon completion of this presentation, participants will be able to:

1. Explain the definition of permeability, and why capillary endothelial permeability is of interest for the evaluation of a spectrum of neurological diseases.
2. Summarize the major parameters that can be extracted from DCE-MRI data, including $v_p$, $K_{trans}$, ve and IAUC, and to explain their relationship to permeability.
3. List the steps used to perform pharmacokinetic analysis of DCE-MRI data, and to specify the sources of error in each step of the technique.

**Presentation Summary**

The imaging of capillary endothelial permeability has been the focus of increased interest in the past few years. Both T1-weighted dynamic contrast-enhanced (DCE) and T2- or T2*-weighted dynamic susceptibility MR imaging (MRI) has been used for this purpose. These techniques are most often applied to evaluation of brain tumors, but other intracerebral applications, including evaluation of stroke, multiple sclerosis and Alzheimer disease, and extracerebral applications, including evaluation of head and neck cancers and of carotid plaques, are of interest to neuroradiologists. The focus of this lecture will be on the theory and application of perfusion imaging, with emphasis on DCE MRI. The parameters that can be extracted from DCE MRI, including $v_p$, $K_{trans}$, ve and IAUC, and their meaning (1, 2) will be discussed. It is important to note that none of these parameters specifically measures permeability, but that under specific conditions permeability is a major component of the $K_{trans}$ and IAUC measurements. The major steps in performing pharmacokinetic analysis of DCE MRI data will be reviewed: 1) mapping tissue T1; 2) acquiring DCE MRI images; 3) transforming signal intensity images into estimates of gadolinium contrast agent concentration; 4) estimating a vascular input function and 5) fitting data to a physiological model. Although broad recommendations have been made about how DCE MRI should be performed for oncological studies (3, 4), each of the analysis steps remains the subject of controversy. The tradeoffs between acquisition speed, coverage of relevant anatomy and signal-to-noise ratio will be discussed. The challenges that need to be overcome for successful DCE MRI at 3T also will be reviewed. The promise of DCE MRI imaging as shown in recent studies will be assessed.

**References**


**Vascular Reactivity**

*David J. Mikulis, MD*

**Learning Objectives**

Upon completion of this presentation, participants will be able to:

1. Define the pathophysiology of exhausted cerebral autoregulation and vascular steal.
2. Describe the acquisition and analysis of MRI based CVR measurements.
3. Review significant clinical applications including the utility of BOLD CVR MRI for distinguishing embolic from hemodynamic transient ischemic attacks, a differentiation important for triaging patients toward invasive revascularization procedures (endarterectomy, angioplasty and stenting).

**Presentation Summary**

Blood pressure extremes can have serious neurological consequences. The cerebral vasculature therefore has evolved a carefully controlled protective mechanism for maintaining constant baseline blood flow through a wide range of pressures. The mechanism involves controlling flow resistance with effectors in the pre-capillary vasculature at the level of the arterioles. The muscular tone in the pre-capillary arterioles (called pre-capillary “sphincters” by some investigators) is the source of this control responding to changes in blood pressure via a reflex mechanism mediated through arachidonic acid metabolism.1 Smooth muscle tone can also be influenced by other agents including carbon dioxide, acetazolamide, neuronal activity, and release of serotonin and histamine by platelets. Measuring changes in blood flow in response to these agents can therefore provide information concerning the ability of the flow network to provide increased flow. CVR measurements can be made by observing the change in blood flow induced by a unit change in an applied stimulus. As the stimulus is increased, the ability of the sphincters to dilate eventually will reach an upper limit.
where further relaxation of the smooth muscle is no longer possible. In diseases of the proximal vasculature such as carotid artery atherosclerosis, pre-sphincteric pressure drops will invoke a compensatory relaxation of vascular tone in the sphincters. If the proximal stenosis is severe, full relaxation of sphincter tone may be required to maintain flow. A lowering of blood pressure any further (exhausted autoregulation) may result in ischemia with diversion of blood toward vascular beds whose resting tone vascular tone is not fully relaxed (steal phenomenon). In fact, this type of physiology has been associated with an annual stroke risk of up to 30% per annum2 which is typically three to five times higher than that seen in patients without CVR impairment. Identification of this physiology, where transient symptoms are thought to be hemodynamic as opposed to embolic in origin, has attracted the interest of numerous investigators and, as a result, many methods exist for measuring CVR. The purpose of this presentation is to describe a fast, efficient, and quantitative MRI method for measuring CVR. The method uses a novel gas sequencer that can provide tight control of end tidal oxygen and carbon dioxide in conjunction with BOLD MRI for assessing the state of autoregulation in patients.1. Harder DR, Roman RJ, Gebremedhin D, Birks EK, Lange AR. A common pathway for regulation of nutritive blood flow to the brain: arterial muscle membrane potential and cytochrome P450 metabolites.

REFERENCES
Brain Review Session I

Christine M. Glastonbury, MBBS, FRANZCR

LEARNING OBJECTIVES
Upon completion of this presentation, participants will be able to:
1) Review the clinical presentation of important neurovascular disease entities.
2) Cite the typical and unusual CT and MR imaging appearances of these disorders.

PRESENTATION SUMMARY
Through the presentation of unknown cases this session will review the CT and MR imaging appearances of several important common and uncommon neurovascular diseases in adults and children. The central theme of this presentation is solidifying an understanding of both typical and unusual CT and MR imaging appearances of these disorders, and recognizing their clinical presentations. Emphasis also will be made on the value of additional imaging tools such as CT perfusion (CTP), MR angiography (MRA), MR spectroscopy (MRS) and conventional angiography.

REFERENCES

Brain Review Session II

Abraham M. Obuchowski, MD

Thursday Morning

7:45 AM – 8:45 AM
Grand Ballroom C-F

(50) Maintenance of Certification (MOC) – Brain Review Session Audience Response Plus+ (AR+)*

(313) Brain Review Session I
— Christine M. Glastonbury, MBBS, FRANZCR

(314) Brain Review Session II
— Abraham M. Obuchowski, MD
Moderator: Ay-Ming Wang, MD, FACR

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

**Formerly Berlex

Thursday Morning

8:45 AM – 9:45 AM
Grand Ballroom C-F

(51) General Session: Spine

(315) Cervical Spine Fusions
— Paul A. Anderson, MD

(316) Cervical Myelopathy from Degenerative Causes
— Adam E. Flanders, MD

(317) Stem Cell and Spinal Cord Injury
— John A. Kessler MD
Moderator: Erin Simon Schwartz, MD

Cervical Spine Fusions

Paul A. Anderson, MD

LEARNING OBJECTIVES
Upon completion of this presentation, participants will be able to:
1) Review new paradigms in treatment of cervical spine diseases.
2) Identify designs of cervical hardware and their expected
radiographic features.

3) Report best means to determine cervical fusion outcome.

**Presentation Summary**

Although the treatment of cervical spine diseases is changing from fusion to motion sparing, indications for cervical spine surgery remain unchanged. In patients with degenerative conditions with radiculopathy or myelopathy, surgery is warranted for failure to respond to nonoperative care or progressive neurologic deficits. Posterior foraminotomies are indicated in patients with lateral disk herniations although the anterior decompression is the most preferred approach in cases of central disk herniations or cervical spondylosis. Reconstruction following anterior disectomy has changed with the use of allograft, various bone substitutes including metal and plastic cages and the use of plates. Plates are available that are dynamic and static. Static plates do not allow any bending between the screw head and plate whereas with dynamic the screws can toggle allowing some flexion-extension or can allow graft shortening along the long axis of the spinal column. These later devices have been designated translational plates. Because the screws change in relation to the plates, the radiologist must be aware that this is normal and not necessarily a cause for alarm. Fusion often is performed in cases of trauma or instability. Instability is a difficult to determine entity, however, newer quantitative classification systems such as the Cervical Spine Injury Severity Score have been developed to allow surgeons and radiologists to better assess stability. Instability is defined as the potential for increasing neurologic deficit, progressive deformity or chronic pain and disability. The Cervical Spine Injury Classification Score grades each column of the spinal spine (four columns: anterior, posterior and each pillar) on an analog scale of 0-5. This system has been shown to be highly reliable and valid. Bone graft substitutes may make imaging to detect fusion difficult. Metal cages may interfere with observations of bridging and trabecularized bone. Similar problems occur in lumbar interbody devices. Bioabsorbables may appear radiolucent initially or over time and then later it will become radio-opaque during ossification. Plastic cages usually made from polyether ether ketones (PEEK) are strong and have tantalum markers outlining their edges. However, it will be difficult to detect failure of this device. The assessment of cervical spine fusion has been studied extensively. Two techniques have proved to be reliable, CT with reconstructions and flexion extension films. On flexion extension films, the spinous process distance method is more accurate than Cobb angles. The spinous process technique is performed by marking identical points on spinous processes and measuring the spread on flexion and extension radiographs. If there is >2 mm of motion then the patient has a pseudoarthrosis. Because of the more widespread use of hardware, in particular screws that are placed adjacent to the spinal cord, nerve roots and vertebral arteries, increasing use of imaging is required. Specifically, anomalies of the vertebral artery system need to be identified and if significantly abnormal, called to the attention of the surgeon. Important anomalies that have been associated with intraoperative injuries include vertebral artery ectasia where the vertebral artery extends into the vertebral bodies from the foramen transversarium. High-riding vertebral artery in C2 which will be placed in the path of a transarticular C1-2 screw and ponticulus posticus where the vertebral artery is inside what appears to be a very large lamina of C1. Conclusion: Although there is a paradigm away from fusion, arthrodesis is still common and will require radiographic assessment. Careful preoperative assessment may increase patient safety. When abnormalities are present, it is helpful to bring them to the attention of the surgeon. Assessment of the fusion in the cervical spine is performed by either flexion extension radiographs or high-resolution CT scanning.

**Cervical Myelopathy from Degenerative Causes**

**Adam E. Flanders, MD**

**Learning Objectives**

Upon completion of this presentation, participants will be able to:

1) Contrast the differences between myelopathy and radiculopathy.

2) Distinguish the physical and imaging manifestations of cervical spondylotic myelopathy versus traumatic myelopathy and myelopathy from other causes.

3) Describe the importance of signal intensity abnormality in the spinal cord in the setting of degenerative spondylotic disease.

4) Discuss the potential of advanced MR techniques in the diagnosis and treatment of this disorder.

**Presentation Summary**

Myelopathy refers to an intrinsic dysfunction of the spinal cord. The most common cause of acute myelopathy is trauma; however, inflammatory and neoplastic causes also can result in acute spinal cord dysfunction. Cervical spondylotic myelopathy (CSM) is the most common cause of chronic progressive myelopathy in the adult population. The clinical hallmarks of cervical spondylotic myelopathy include weakness or stiffness in the legs as well as hand weakness, neck stiffness, shoulder and arm pain as well as an unsteady gait. Hyperreflexia is a characteristic finding. Unlike a radiculopathy which produces symptoms in a dermatomal distribution, myelopathy is indicative of spinal cord dysfunction. This process is related to degenerative disease of the spinal axis that results in mechanical compression of the spinal cord. Three pathophysiologic factors contribute to CSM: (1) static/mechanical or developmental spinal canal stenosis; (2) dynamic/mechanical in which normal cervical motion produces increased compression of the spinal cord in flexion and extension due to protruding osteophytic ridges and buckling of the ligamentum flavum; and (3) spinal cord ischemia. Ischemia is thought to play a substantial role in the pathophysiology of CSM; however the mechanism is not precisely understood. It is postulated that the compressive effects of stenosis and cervical spondylosis during normal physiologic motion creates alteration in the cord microvasculature that predisposes to demyelination and loss of axons. Postoperative myelopathy occasionally occurs following decompressive surgery on the cervical spine attributed to suble trauma or mild vascular compromise. Diagnostic imaging for CSM includes radiography, myelography, computed tomography (CT) and magnetic resonance imaging (MRI). MRI is thought to be most valuable in this clinical application because it is the only modality that visualizes the internal architecture of the spinal cord; therefore it can be useful in discriminating other causes of myelopathy such as neoplasia, syringomyelodyemia, demyelinating disease as
well as primary degenerative diseases of the spinal cord. Objective symptoms of myelopathy may be present in the absence of even subtle signal changes in the spinal cord on routine MRI. Preexistent cervical stenosis, demonstrable cord deformity/compression and cross-sectional area reduction of the spinal canal have been shown to be independent predictors of myelopathy in published series. Surgical compression is the treatment of choice for CSM; however, the type of surgery and timing of surgery remains controversial. Surgical proponents advocate early surgical intervention because it may correlate better with improved functional outcomes. Diffusion, perfusion and even proton MR spectroscopy have been shown to demonstrate subtle functional differences that are detectable with these advanced MR techniques that correlate better with physical disability compared to conventional anatomical MR imaging. It is plausible that these methods may prove valuable in selecting patients who will benefit the most from decompressive surgery as recovery after surgery varies once myelopathy is clinically evident.

Stem Cell and Spinal Cord Injury
John A. Kessler MD

Thursday Morning
10:15 AM – 12:00 PM
Grand Ballroom C-F

(52a) INTERVENTIONAL: Aneurysms II
(Scientific Papers 318 – 329)

See also Parallel Sessions
(52b) INTERVENTIONAL: New Devices and Equipment
(52c) ADULT BRAIN: Cerebrovascular Occlusive Disease II and Epilepsy
(52d) TRAUMA: Head and Spine

Moderators: Aquilla S. Turk, DO
Gregg H. Zoarski, MD

Paper 318 Starting at 10:15 AM, Ending at 10:23 AM
Stent Placement Reduces Angiographic Recurrence of Aneurysm Treated with Coils
Moret, J. · Mounayer, C. · Piotin, M. · Spelle, L. · Loureiro, C.
Fondation Rothschild Hospital
Paris, FRANCE

PURPOSE
To assess the impact of stent on the rate of angiographic recurrence of intracranial aneurysms treated with coils.

MATERIALS & METHODS
Results at follow-up angiography of 563 aneurysms in 483 patients (325 women and 158 men with a mean age of 49 years) were dichotomized into presence or absence of recurrence according to the Montreal classification (1). The impact of stent placement across the aneurysm neck on the rate of angiographic recurrence was statistically assessed with the Fischer Exact Test.

RESULTS
Dome and neck sizes of the stented and no-stented aneurysms were 11 mm/6.5 mm and 7.5 mm/4 mm respectively. Among the stented aneurysms, 16% (7/44) had presented with SAH, while in the no-stent group 46% (239/519) of the aneurysms had previously ruptured. Follow-up angiography revealed recurrence in 32.5% (183/563) of the followed aneurysms at a mean follow-up time of 17 months, 10% (56/563) were amenable to retreatment. Aneurysms treated with stent and coils and those treated with coils only had a recurrence rate of 11% (5/44) and 34% (178/519) respectively. There was a statistically significant difference between the recurrence rate of aneurysms treated with stent and coils and those treated with coils alone (P = 0.0013).

CONCLUSION
Stent placement across the neck diminishes significantly the angiographic recurrence rate of aneurysm treated with coils.

REFERENCES

KEY WORDS: Aneurysms, stents

Paper 319 Starting at 10:23 AM, Ending at 10:31 AM
Deconstructive Technique in the Selective Treatment of Intracranial Aneurysm with Coils
Piotin, M. · Spelle, L. · Mounayer, C. · Moret, J.
Fondation Rothschild
Paris, FRANCE

PURPOSE
Coiling of intracranial aneurysm is sometimes limited by the presence of a branch merging from the sac. However, this can be overcome by using a deconstructive technique consisting in the occlusion of the merging arterial branch. We retrospectively evaluated the safety and efficacy of coil
embolization of aneurysms with the deconstructive technique.

**Materials & Methods**

Over 5 years, 854 aneurysms in 736 patients (68% women, mean age 49 years) were treated selectively with coils. For all aneurysms, aneurysm characteristics (dome and neck sizes, location, mode of presentation), immediate and follow-up angiographic results, patient clinical outcome were prospectively gathered in a database. Aneurysms were dichotomized in two groups according to the use or not of the deconstructive technique. Special attention was paid to the occurrence of procedure-related ischemic events and angiographic recanalization using the Montreal angiographic classification (1). Results were assessed for statistical significance with the Fisher Exact Test.

**Results**

Only 4% (35/856) of all aneurysms were treated with the deconstructive technique. Among them (dome and neck sizes: 8 mm/3.8 mm), 51% had presented with SAH. Procedure-related ischemic events were noted in 8.5% (3/35), no procedure-related mortality occurred. Follow-up angiography revealed recanalization in 14% (3/21) of the followed deconstructed aneurysms. In the group of not-deconstructed aneurysms (dome and neck sizes: 7.6 mm/4.2 mm), 46% (376/819) had hemorrhaged at presentation. Ischemic events were noted in 4.2% (35/819), leading to death in 1% (7/819). Follow-up angiography revealed recanalization in 33% (180/542) of the followed not-deconstructed aneurysms. There was no statistical difference between the rates of ischemic events in both groups (P = 0.0947). Less recanalization occurred in the group of deconstructed aneurysms but without reaching a level of statistical significance (P = 0.0947).

**Conclusion**

Our study suggests that saccular intracranial aneurysms with a branch arising from the sac may be treated by endovascular approach with good clinical results. Long-term follow-up angiography confirms better anatomical stability of the deconstructed aneurysms.

**References**


**Key Words:** Aneurysm, endovascular treatment, anatomy

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**Paper 312 Starting at 10:39 AM, Ending at 10:47 AM**

**Clinical Outcome of Third Nerve Palsies after Aneurysm Coil Embolization**

Berube, M. D. · Nguyen, T. N. · Mahmoud Gamal El Din, M. · Weill, A. · Guilbert, F. · Raymond, J. · Roy, D.

CHUM Notre Dame Hospital
Montreal, PQ, CANADA

**Purpose**

The clinical outcome of third nerve palsy (TNP) caused by posterior communicating (PCOM) or superior cerebellar artery (SCA) aneurysms remains controversial between coiling and clipping. The purpose of this study was to assess the clinical recovery of TNP in patients treated by coil embolization.
Materials & Methods
Between 1995 and 2006, 29 patients with TNP caused by a PCOM (n = 26) or SCA (n = 3) aneurysm were coiled. Clinical recovery was assessed by retrospective chart review of the ophthalmologic exam, documenting the extent of TNP by the presence of ptosis, ophthalmoplegia, or anisocoria. In 12 patients, additional follow up was assessed by telephone interview. Ruptured aneurysm was defined by the presence of hemorrhage on CT scan. Functional recovery was classified: (1) satisfactory, including complete recovery or partial but functional recovery (not interfering with daily activities including reading) (2) unsatisfactory, defined as no change or partial but nonfunctional recovery.

Results
Of 29 patients, there were 17 (59%) ruptured aneurysms. Mean aneurysm size was 9.1 ± 5.2 mm. Clinical features at presentation were ptosis (n = 27), ophthalmoplegia (n = 23) and anisocoria (n = 27). Twenty-two (76%) patients had complete TNP, defined by the presence of all three features. Three patients died due to the initial subarachnoid hemorrhage, four patients had incomplete follow up, leaving 22 patients with mean follow up of 25 months. Overall, 11/22 (50%) patients had complete recovery first noted at a mean of 2.8 months (range 5 days-9 months), 10/22 (45%) had partial recovery and one had no improvement. Overall, combined partial and complete recovery of TNP was achieved in 21/22 (95%) patients. Functional recovery was satisfactory in 17/22 (77%) patients.

Conclusion
In patients with third nerve palsy secondary to PCOM or SCA artery aneurysms, coil embolization results in good clinical and functional recovery in most patients.

Key Words: Aneurysm, endovascular therapy, third nerve palsy

Paper 322 Starting at 10:47 AM, Ending at 10:55 AM
Endovascular Coiling of Ruptured Intracranial Aneurysms: Ten-Year Single Center Experience

Benes, V. 1,2 · Bradley, M. D. 2 · Renowden, S. A. 2 · Molyneux, A. J. 2
1Regional Hospital Liberec, Liberec, CZECH REPUBLIC, 2Frenchay Hospital, Bristol, UNITED KINGDOM

Purpose
The International Subarachnoid Aneurysm Trial (1) (ISAT) demonstrated that the rate of death and dependency at 1 year after endovascular treatment of ruptured intracranial aneurysm is superior to surgical clipping (23.5% versus 30.9%) and the advantage is maintained for at least 7 years (2). Results from a single center also can provide invaluable information regarding the rates and outcomes of procedural complications and rebleeding. Comparing institutional long-term clinical outcome to ISAT can help monitoring the center’s safety and efficacy. Here we present 10 years of experience from January 1996 to December 2005 at our institution.

Materials & Methods
During the 10-year period patients’ data, hemorrhage severity, aneurysm characteristics, procedural information including complications, immediate and long-term outcome were entered into a prospectively collected database and subsequently analyzed.

Results
A total of 780 aneurysms were treated in 711 patients who presented with subarachnoid hemorrhage from a ruptured intracranial aneurysm over this period. Endovascular coiling was not successful in treatment of 25 aneurysms (3%), 20 patients underwent surgical clipping, five patients, all poor surgical candidates, were treated conservatively. Procedural ruptures occurred in 37 cases (4.7%), six patients died, one became dependent, remaining ruptures were either asymptomatic or the patients made good recoveries. Thromboembolic complications occurred in 27 procedures (3.4%), four patients died and one became dependent, remaining events were either asymptomatic or transient and the patients made good recoveries. One patient died after basilar artery rupture, three patients became dependent or dead after accidental parent artery occlusion. Altogether 9.3% of procedures were complicated by the mentioned events. Rebleeding occurred in 16 patients (2.1%) of which 12 died. At 6-month follow up 130 patients (18.3%) were dependent or dead, 580 (81.6%) made excellent or good recovery, one patient was lost to clinical follow up. Angiographic follow up was available on 511 aneurysms, 121 (23.7%) recanalized. Retreatment for recurrence was necessary in 51 aneurysms (7.1%).

Conclusion
At our institution overall procedural morbidity-mortality of endovascular treatment accounts for death or dependency in 2% of patients. Approximately 5% of aneurysms rupture during coiling and 3-4% of procedures are complicated by a thromboembolic event; however most of these complications remain clinically silent. Rebleeding after therapy accounts for 1.7% mortality. One quarter of aneurysms is likely to be recanalized on follow up and 7% will require retreatment. Long-term clinical outcome of aneurysmal subarachnoid hemorrhage patients treated by coil embolization at our institution compares favorably with the high standard set by the ISAT study.

References

Key Words: Ruptured aneurysm, coiling, complication

Paper 323 Starting at 10:55 AM, Ending at 11:03 AM
Frequency of Thromboembolic Events Associated with Endovascular Aneurysm Treatment

Brooks, N. · Turk, A. S. · Niemann, D. · Aagaard-Kienitz, B. · Pulfer, K. · Strother, C.
University of Wisconsin Madison, WI

Purpose
There is little evidence addressing whether procedures requiring adjunctive devices lead to an increased frequency
of thromboembolic complications. We report our experience of 155 aneurysms treated with and without adjunctive devices.

**MATERIALS & METHODS**
We retrospectively reviewed our last 155 aneurysm coiling procedures. The patients’ records were reviewed for 1) evidence of procedural thrombus formation, 2) clinical evidence of stroke, and 3) the presence of acute ischemia in the treated vascular territory on diffusion-weighted imaging (DWI).

**RESULTS**
Of the 155 aneurysms treated in 132 patients, 66 were coiled, 45 had stent-assisted coiling, 33 underwent balloon remodeling (BR), and 11 had stent placed after BR. Small DWI abnormalities were present in the treated vascular territory in 24% of cases (n = 37). Specifically, 21 (32%) of 66 in the coil group, six (13%) of 45 in the stent-assisted coil group, eight (24%) of 33 in the BR group, and two (18%) of 11 in the balloon and stent group showed DWI positivity. Further, 68% (25 of 37) (p = 0.001) of the DWI positive cases occurred in patients presenting with subarachnoid hemorrhage (SAH). Clinically evident stroke or TIA was present in 10 of 37 (35%) cases that had DWI abnormality, with 70% of these patients presenting with SAH.

**CONCLUSION**
Utilization of adjunctive devices in treating aneurysms does not appear to increase the frequency of embolic or ischemic events. The presence of DWI abnormalities usually does not translate into a clinically evident deficit. The presence of DWI abnormalities and clinical stroke was actually less when adjunctive devices were utilized and in electively treated cases, likely related to perioperative antiplatelet medical management.

**KEY WORDS:** Aneurysm, thromboembolic, complication

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**Paper 324 Starting at 11:03 AM, Ending at 11:11 AM**

**Safety of Endovascular Intracranial Aneurysm Therapy Using Three-Dimensional Digital Subtraction Angiography: A Single Center Experience**

Loh, Y. · McArthur, D. L. · Tatoshima, S. · Jahan, R. · Duckwiler, G. R. · Vinuela, F.

University of California Los Angeles
Los Angeles, CA

**PURPOSE**
Three-dimensional digital subtraction angiography (3D DSA) assists the endovascular operator in case selection as well as planning, which may ultimately result in improved safety. We propose that the use of 3D DSA results in decreased procedural complications.

**MATERIALS & METHODS**
We retrospectively searched our database for all aneurysms that were treated at our institution since February 1999. We identified two cohorts- those treated before the installation of our 3D DSA and reconstruction software and those treated afterwards. We then compared the two groups with regards to rates of immediate procedural complications. We further stratified aneurysms by number, size, and neck dimension and performed subgroup analyses.

**RESULTS**
There were 579 patients treated before and 641 after the implementation of 3D DSA. The complication rate in the pre-3D group was 6.6% and 3.0% in the post-3D group (odds ratio 0.44). Complication rates were decreased for patients with single but not multiple aneurysms. Complication rates also were decreased in the subgroups with small and large but not medium-sized aneurysms, and those with wide but not narrow necks. However, these other subgroups all trended towards improved safety with 3D DSA. Post-hoc analysis demonstrated no safety improvement within chronological subgroups of the pre-3D or post-3D cohorts, suggesting that the improved safety profile after 3D DSA implementation is not merely a temporal epiphenomenon.

**CONCLUSION**
3D DSA implemented during endovascular therapy for intracranial aneurysms improves the safety of the procedure. This may be a result of either improved aneurysm analysis and thus case selection, improved working position selection, or both.

**KEY WORDS:** Digital subtraction angiography, safety, aneurysm

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**Paper 325 Starting at 11:11 AM, Ending at 11:19 AM**

**Flow Divertors as Monotherapy for Cerebral Aneurysms: In vivo Results at 6 Months Posttreatment**

Wakhloo, A. K. · Lieber, B. B. · Sadasivan, C. · Cesar, L. · Seong, J.

1University of Massachusetts Medical School, Worcester, MA; 2University of Miami, Miami, FL

**PURPOSE**
Sufficient clinical and in vivo evidence has been accumulated to suggest that cerebral aneurysms can be treated successfully solely by the deployment of a flow diverter across the aneurysm neck. Following a series of in vitro experimentation that provided detailed information about the local hemodynamics in an aneurysm model, three flow diverter designs were investigated in a large cohort of elastase-induced saccular aneurysm models in the rabbit.

**MATERIALS & METHODS**
Aneurysms were created at the root of the right common carotid artery in rabbits after incubating porcine pancreatic elastase with balloon protection. After allowing 21 days for the aneurysms to mature, the devices were implanted. For each of the three device designs, 10 animals were implanted and angiographic follow up was performed at 21 days (n = 3), 90 days (n = 3) and 180 days (n = 4) following implantation. Another group of 10 animals having aneurysms, but no implanted devices, served as a control. At each follow-up point, the animals were killed; and the aneurysm and parent vessel were harvested for histologic analysis. Devices were maneuvered into the innominate artery of the rabbit via a right transfemoral approach and launched with the goal of maintaining equal landing zones on either side of the
aneurysm, while also covering the vertebral artery. In order to quantify treatment efficacy, high-speed angiography was acquired under identical injection and acquisition parameters before and immediately after device deployment, and at follow-up. By delineating the aneurysm as a region of interest, an aneurysmal washout curve was generated, which then was mathematically modeled. The optimized model parameters served as estimators of treatment efficacy. Preliminary histologic results were obtained to verify degree of aneurysm occlusion as observed on angiography and evaluate tissue response to the endoluminal prosthesis.

RESULTS
Depending on the device design, angiographic results up to 6 months posttreatment showed that the aneurysm can be excluded successfully from the circulation. Specifically, results thus far suggest that the finer porosity device performed the best (100% angiographic occlusion at 6 months). With this device, angiographic follow up at 6 months also showed a patent parent artery with no angiographic evidence of device thrombosis or significant inflammatory vascular response. The vertebral artery, which was covered to simulate potential involvement of cerebral perforators adjacent to cerebral aneurysms, remained patent at 6 months with all three devices. Very preliminary histologic and SEM results obtained at 3 weeks showed neointimal coverage of the inner surface of the device with smooth lining of endothelial cells.

CONCLUSION
The results obtained in the rabbit elastase-induced aneurysm model demonstrate the feasibility of curing cerebral aneurysms with a device that redirects flow away from the aneurysm and providing a scaffold over which the parent vessel may remodel. By a judicious selection of design parameters, flow divertors may be used successfully as monotherapy for cerebral aneurysms.

KEY WORDS: Aneurysm, hemodynamics, device

Paper 326 Starting at 11:19 AM, Ending at 11:27 AM
Risk of Symptomatic Retinal Ischemia following Endovascular Treatment of Ophthalmic Carotid Aneurysms

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Centre Hospitalier de l’Université de Montréal
Montreal, PQ, CANADA

PURPOSE
To determine the risk of symptomatic thromboembolic complications of the central retinal artery following endovascular treatment of ophthalmic carotid aneurysms.

MATERIALS & METHODS
This was a retrospective cohort study conducted in a single medical center. All angiographic exams were reviewed to evaluate the size and anatomical localization of ophthalmic carotid aneurysms according to Day’s classification. The medical records were reviewed to determine treatment(s) offered, immediate result, procedure-related ischemic complications and clinical evolution.

RESULTS
A total of 148 patients with 160 aneurysms in the carotid ophthalmic segment were treated by endovascular route between 1992-2005. Forty-five patients (30%) presented with SAH. Twenty-three (23/103, 22%) patients with unruptured aneurysms presented with compressive optic neuropathy, whereas 78% were asymptomatic. Aneurysms were treated initially by coiling only (n = 142, 89%), carotid occlusion (n = 6), Onyx (n = 6), combined coiling and carotid artery occlusion (n = 6). Two patients with paracnoidal ophthalmic aneurysms suffered visual loss from thromboembolic complication and treated with intraarterial thrombolysis. Nonvisual symptomatic thromboembolic complications were present in three patients. The relative risk of a nonretinal compared to retinal ischemic event was 1.5.

CONCLUSION
Despite the proximity of the ophthalmic artery, endovascular treatment of ophthalmic carotid aneurysms carries a relatively low probability of retinal ischemic complications, comparable to ischemic events in other vascular territories.

KEY WORDS: Ophthalmic carotid, aneurysm, retinal ischemia

Paper 327 Starting at 11:27 AM, Ending at 11:35 AM
Endovascular Treatment of Distal Anterior Cerebral Artery Aneurysms: Midterm Follow Up of 56 Aneurysms in 53 Patients

Chu de Nancy
Nancy, FRANCE

PURPOSE
Starting October 1992 until October 2001, 940 patients harboring 1120 aneurysms were evaluated for endovascular treatment.

MATERIALS & METHODS
Fifty-six distal anterior cerebral artery aneurysms (DACAAs), that is 5%, were observed in 53 patients. Forty aneurysms were ruptured (71.5%) and 16 nonruptured (28.5%). Ninty-three percent had a diameter smaller than 10 mm. Twenty-five patients (47.2%) presented with multiple aneurysms. Patients were followed up clinically and by angio-MRI or angiography at 6 months, 1 year, 3 years and 5 years after the intervention. Forty-nine aneurysms (87.5%) were treated. Satisfactory occlusion was achieved in 40 cases (81.7%) (total occlusion in 9 cases and subtotal in 31 cases), and partial occlusion in nine cases (18.3%). During follow up, there was one minor repermeabilization (2.2%) and 13 cases of major repermeabilizations (26.5%), of whom 12 occurred during the first year posttreatment. Ten additional treatments (20.4%) were necessary (2 surgical and 8 endovascular). One patient died during the initial phase because of rebleeding. Of 46 patients, 45 were followed at 6 months, 42 at 1 year, 37 at 3 years and 27 at 5 years with a mean follow up of 3.8 years. There was no rebleeding during this period.
**Results**
Distal anterior cerebral artery aneurysms (DACAA) are rare, small, often associated with other aneurysms.

**Conclusion**
Endovascular treatment is not associated with more technical difficulties or complications in this localization. Endovascular treatment is efficient regarding rebleeding prevention but there is a high repermeabilization rate justifying more frequent retreatment.

**Key Words:** Aneurysms, endovascular

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**Paper 328 Starting at 11:35 AM, Ending at 11:43 AM**

**Factors Associated with Wall Enhancement and Edema after Endovascular Coiling of Cerebral Aneurysms**

Fanning, N. F. · Willinsky, R. A. · terBrugge, K. G.
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Toronto, ON, CANADA

**Purpose**
Symptomatic peri-aneurysmal inflammatory changes have been reported following endovascular treatment of cerebral aneurysms (1). Our aim was to evaluate the frequency and determinants of asymptomatic wall enhancement and peri-aneurysmal edema after endovascular coiling of intradural cerebral aneurysms.

**Materials & Methods**
We retrospectively reviewed 235 gadolinium-enhanced MR studies performed during follow up of 130 coiled cerebral aneurysms in 124 patients. Seventy-two (55%) aneurysms were treated with bare platinum coils, 35 (27%) with Matrix coils and 23 (18%) with HydroCoils. Wall enhancement was defined as a complete enhancing ring around the coiled aneurysm on gadolinium T1-weighted images and edema as the presence of peri-aneurysmal FLAIR hyperintensity. Images were assessed by two neuroradiologists blinded to clinical and treatment data. Median follow up from time of treatment to final MR imaging was 11.9 months. Wall enhancement and edema were correlated with clinical presentation, coil type, aneurysm size, packing density, extent of initial aneurysm occlusion and MR imaging follow-up interval.

**Results**
Wall enhancement was seen in 30% (38/130) and edema in 12% (15/130) of coiled aneurysms. Wall enhancement and edema were correlated with coil type (r = 0.43 and r = 0.51 respectively, P < 0.01), larger aneurysm size (r = 0.37 and r = 0.40 respectively, P < 0.01) and greater percentage packing density (r = 0.31, and 0.42 respectively, P < 0.01). Wall enhancement was significantly more frequent with HydroCoil treated aneurysms (16/23, 68%, P < 0.001) compared to bare platinum (12/72, 17%) and Matrix (10/35, 29%) coils. Interval follow up was available in 32/38 (84%) aneurysms with wall enhancement (median interval 6.0 months). Wall enhancement remained stable in 19 (59%) aneurysms, resolved or improved in nine (28%) aneurysms and increased in four (13%) aneurysms. Peri-aneurysmal edema was also more frequent in HydroCoil treated aneurysms (12/23, 52%, P < 0.001), being found in only one patient with bare platinum (1/72, 1.4%) and two patients with matrix (2/35, 5.7%) treated aneurysms. Interval follow up was available in 13 of 15 (87%) aneurysms with peri-aneurysmal edema (median interval 8.3 months). The edema resolved or improved in 10 aneurysms (77%), remained stable in two (15%) aneurysms, and increased in one (8%) aneurysm.

**Conclusion**
Asymptomatic wall enhancement and edema can be seen after coiling with bare platinum, Matrix and HydroCoils. It is significantly more frequent with HydroCoil treatment, and in aneurysms that are larger and well packed. The significance of wall enhancement and edema in terms of efficacy of treatment is not yet determined.

**References**

**Key Words:** Wall enhancement, edema, endovascular coiling

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**Paper 329 Starting at 11:43 AM, Ending at 11:51 AM**

**Outcomes of Ruptured Intracranial Aneurysms Treated by Microsurgical Clipping and Endovascular Coiling in a High Volume Center**

Natarajan, S. K. · Sekhar, L. N. · Britz, G. W. · Ghodke, B. · Temkin, N.
University of Washington
Seattle, WA

**Purpose**
To analyze the outcomes of patients with intracranial aneurysms with SAH, in a consecutive series of patients managed from January 2005 to June 2006.

**Materials & Methods**
A retrospective review was performed of the records of 195 patients (204 aneurysms) with ruptured intracranial aneurysms. Three patients were excluded from analysis as they died before they were selected for clipping or coiling. Only patients with ruptured anterior communicating artery (ACOM) aneurysms (n = 72) had sufficient numbers for a subgroup analysis. The admission grade and the outcome of patients in our study was compared to that of the patients in the ISAT study.

**Results**
The outcomes in our patients at 3 months in our group was comparable to the 1 year outcomes of patients in the ISAT study, despite the fact that the admission grades in our patients were worse than the patients in the ISAT study. Only 30% of patients with aneurysmal SAH were dead or disabled (Rankin score 3-5). Even patients with bad grades of Hunt & Hess and Rankin scores at admission have a 30% chance of having functional recovery. There were 105 (55%) patients who had microsurgical clipping and 87 (45%) patients who had endovascular coiling. The pretreatment variables were
comparable in these groups, except the admission Rankin, Hunt and Hess, WFNS and Fisher grades which were worse in the coiling group. The predictors for 3-month Rankin scores in patients with ruptured intracranial aneurysms were admission Rankin scores ($p = 0.024$) and presence of intracerebral hemorrhage ($p = 0.019$) in the overall group; and Co morbidity ($p = 0.028$), admission Hunt and Hess ($p = 0.054$), Fisher ($p = 0.005$) score in patients with ruptured ACOM aneurysms. The ICU stay (16 vs 13 days) ($p = 0.032$), the incidence of TCD diagnosed vasospasm (66% vs 52%) ($p = 0.026$) and the number of patients sent for rehabilitation (35% vs 23%) ($p = 0.034$) were significantly more in patients who were clipped. There was a higher failure rate in the coiled patients (10% vs 2%). The mortality at 3 months is significantly higher in the endovascular group even after controlling for the differences in the pretreatment variables (21% vs 9%) ($p = 0.008$). There is no difference in the outcomes as measured by 3-month Rankin scores between the clipped and the coiled group in patients with SAH ($p = 0.632$). Patients with ruptured ACOM aneurysms tend to have better outcomes as measured by 3-month Rankin scores in the microsurgical group (average score: 2.74 vs 1.58) ($p = 0.056$) when compared to the endovascular group by multivariate analysis.

**CONCLUSION**

Our overall treatment outcomes are better than the ISAT study. In our study, there was no difference in the outcomes as measured by 3-month Rankin scores between the clipped and the coiled group in patients with SAH. Patients with ruptured ACOM aneurysms tend to have better outcomes as in the microsurgical group.

**KEY WORDS:** Intracranial Aneurysms Outcomes, Intervention, Microsurgery

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**Thursday Morning**

**10:15 AM – 12:00 PM**

**Columbus I-L**

(52b) INTERVENTIONAL: New Devices and Equipment

(Scientific Papers 330 – 341)

See also Parallel Sessions

(52a) INTERVENTIONAL: Aneurysms II

(52c) ADULT BRAIN: Cerebrovascular Occlusive Disease II and Epilepsy

(52d) TRAUMA: Head and Spine

**Moderators:** Robert W. Tarr, MD

Philippe E. Gailloud, MD

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**Paper 330 Starting at 10:15 AM, Ending at 10:23 AM**

**Proximal versus Distal Embolic Protection Devices: Frequency of Peri-Procedural Embolism Related to Carotid Stenting**

El-Koussy, M. M. R. · Schroth, G. · Do, D. · von Bredow, F. · Gralla, J. · Remonda, L. · Brekenfeld, C.

University Hospital Bern

Berne, SWITZERLAND

**PURPOSE**

Stroke after carotid stenting is either due to peri-procedural embolism or hyperperfusion injury, the latter being more common. Previous reports suggested the efficacy of embolic protection in the setting of carotid stenting. This study aims at comparing the frequency of embolism related to carotid stenting protected with proximal versus distal embolic protection devices (EPD) assessed by diffusion-weighted MR imaging (DWI).

**MATERIALS & METHODS**

We analyzed 61 cases that underwent protected carotid stenting with DWI before and after the intervention over a period of 3 years (October 2003 - October 2006). In 31 cases a proximal protection device (Group I) and in 30 cases a distal filter device (Group II) was used.

**RESULTS**

There was no statistically significant difference between both groups as evaluated by Mann-Whitney test, with embolism occurring in nearly one third of cases protected by either method. The use of proximal protection was advantageous in two cases complicated with in-stent thrombosis.

**CONCLUSION**

There is no significant difference in the “protective value” of both EPD devices. Furthermore, based on our experience proximal EPD can be useful to control and treat acute in stent thrombosis.

**KEY WORDS:** Carotid stenting, embolic protection, diffusion-weighted MR imaging

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**Paper 331 Starting at 10:23 AM, Ending at 10:31 AM**

**Long-Term Outcomes in Stenting of Intracranial Atherosclerosis in Small Distal Cerebral Vessels**

Turk, A. S. · Ahmed, A. · Aagaard-Kienitz, B. · Niemann, D. · Pulfer, K. · Strother, C.

University of Wisconsin

Madison, WI

**PURPOSE**

Intracranial atherosclerosis (ICAD) accounts for up to 10% of the 700,000 strokes that occur each year. Newer, sophisticated endovascular devices now allow treatment of distal cerebral vessels that were previously inaccessible. There are no reports in the literature addressing stent placement in small distal cerebral vessels. We report the first known series of endovascular stents placed in distal small (< 2 mm) vessels for treatment of medically refractory ICAD with long-term clinical and angiographic follow up.
Materials & Methods
Four patients, age 33 to 80 years old (mean = 60 years) with medically refractory ICAD underwent endovascular angioplasty and stenting of small (< 2 mm) distal intracerebral vessels. All patients received Plavix 75 mg and Aspirin 325 mg daily at least 5 days prior and 3 months after treatment with Aspirin continued indefinitely. Vessel location and length of follow up were ACA A1 (3 months), ACA A2 (18 months), MCA M1 (18 months), and PCA P1 (8 months) segments with vessel calibers ranging from 1.1 to 1.9 mm. Newer self-expanding stents were used in all cases after angioplasty with either a 1.5 mm balloon or serial microcatheter dilation. Clinical follow up ranged from 3 to 18 months. Imaging follow up was performed with CTA or DSA.

Results
All procedures were performed successfully without immediate or delayed complication. Follow up out to 18 months demonstrate durable clinical and angiographic results with patent stented portion of the vessels. One patient died 8 months after stenting, not related to neurologic disease. The remaining patients experienced resolution of the presenting symptomatology and have remained asymptomatic throughout follow up.

Conclusion
Stenoses of distal (< 2 mm) cerebral vessels are amenable to treatment using newer self-expanding stent technology. Longer term clinical follow up is required to determine the durability and viability of this therapy. Further follow up and more experience is necessary to further determine long-term results and we will update our information as data become available.

Key Words: Stent, stenosis, outcomes

Paper 332 Starting at 10:31 AM, Ending at 10:39 AM
Initial Experience of Wingspan Stent for the Treatment of Intracranial Atherosclerotic Stenoses

Lee, D. · Morsi, H. · Diaz, O. · Arat, A. · Mawad, M. E.
Baylor College of Medicine
Houston, TX

Purpose
A self-expandable nitinol stent (Wingspan stent) was introduced for the treatment of intracranial stenoses. By virtue of its peculiar design and deploy mechanism, good trackability and facilitated safety and efficacy are expected. The purpose of this study is to present our initial experience with the Wingspan stent for the treatment of atherosclerotic stenoses of the cerebral arteries.

Materials & Methods
A total of 32 patients (mean age: 66.7 years, 13 men and 19 women) with atherosclerotic stenoses of various anatomical sites (9 ICA, 7 MCA, 3 ACA, 1 PCA, 4 VA, and 8 BA) were treated with Wingspan stent (Boston Scientific) from November 2005 to December 2006. Inclusion criteria was symptomatic high-grade stenosis (> 50%). Parent artery mean diameter of target lesion was 2.9 mm (range, 2.1-3.2). The diameters of balloon catheters and stents were 2-3.5 mm and 2.5-4.5 mm, respectively. Treatment result was evaluated in terms of technical success rate, intraprocedural event, and clinical course. Neurologic morbidity (TIA and stroke) and mortality rates were obtained. Arterial patency was evaluated with the 6-month follow-up angiogram. Restenosis over 50% was regarded as significant.

Results
Delivery of the stent-deploy system following balloon angioplasty was successful in all cases. During the procedure, flow-limiting vasospasm or dissection after balloon angioplasty (n = 3), misplacement of the stent (n = 3, placement of another stent in 2), and acute in-stent thrombosis requiring parenteral antiplatelet treatment (n = 1) occurred. The initial stenosis before the procedure (72%) was improved after balloon angioplasty (39%) and after subsequent stent placement (19%). Neurologic morbidity rate was 18.8% (TIA in two, minor stroke or symptom aggravation in three, and major stroke in one). There were two deaths, one from progression of the major infarction and the other from aspiration pneumonia. Significant restenosis was noted in four (45%) of the nine patients who underwent follow-up angiogram (Fig).

Conclusion
Wingspan stents could be delivered to the target lesions without difficulty. However, the system showed technical problems such as misplacement. Restenosis seemed not infrequent on our limited follow-up observations.

Key Words: Intracranial stent, intracranial stenosis, Wingspan

Paper 333 Starting at 10:39 AM, Ending at 10:47 AM
Incidence of In-Stent Stenosis of Neuroform Stents: Experience with 81 Stents in 69 Patients

Nasseri, F. · Klucznik, R. · Ebrahimi, N. · Meyer, D. · Benndorf, G.
1The Methodist Hospital, Houston, TX, 2University of Houston, Houston, TX

Purpose
The Neuroform stent is the first microcatheter-delivered stent designed specifically for the treatment of cerebral aneurysm. There are conflicting data regarding the incidence of in-stent stenosis of the Neuroform stent and publications on angiographic follow up of the Neuroform stents are limited. We report incidence of in-stent stenosis in our patients...
treated with Neuroform stents with 6-36 months of angiographic follow up.

**Materials & Methods**
The neurointerventional data base of our institution was reviewed retrospectively to identify cases of in-stent stenosis observed during the follow up of cerebral aneurysm treated with Neuroform stent. Sixty-nine patients were treated with 81 Neuroform stents from 2003 - 2006. Forty-eight of 81 (59%) stents have had at least 6 months follow up. Out of these, eight patients have had at least 24 months follow up. Those patients with a minimum of 6 month post-stent angiogram were included in the study.

**Results**
Forty-eight stents were studied in 44 patients, 39 females and 5 males. The mean age of patients was 60.7 years (range: 44-78 years). Thirty-nine of 48 aneurysms were unruptured and nine were ruptured. The locations of stent deployment were: ICA: 30, BA - P1: 8, A1 - A2: 6, BA: 3 and VA - PICA: 1. The mean follow up for these stents was 9.9 months (range: 6-36 months). Four (8.3%) stents with in-stent stenosis were found. The mean degree of in-stent stenosis was 30.2 (range: 19-47%). None of the patients with stenoses was symptomatic.

**Conclusion**
Despite its relatively low incidence (8.3%), in-stent stenoses in patients treated with NF are serious complications and need regular angiographic and clinical follow ups. More long-term, prospective data are required in order to reveal the natural course and the clinical impact of this complication.

**Key Words:** Stent

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**Paper 334 Starting at 10:47 AM, Ending at 10:55 AM**

**Intravascular Imaging of the Carotid Artery Using a Combined Stent and Imaging Catheter in a Porcine Model**

Heidenreich, J. O. · Derakhshian, J. J. · Paul, S. · Nour, S. G. · Rippe, M. J. · Griswold, M. A. · Duerk, J. L. · Sunshine, J. L.

Case Western Reserve University
Cleveland, OH

**Purpose**
MR-guided catheterization of the carotids and stent placement has been reported. High-resolution intravascular MR imaging has been demonstrated in the abdominal aorta of pigs. Combining imaging and treatment properties in one endovascular device may reduce procedure times and increase procedure safety. Therefore we built a prototype stent and imaging catheter to combine these properties. The aim of this study is to determine feasibility of MR-guided catheterization of carotids with a stent and imaging catheter; to assess MR sequences for intravascular imaging of vessel walls; and to image within the deployed stent.

**Materials & Methods**
All examinations were approved by the IACUC. Standard 7 French (Fr) stent catheters (Bard, Karlsruhe, FRG) were modified adding solenoid coils resulting in 12-14 Fr outer diameter. Stent catheters were introduced into the carotid arteries of six pigs using a guidewire (Somatex, Teltow, Germany). For catheter guidance, a real-time catheter tracking sequence (TrueFISP Interactive Real-Time Tip Tracking) was adapted to the 1.5 T MRI unit (Magnetom Espree, Siemens, Erlangen, FRG). Catheter position was verified by intraarterial injections of contrast during near-real-time imaging. High-resolution images of arteries and tissue were acquired before stent placement. The protocol included small field-of-view TrueFISP, HASTE, spin echo-EPI, segmented EPI, SE and TSE sequences with in-plane resolution of 300 µm and 3 mm slice thickness. After stent deployment, we introduced a 5 Fr MR imaging catheter (MR Eye, I3, Cleveland, OH) into the stent and acquired images via the same protocol. All vessels were harvested for pathology.

**Results**
Successful carotid artery access was obtained in all six animals under MR guidance. High-resolution vessel wall images were acquired and all sequences allowed differentiation of the vessel wall from other tissue. On T2-TSE, T2-SE and T1-SE sequences multiple vessel wall layers could be distinguished. With an acquisition time of 11s/slice TrueFISP sequences showed two different wall layers and allowed clear vessel/tissue differentiation. Stent deployment was feasible under MR guidance. Due to catheter size, we were unable to reintroduce the catheter into the stent lumen. However, we successfully guided a smaller catheter into the stent and acquired images from within the stent. There, we could delineate lumen, catheter tip, stent mesh and surrounding tissue.

**Conclusion**
This study shows feasibility of carotid artery access with an imaging and stenting catheter entirely under MR guidance. It allowed acquisition of high-resolution vessel wall images. With the 12 Fr catheter size, medium-sized vessels can be catheterized without damaging the wall as documented on gross pathology. Although failing to reintroduce the device into the stent, we managed to acquire images from within the stent using the same type of catheter, provided it has an appropriate diameter. The capability to image within a stent and the opportunity to differentiate lumen from stent and surrounding tissue has not, to our knowledge, been reported and may have a tremendous impact upon the understanding of posttreatment course in patients with atherosclerotic disease. Follow-up examinations will help to evaluate the stent behavior of vascular structures.

**Key Words:** Intervventional MR imaging, intravascular MR imaging, carotid stenting
Use of Drug-Eluting, Balloon-Expandable Stents for the Treatment of the Vertebral Artery Ostial Stenoses: A Single Center Experience

Lee, D. · Morsi, H. · Diaz, O. · Arat, A. · Mawad, M. E.
Baylor College of Medicine
Houston, TX

Purpose
Atherosclerotic stenosis of the vertebral artery ostium is not uncommon and often refractory to the conventional balloon angioplasty and/or stenting. The purpose of this study is to evaluate our early experience of using drug-eluting, balloon-expandable stents for those lesions in terms of technical feasibility and short-term clinical and angiographic follow-up results.

Materials & Methods
From May 2005 to August 2006, a total of 11 lesions in 11 patients (6 men, average age of 70 years, range 58 to 86) were undergoing stenting of the ostial lesion using drug-eluting stents (9 Cypher; Cordis, 2 Taxus; Boston Scientific). The indication of stenting was bilateral or single vertebral artery lesions with significant stenosis (> 50% by NASCET method), which were refractory to conventional antithrombotic treatment or already symptomatic. The procedure was performed under more than 5 days of dual antiplatelets use. Technical and angiographic results were analyzed together with 6-month clinical and angiographic results. Significant restenosis was defined as > 50% diameter narrowing.

Results
Initial stenosis was 74% (range, 64–90%). The stenting procedure was successful in all patients without procedure-related complication. A case of acute in-stent thrombosis was managed successfully with use of intravenous abciximab. The size of stents used was 3–3.5 mm in diameter and 8–13 mm in length. Pre and poststenting balloon dilatations were required in two cases, respectively. The stenosis was improved after stenting with a residual stenosis of 10% (range, 0–27%). The residual stenosis was mainly due to larger reference artery diameter than the available stent diameter in two cases and tight stenosis especially at the most proximal portion of the ostium in five cases. Angiographic follow up was performed in five patients. All the patients were stable after the procedure and on clinical 6-month follow up even in the patient with angiographic restenosis (53%) (Fig 1) and in the patient with breakage of the stent body (Fig 2).

Conclusion
Use of drug-eluting, balloon-expandable stents for the vertebral artery ostial stenoses was feasible and effective. However, size limitation of the currently available stent diameter and frequent residual stenosis at the most proximal portion remained as technical barriers. The stent could not prevent in-stent restenosis. Breakage of the stent body might be a specific problem in the vertebral artery ostial lesions.

Key Words: Vertebral artery stenosis, drug-eluting stent

Evolution of Neuroform (1, 2, 2 Treo and 3): Ease of Stent Deployment, Procedural Stent Movement, Frequency of In-Stent Stenosis and Complication Rate

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Purpose
Since its introduction in 2003, Neuroform (Boston Scientific) has revolutionized the treatment of wide-neck aneurysms, not only by preventing coil prolapse into the parent artery, but also by changing the flow dynamics within the aneurysm lumen. We assessed the ease of stent deployment, procedural stent movement, the frequency of in-stent stenosis and the complication rate, comparing Neuroform 1, Neuroform 2, Neuroform 2 Trio, and Neuroform 3.

Materials & Methods
This is a single-center, nonrandomized, retrospective study with 80 consecutive patients (17 male and 63 female), 119 stent deployment attempts and 91 successful deployments. We retrospectively reviewed medical charts, radiographic images and procedure notes in search of deployment success rates, procedural stent movement, frequency of in-stent stenosis and the overall complication rate of the procedure.

Results
The mean age of the 80 patients in our cohort was 52 years (range, 25–78). One hundred nineteen stent deployment attempts were made with an overall deployment success rate of 76% [Neuroform 1-88% (12% primarily), Neuroform 2-78% (57% primarily), Neuroform 2 Treo-57% (43% primarily) and Neuroform 3-79% (73% primarily)]. The patients were followed routinely for aneurysm recurrence and in-stent stenosis. Fifty-three patients had follow-up angiography with a mean time interval of 16 months (range, 1-40 months). Ninety-one percent of our patients showed no in-stent stenosis. Stent movement during the follow-up (aneurysm coiling) procedure occurred in 5% of patients. Procedural stent movement occurred in 5% as well. The overall complication rate was 16% (CCF, SAH, IPH, stretched coils, clot and vascular sacrifice).

Conclusion
Neuroform has made significant evolutionary progress since its introduction in 2003, not only in terms of ease of use/deployment, but also in terms of the overall procedural complication rate. In our study we successfully navigated and deployed the Neuroform stent in 76% of patients. The ease of navigation and deployment improved as the neuro-
form system evolved. Our overall complication rate was 16% (NF1-13%, NF2-11%, NF2Treo-29% and NF3-3%). The complication rate decreased as the neuroform stent system evolved as well, except for the NF2Treo.

**KEY WORDS:** Neuroform stent, in-stent stenosis

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**Paper 337 Starting at 11:11 AM, Ending at 11:19 AM**

Reperfusion Syndrome after Carotid Stent Angioplasty

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**PURPOSE**

This study assesses the incidence and significance of hyperperfusion syndrome (HS) occurring after CAS.

**MATERIALS & METHODS**

We retrospectively reviewed the prospective database of 396 consecutive patients who were treated with CAS in our department to identify patients who developed hyperperfusion syndrome and/or ICH. MR imaging including perfusion and diffusion-weighted imaging was acquired before and after CAS in 340 cases.

**RESULTS**

Of the 340 carotid arteries that were stented and received MR imaging we found a hyperperfusion syndrome in 2.64% (9 cases). In two of these nine cases an intracerebral hemorrhage occurred. The mean preoperative stenosis was 95% in these patients. Two hemorrhages occurred shortly (8 and 10 hours) after stent placement with sudden onset of massive neurologic dysfunction (hemiparesis, disturbance of consciousness). CT detected a bleeding in the central region in the first, and a massive hemorrhage in the second patient. This hemorrhage was fatal. Seven patients presented with slight headache, but without neurologic deficits. A signal increase in the subarachnoid space belonging to the side of the stented carotid artery could be detected in FLAIR images, but CT was normal.

**CONCLUSION**

HS seems to occur more frequently than previously described as patients may be neurologically asymptomatic.

**KEY WORDS:** Carotid, hyperperfusion, stent

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**Paper 338 Starting at 11:19 AM, Ending at 11:27 AM**

Use of the Duett Femoral Arteriotomy Closure Device in Neuroendovascular Procedures

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University of Wisconsin Madison, WI

**PURPOSE**

The increasing availability and utilization of various anticoagulation medications for interventional procedures potentially raises the risk of femoral artery access-site complications. Therefore, arterial puncture closure devices have grown in popularity in order to assist in the achievement of arteriotomy hemostasis. The use of such closure devices has been well documented in cardiology but has had limited reporting in the neurointerventional field. Here we report on our use of the Duett femoral arteriotomy closure device in neuroendovascular procedures.

**MATERIALS & METHODS**

Medical records were reviewed retrospectively for 418 consecutive patients undergoing neuroendovascular procedures over a period of 2.5 years. The utilization of Duett closure was recorded as well as any device-related complications or failures.

**RESULTS**

There were 807 procedures in total. Of that total, 566 (72.0%) cases utilized the Duett closure device while 220 (28.0%) received manual compression alone. There were 97 patients that underwent Duett closure more than once. Of the 566 procedures, 191 (33.7%) were diagnostic and 375 (66.3%) were interventional. The Duett closure device was technically successful in 99.12% of cases. The complication rate associated with Duett deployment was eight out of 566 (1.41%).

**CONCLUSION**

The Duett closure device is a safe and effective means of achieving hemostasis at groin access sites after neuroendovascular procedures.

**KEY WORDS:** Interventional, arteriotomy closure, device

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**Paper 339 Starting at 11:27 AM, Ending at 11:35 AM**

Qualitative Comparison of Intraaneurysmal Flow Structures Determined from Conventional and Virtual Angiograms

Putman, C. M. · Radaelli, A. · Frangi, A. · Cebral, J. R.

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**PURPOSE**

The purpose of this study was to qualitatively compare the flow structures observed in cerebral aneurysms using high frame rate biplane angiography and simulated or virtual angiograms produced from patient-specific computational fluid dynamics (CFD) models constructed from 3D rotational angiography images.

**METHODS**

High frame rate biplane angiograms were obtained during a rapid injection of contrast agent in three patients with intracranial aneurysms. These dynamic images show the filling pattern of the aneurysms and depict the main intraaneurysmal flow structures such as the inflow jet, the major vortex structures and the outflow zones. Patient-specific computational fluid dynamics models were constructed from 3D rotational angiography images of each aneurysm. Time dependent flow fields were obtained from the numerical solution of the incompressible Navier-Stokes equations.
under pulsatile flow conditions derived from phase-contrast magnetic resonance measurements performed on normal subjects. These flow fields were subsequently used to simulate the transport of a contrast agent by solving the advection-diffusion equation. Both the fluid and transport equations were solved with an implicit finite element formulation on unstructured grids. Virtual angiograms were then constructed by volume rendering of the simulated dye concentration field. The flow structures observed in the conventional and virtual angiograms were then qualitatively compared.

RESULTS
The finite element models showed distinct flow types for each aneurysm, ranging from simple to complex. The virtual angiograms showed good agreement with the images from the conventional angiograms for all three aneurysms. Analogous size and orientation of the inflow jet, regions of flow impaction, and flow types were observed in both the conventional and virtual angiograms (see Figure 2). The size, location and sense of rotation of the major intraaneurysmal vortices and regions of outflow also corresponded between the actual and simulated angiographic images. The agreement between the computational models and the angiographic structures is less for slower zones of recirculation later in the washout phase.

CONCLUSIONS
Patient-specific image-based computational models of intracranial aneurysms constructed from 3D rotational angiography can realistically reproduce the major intraaneurysmal flow structures observed with conventional angiography.

KEY WORDS: Aneurysm, fluid dynamics, angiography

Paper 340 Starting at 11:35 AM, Ending at 11:43 AM

Hemodynamics before and after Bleb Formation in Cerebral Aneurysms

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PURPOSE
The purpose of this study was to investigate whether blebs in cerebral aneurysms form in regions of low or high wall shear stress, and how the intraaneurysmal hemodynamic pattern changes once the bleb is formed.

METHODS
Seven patients with intracranial aneurysms harboring well defined blebs were selected from our database. Subject-specific computational models were constructed from 3D rotational angiography images using deformable models. For each patient, a second anatomical model was constructed by manually removing the bleb. This second model represents the aneurysm before the formation of the bleb, while the first model represents the aneurysm after bleb formation. Computational fluid dynamics simulations were performed under pulsatile flow conditions for both models of each aneurysm. The numerical solutions of the incompressible Navier-Stokes equations were obtained using an implicit finite element formulation on unstructured grids. The physiological flow conditions were derived from PC-MRA measurements of flow rates in cerebral arteries of normal subjects. Visualizations of the intraaneurysmal flow pattern and wall shear stress distribution were obtained for each aneurysm before and after bleb formation.

RESULTS
It was found that in six of the seven aneurysms, the blebs formed in a region of elevated wall shear stress associated to the flow impaction zone of the inflow jet. However, the blebs did not necessarily form in the point of maximal wall shear stress, in some cases they formed in a region adjacent to the primary flow impaction zone. In one case, the bleb formed in a region of low wall shear stress associated with the outflow zone. It was observed that in this case, the inflow jet maintained a fairly coherent and concentrated structure all the way to the outflow zone, while in the other six aneurysms the flow jet disperses after the primary impaction against the aneurysm wall. In all the aneurysms, once the blebs formed, new flow recirculation regions were formed inside the blebs and the blebs progressed to a state of low wall shear stress.

CONCLUSION
Blebs form in regions associated with inflow jet impaction and elevated wall shear stress. Elevated wall shear stress may be responsible for localized injury of the vessel wall leading to morphological changes in an aneurysm and potentially aneurismal rupture. Mean wall shear stress before (top left) and after (bottom left) bleb formation, and intraaneurysmal flow pattern before (top right) and after (bottom right) bleb formation. The arrows indicate the location of the blebs.

KEY WORDS: Aneurysm, fluid dynamics, blebs
Cortoplasty- Treatment of Osteoporotic VCF with Cortoss: Preliminary Biomechanical Considerations from the First Prospective, Randomized Clinical Trial at a Single Institution

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PURPOSE
This study assesses the safety and efficacy of the Cortoplasty technique for treatment of vertebral compression fractures (VCF) as compared to commercially available PMMA. Cortoplasty is a Percutaneous Vertebroplasty Procedure in which Cortoss is used to stabilize osteoporotic VCF. While PMMA is the current standard material for treatment of VCF, Cortoss (2) provides significant material advantages. Due to its viscosity and superior strength, comparable to cortical bone (Fig 1), less material is required for similar pain relief (1). Cortoss is currently under an FDA IDE and involved in its First Prospective Randomized Clinical Trial.

MATERIALS & METHODS
Nineteen sites are to enroll 243 patients with a 2:1 randomization (162 Cortoss and 81 PMMA patients treated). Patient outcome will be assessed by VAS, ODI, SF-12 and maintenance of height and alignment at the level(s) treated. Patients will be evaluated at pre-op, post-op, 72 hours, 1 week, 1, 3, 6, 12, and 24 months. A minimum VAS of 50, ODI of 30%, osteoporotic compression fracture at 1-2 levels, presence of edema on MRI or bone scan and an informed consent are the inclusion criteria. The exclusion criteria includes greater than 70% collapse, canal compromise, neurologic deficit at the level(s) to be treated and/or tumors. Postoperative CT and radiographs are being used to assess leakage.

RESULTS
To date, 50 patients have been enrolled at this site (20 PMMA and 30 Cortoss). The average ages in the Cortoss and PMMA groups are 77 and 78 years, respectively. 65 levels have been treated (24 PMMA, 41 Cortoss). The average injected volume of Cortoss (2 cc) was lower than PMMA (3.5 cc). Leakages were found to be similar in both groups. All extravasations were asymptomatic with no cardiopulmonary complications. Improvement in VAS and ODI also were comparable out to 12 months.

CONCLUSION
These results suggest that Cortoss provides similar pain relief while requiring 43% less material than PMMA. This is attributed to the high strength and interdigitated fill pattern of Cortoss. These results are consistent with results from a European prospective vertebroplasty study using Cortoss (3). The preliminary results of this investigation suggest that Cortoss is a novel material for the treatment of VCF in patients with osteoporosis.

REFERENCES

KEY WORDS: Cortoss, vertebroplasty, vertebral compression fractures

Thursday Morning
10:15 AM – 12:00 PM
Grand Ballroom A

(52c) ADULT BRAIN: Cerebrovascular Occlusive Disease II and Epilepsy
(Scientific Papers 342 – 354)

See also Parallel Sessions
(52a) INTERVENTIONAL: Aneurysms II
(52b) INTERVENTIONAL: New Devices and Equipment
(52d) TRAUMA: Head and Spine

Moderators:  Jay J. Pillai, MD
             Pina C. Sanelli, MD
Ischemic Threshold Measurement Using MR Quantitative Perfusion Imaging

Bhatt, H. M.¹ · Shin, W.² · Shah, M.³ · Walker, M. T.⁴ · Carroll, T. J.¹ · Shaibani, A.¹ · Bernstein, R.²
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PURPOSE
To evaluate the ischemic penumbra for salvageable tissue during an ischemic stroke. We present a method of quantitative MR perfusion imaging to aid us in the evaluation of ischemic stroke.

MATERIALS & METHODS
We present a means of quantifying CBF based on the bookend technique. The bookend technique determines whole brain qCBF based on absolute T1-derived CBV value in white matter. This approach to quantify CBV has been shown to depend strongly on the water exchange effects between intra and extravascular spaces. We have implemented an improvement over the existing bookend technique that improves the accuracy of the qCBF measurement by including water exchange correction on T1-derived CBV measurement. Bookend Protocol: Twenty-two stable acute stroke patients were scanned on a clinical 1.5T unit (Siemens Medical Solutions). For the T1 measurement, inversion recovery lock-lock-EPI sequences (nonselective IR pulse, TR/TE = 21/9.9 ms, 15 lines per segment, total scan time = 1.00 min) were scanned before and after a perfusion scan (TR/TE = 1500/46 ms, slice thickness = 5 mm, 13 slices, total scan time = 1:10) acquired with a single-dose contrast injection (Magnevist). Data analysis: Infarcted regions were defined as hyperintense on diffusion-weighted images. A receiver operating characteristic analysis was used to determine the diagnostic accuracy of the qCBF parameter to identify the ischemic threshold for cell death in white matter and gray matter. Sensitivity, specificity and area under the curve (AUC) are reported.

RESULTS
The mean value of CBF was found to be significantly different in the normal and infarcted regions (p < 0.05). The ischemic threshold for cell death in white matter and gray matter were estimated as 18 and 23 ml/100 g-min, where specificity and sensitivity are equal. For a threshold of 18 ml/100g-min in white matter, we found sensitivity and specificity were 86%. For a threshold of 23 ml/100g-min in gray matter, we found sensitivity and specificity were 74%. The diagnostic accuracy for our technique to qCBF exhibited high diagnostic accuracy (area under curves (AUC) = 0.93/0.82 in white matter/gray matter, respectively).

CONCLUSION
Our estimates of the ischemic threshold for cell death agreed with prior findings of 18 ml/100g-min in a primate model of stroke. Furthermore, different threshold values between white matter and gray matter were corresponding to finding of 12.3 and 20 ml/100g-min in white matter and gray matter in previous similar study. We have shown that the modified bookend technique has the potential to quantify cerebral perfusion in a setting of acute stroke. Furthermore our qCBF values show a high diagnostic accuracy (overall AUC = 0.88) for identifying ischemic tissue.

KEY WORDS: MR perfusion, stroke, ischemic penumbra

3T Evaluation of the Hippocampus in Seizure Disorders: PROPELLER T2 FSE versus Routine T2 FSE: A Prospective Study of 50 Patients

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PURPOSE
PROPELLER (BLADE) has proved to be a useful tool by reducing patient motion and susceptibility artifacts at both 1.5T and 3T MRI for T2 FSE, T2 FLAIR and diffusion-weighted imaging pulse sequences in evaluating the brain. Until recently, this technique was available in only axial or up to 40 degrees off axial planes. This precluded its use in adequately evaluating the hippocampal formation in patients with seizure disorders. The purpose of this study was to determine whether a high matrix (384 x 256) coronal T2FSE PROPELLER pulse sequence angled through the hippocampus was superior to the routine higher matrix (512 x 366) T2FSE pulse sequence angled perpendicular to the hippocampus in the evaluation of patients with epilepsy.

MATERIALS & METHODS
Fifty consecutive patients, ages ranging 11 months to 52 years, with seizure disorders were scanned prospectively on a GE 3T HDX MR imaging system with both routine high matrix, 3 mm T2 FSE and the same pulse sequence with PROPELLER. All scans were interpreted independently by one neuroradiologist and one fellowship-trained MR imaging radiologist.

RESULTS
In 28 of 50 patients the PROPELLER sequence was superior to the routine sequence in evaluating hippocampal anatomy and pathology due to its inherent, intended ability to reduce patient motion artifact. In no patient was the routine, higher matrix T2FSE sequence judged to be better.

CONCLUSION
1) PROPELLER (BLADE) T2FSE angled perpendicular to the hippocampus is superior to routine T2 FSE in evaluating the hippocampus in patients with seizure disorders due to the reduction in motion artifact. 2) PROPELLER requires approximately 90 seconds more scan time. 3) Both adult and pediatric patients frequently demonstrate head motion while being scanned.

KEY WORDS: PROPELLER, epilepsy, MR imaging
Paper 344 Starting at 10:31 AM, Ending at 10:39 AM

Pretreatment ASPECTS Is Associated with Outcome for the Intraarterial Treatment of Acute Anterior Circulation Stroke When It Involves the Left Hemisphere

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PURPOSE
ASPECTS (Alberta Stroke Program Early CT Score) is a scoring system that quantifies CT hypodensity in the setting of acute anterior circulation stroke. The prognostic significance of pretreatment ASPECTS with regard to outcome in acute stroke has been studied in trials of intravenous and intraarterial therapy (IAT). Our purpose was to correlate pretreatment ASPECTS on noncontrast CT (NCCT) and CT angiogram source images (CTA-SI) with clinical outcome, in patients with anterior circulation ischemic infarction, treated with IAT.

MATERIALS & METHODS
We retrospectively analyzed the imaging and clinical outcome of 43 patients with pretreatment CTA demonstrating anterior circulation large vessel thrombus, who were treated with intraarterial therapy between 2004 and 2006. We graded the pretreatment NCCT and CTA-SI with ASPECT scores. Postprocedure angiograms were graded for recanalization on the Mori scale (0-1: no recanalization, 2: partial recanalization, 3-4: complete recanalization). Rankin score at 3 months was dichotomized into good outcome (mRS 0-2) and poor outcome (mRS 3-6).

RESULTS
Eleven of 43 (25%) patients had good outcome and 32/43 (75%) had poor outcome. Twenty-eight of 43 (65.1%) had left hemispheric strokes and 15/43 (34.9%) had right hemispheric strokes. The time to recanalization was significantly longer in the left (average 7.16, range 3.83-17.45 hours) versus the right (average 5.55, range 3.0-9.12 hours) (P=0.02). No other clinical variables (age, time to imaging, admission NIHSS, follow-up mRS) were significantly different between the two groups. The following results pertain to patients with left-sided strokes: (1) 6/28 (21%) of patients had good outcome; (2) Patients with good outcome had a significantly higher NCCT ASPECT score (8.2, range 8-9) versus those with poor outcome (6.8, range 0-8) (P=0.01); (3) Patients with good outcome also had a significantly higher CTA-SI ASPECT score (6.8, range 3-8) versus those with poor outcome (4.2, range 0-8) (P=0.03); (4) The NIHSS was significantly lower with good outcome (13.3, range 9-17) versus poor outcome (21.4, range 14-30) (P=.002); (5) There were moderate inverse correlations between CTA-SI ASPECTS versus admission NIHSS (R²=0.47, P=0.008) and between CTA-SI ASPECTS versus mRS at 3 months (R²=0.49, P=0.006). Five of 15 (33%) patients with right-sided strokes had good outcome. In patients with right-sided strokes, no significant difference was seen in admission NIHSS, ASPECT scores on NCCT or CTA-SI in patients with good versus poor outcome.

CONCLUSION
Patients with left-sided anterior circulation strokes and good outcomes have significantly higher pretreatment NCCT ASPECTS, CTA-SI ASPECTS and lower NIHSS versus those with poor outcomes. In these patients, there is also a moderate inverse correlation between CTA-SI ASPECTS and both initial NIHSS and mRS at 3 months. These correlations are not observed in strokes involving the right hemisphere. This difference between left and right hemispheric strokes likely relates to the fact that most people are right handed and language centers usually are located in the left hemisphere. This suggests that left and right hemispheric strokes should be viewed as separate entities both clinically and in future research studies. This information may be important for selecting which patients will benefit most from intraarterial recanalization.

KEY WORDS: Stroke, CT angiography, intraarterial therapy

Paper 345 Starting at 10:39 AM, Ending at 10:47 AM

Neurovascular Abnormalities in Acute Ischemic Stroke: A Study in an Indian Population

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Hyderabad, INDIA

PURPOSE
To study the topographic patterns of infarcts in acute ischemic stroke of the anterior circulation and associated abnormalities of the extracranial and intracranial carotid vasculature in an Indian population.

MATERIALS & METHODS
Inclusion criteria: Acute ischemic stroke of the anterior circulation. Exclusion criteria: Posterior circulation stroke, cardioembolic stroke, dissection of the ICA. Cerebral MR angiography (MRA), diffusion-weighted imaging (DWI) and color Doppler (CD) sonography of extracranial vessels of 71 such patients admitted to our hospital in the last 2 years were reviewed. DWI patterns of infarcts were classified as: (I) Territorial Infarcts, (II) Borderzone infarcts, (III) Capsulostriatal infarcts, (IV) Cortical infarcts, (V) Small superficial infarcts. The intracranial MRA abnormalities were classified as (a) occlusive disease of mainstem MCA, (b) stenotic disease of mainstem MCA, (c) Sylvian vessel disease. The ICA abnormalities on CD were classified as mild stenosis (<50%), moderate stenosis (50%-79%), severe stenosis (80-99%), and occlusion.

RESULTS
1) Territorial infarcts - 19 patients (27%): a. Fifteen had MCA infarcts (79%): cerebral MRA showed occluded MCA in two, stenotic MCA in nine and Sylvian disease in four patients. CD showed mild stenosis in seven, ICA occlusion in two and a normal study in one patient. Four did not undergo CD. b. Two had ICA infarcts (10%): Cerebral MRA showed occluded ICA, MCA and ACA in both. CD showed severe stenosis in one patient and one did not undergo CD study. c. Two had ACA infarcts (10%): Cerebral MRA showed stenotic ACAs in both. CD showed mild stenosis in one, and was not done in other patient. 2) Borderzone infarcts - 23 patients (32%). On cerebral MRA two had
occluded MCA, nine stenotic MCA, five Sylvian vessel disease and six a normal MRA. On CD, 10 had mild stenosis, four moderate stenosis, one ICA occlusion and one normal study. Six did not under go CD. 3) Capsulostriatal infarcts - 14 patients (20%). On cerebral MRA, one had occluded MCA, five stenotic MCA, six Sylvian vessel disease and three a normal MRA. On CD, 11 had mild stenosis, one had a normal study and two did not under go CD. 4) Cortical infarcts - Nine patients (12.7%). On cerebral MRA, three had stenotic MCA, four Sylvian disease, one normal study. On CD, five had mild stenosis, two had moderate stenosis and two did not under go CD. 5) Small superficial infarcts - Six patients (0.08%). On cerebral MRA, two had stenotic MCA, three had Sylvian disease, one had a normal study. On CD, three had mild stenosis and three did not under go CD.

CONCLUSION
No specific co-relation between the topographic distribution of infarcts and the degree of extracranial carotid stenosis could be identified in this study. Intracranial atherosclerosis causing stenotic MCA and Sylvian vessel disease were the most common features in all infarct subtypes, except in ICA territorial infarcts. The study suggests that the routine screening for stroke patients in Indian population must include mandatory evaluation of intracranial blood vessels.

KEY WORDS: Acute ischemic stroke, MR angiography - brain, carotid Doppler

Paper 346 Starting at 10:47 AM, Ending at 10:55 AM
Fast Quantitative Analysis of Hippocampal Atrophy in Patients with Mesial Temporal Sclerosis Using 3T MR Imaging
Bhuta, S.1;2 · Symons, S.2 · Fox, A.2 · Tomlinson, G.1 · Mikulis, D.1
1University of Toronto, Toronto Western Hospital, Toronto, ON, CANADA, 2Sunnybrook Health Sciences Centre, Toronto, ON, CANADA

PURPOSE
Visualization of detailed anatomical structure at 3T compared to 1.5T can be achieved as a result of improved spatial resolution enabled by increased signal to noise. We have observed greater detail in coronal images of the hippocampus at 3T including a structure that we believe represents the Schaeffer collateral. We applied this knowledge for developing a measurement scale that can be used to quickly ascertain the presence of hippocampal atrophy with high specificity for mesial temporal sclerosis (MTS).

MATERIALS & METHODS
Twenty-five cases with unilateral MTS diagnosed by history, imaging, and EEG findings were compared to 25 patients referred with the diagnosis of acoustic neuroma or pituitary adenoma. All subjects underwent 3T MR imaging (GE Signa Excite System) epilepsy protocol with key sequence consisting of a coronal fast STIR (Parallel factor 2, TR 6500, TE 41, Echo Train Length 12, Slice thickness 3mm with 1 mm gap, FOV 22 X 22 cm, Matrix 512X 512) oriented perpendicular to the axis of the hippocampus. 3T images revealed a linear band of decreased signal in the hippocampus presumably representing the Schaeffer collateral. The distance between this band and the outer margins of the hippocampus were measured on an Agfa Impax workstation by three neuroradiologists blinded to all patient information (Fig). The data then were analyzed to determine if there was a statistically significant difference between normal and atrophic hippocampi. This included t-test and ROC analysis.

RESULTS
ROC analysis indicated that the lateral measurement had poor sensitivity and specificity compared to the superior and inferior measurements. It was therefore discarded and analysis continued by combining the superior and inferior measurements. The areas under the ROC curves for each of the readers using the combined measurement were reader 1 = 0.7, reader 2 = 0.82, and reader 3 = 0.61. There was an experience effect as reader 2, who was most experienced, had highest area under the ROC curve. If the combined measurement threshold from this reader of 3.4 mm is chosen, then the sensitivity of the measurement is 64%, and the specificity is 96% (p < 0.0001) indicating that hippocampi with measurements smaller than this threshold should be considered atrophic.

CONCLUSION
A fast measurement method for assessing the presence of hippocampal atrophy is proposed that offers high specificity for assisting in the diagnosis of mesial temporal sclerosis.

KEY WORDS: Epilepsy, hippocampus, 3T MR imaging

Paper 347 Starting at 10:55 AM, Ending at 11:03 AM
Diffusion Tensor Study of Ipsilateral Hyperintensity in Diffusion-Weighted Image of Wallerian Degeneration following Cerebral Ischemic Stroke
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PURPOSE
In the patients with Wallerian degeneration (WD) following supratentorial cerebral ischemic stroke, involving cortical spinal tract (CST), diffusion weighted (DW) hyperintensity in the ipsilateral cerebral peduncle has been reported to be
related with poor motor function outcome and sometimes is misdiagnosed as new infarction. Our study is to analyze diffusion tensor imaging (DTI) characteristics of this hyperintensity and evaluate its value in predicting motor function prognosis.

**Materials & Methods**

After reviewing 28 patients with WD by MCA territory infarctions involving CST, there are eight patients with hyperintensity on DW image in ipsilateral cerebral peduncle, these patients ranged from 3 days to 28 days after stroke onset, including six patients with series DTI examinations; and 12 control patients with matched examination time. DTI examinations (EPI sequence TR/TE = 8000/85, b value 1500s/mm², 13 directions) were performed in a GE Signa 3T. Trace apparent diffusion coefficient (trace ADC), fractional anisotropy (FA) in regions of cerebral peduncle were calculated. Motor function ability of 20 patients was evaluated with Brunnstrom scores at 6 months after stroke onset. Trace ADC, FA in regions of cerebral peduncle and motor function ability between the patients with and without hyperintensity in DW images were compared. The relationships between the and sign of hyperintensity in DW, ipsilateral FA values were analyzed.

**Results**

Consecutive DW images of five patients showed the hyperintensity disappeared in the follow-up examinations. In the patients with hyperintensity on DW images, ipsilateral mean trace ADC value (0.66 ± 0.11 × 10⁻³ mm²/s) and mean FA value (0.52 ± 0.1) were significant lower than contralateral side (P < 0.01). In the patients without hyperintensity in DW images ipsilateral mean trace ADC value (0.746 ± 0.08 × 10⁻³ mm²/s) and mean FA value (0.516 ± 0.1) were also significantly lower than contralateral side (P < 0.01). Between the patients with and without hyperintensity in DW images, there is no significant difference in mean trace ADC, FA value and Brunnstrom scores (P > 0.05). But the Brunnstrom scores significantly correlated with ipsilateral FA value (P = 0.003 in the patients with hyperintensity; P = 0.025 in the patients without hyperintensity).

**Conclusion**

The hyperintensity in DW image is a transient process of WD. This may be because of intra-myelin edema, which shows decreased trace ADC. This sign is not related with worse motor function recovery. However the motor function disability is related with the decrease of ipsilateral FA value.

**Key Words:** Diffusion tensor imaging, Wallerian degeneration, ischemic stroke

**Paper 348 Starting at 11:03 AM, Ending at 11:11 AM**

**Reversible Delayed Posthypoxic Leukoencephalopathy: MR Imaging Findings in Three Patients**

Ritter, J. L. · Kubal, W. S.

Yale University School of Medicine
New Haven, CT

**Purpose**

Following an hypoxic episode, the acute cerebral insult most typically involves the gray matter followed by some degree of clinical recovery. A few patients demonstrate a different course. They suffer a second neurologic insult 1-3 weeks posthypoxia, with imaging findings of leukoencephalopathy, followed by a good clinical recovery. This uncommon presentation has been named reversible delayed posthypoxic leukoencephalopathy. To our knowledge, this is the largest cohort of patients studied with serial MR exams. Although uncommon, this is an important clinical entity because the delay between the initial hypoxic event and the onset of new neurologic symptoms can be confusing to clinicians as to the etiology of the new neurologic findings. Recognition of this entity is important as it suggests good neurologic recovery.

**Materials & Methods**

Retrospective review of neuroradiology teaching file cases elicited three male patients (ages 21 to 59 years old) with acute hypoxic events who, after initial recovery, developed new neurologic symptoms after a delay (8 to 24 days). A total of 8 MR examinations of these patients were performed on a 1.5T MR imaging unit including T1, T2, FLAIR, trace diffusion-weighted imaging (DWI), and apparent diffusion coefficient (ADC) sequences. One patient also had MR spectroscopy (MRS). With supportive care, each patient went on to a good clinical recovery.

**Results**

Imaging performed at the time of initial hypoxic event demonstrated no significant white matter abnormalities. After 8 to 24 days and associated with the development of new neurologic symptoms, MR imaging demonstrated extensive diffuse subcortical and periventricular white matter T2 prolongation on the T2 (Figure A) and FLAIR sequences. Restricted diffusion was present in these same areas demonstrated by the DWI sequences (Figure B) and confirmed by the ADC sequences. There was sparing of the cerebral cortex, subcortical U fibers, basal ganglia, and cerebellum. The single MRS showed decreased NAA and increased choline within the abnormal white matter, but no significant lactate was detected.

**Conclusion**

This presentation helps to define the MR findings in patients with reversible delayed posthypoxic leukoencephalopathy. Recognizing this uncommon entity allows the radiologist to provide clinicians with an understanding of the potential cause of new neurologic symptoms, which may develop weeks after a hypoxic event. Identification of this entity is important prognostically because the patients progress to good neurologic recovery.

**Key Words:** Leukoencephalopathy, posthypoxic, reversible
Quantifying Cerebral Chromophore Changes during Ischemia Using Spatial Modulation of Near Infrared Light

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Purpose
The authors report the results of utilizing spatially modulated near infrared light using modulated imaging (MI) technology in quantitatively imaging cerebral ischemia.

Materials & Methods
Adult male Sprague-Dawley rats underwent permanent surgical occlusion of the left MCA, laser photothrombosis to simulate a transient ischemic attack (TIA), and induction of cortical spreading depression with potassium chloride (KCl). MI images of the left parietal cortex were obtained over an open field (5 mm x 3 mm), at baseline (preocclusion) and up to an hour after experimental manipulation. Tissue chromophore maps were obtained to demonstrate temporo-spatial changes in the distribution of oxy, deoxy, and total hemoglobin, oxygen saturation, lipids, and water. Before and after ischemia induction, activation of the somatosensory barrel cortex was evoked by whisker stimulation.

Results
MI recorded baseline tissue oxyhemoglobin concentrations in the range of 81.8 μM, which decreased to 19.7 μM following MCA occlusion. This pattern was mimicked by tissue oxygen saturation curves, and was reciprocal to patterns of tissue deoxyhemoglobin concentration. Intrinsic optical signal (IOS) was used to detect functional activation of the somatosensory barrel cortex to whisker stimulation. This activation was completely lost following MCA occlusion and photothrombosis. Rats that underwent TIA, showed recovery of blood flow to the ischemic area after an hour and a half.

Conclusion
The MI technique is sensitive to imaging changes in the spatiotemporal distribution of tissue chromophores in varying degrees of ischemia. Unlike IOS imaging, this method is able to distinguish light scattering from absorption yielding quantitative data on physiologic tissue chromophore concentrations.

Key Words: Cerebral ischemia, near infrared, modulated imaging
**Materials & Methods**

Catheter-based in vivo endovascular OCT imaging was carried out in the CCAs of adolescent pigs. Images were obtained with bilateral CCA proximal occlusion as well as using 30 to 50 cc saline flushes in nonoccluded carotid arteries with intact blood flow. Inch long segments of the descending thoracic aorta from three adult rabbits also were imaged ex vivo using OCT. 1 mm thick linear scanning OCT probes were used for image acquisition.

**Results**

The normal structure of the intact blood vessels including the intima, internal elastic lamina (IEL), media, external elastic lamina (EEL), and adventitia were clearly visualized. Elastin fibers in the IEL and EEL showed up as relatively high-signal bands in the CCAs. A thick intimal-medial layer of high-signal elastin was detected in the aorta. In order to confirm the accurate detection of elastin signal, bilateral swine CCAs and rabbit aorta were incubated in porcine pancreatic elastase enzyme. The elastase enzyme effectively digested structural elastin in both arteries which was accurately detected using OCT imaging. All findings were confirmed with histology and were highly reproducible. We were able to get up to 8 microns resolution from imaged tissue.

**Conclusion**

Endovascular OCT imaging can detect with high resolution the structure of normal arteries. Understanding OCT imaging in normal arteries is important in establishing baseline findings, necessary for interpretation of pathologic processes.

**Key Words:** Optical coherence tomography, histologic correlation, common carotid artery

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**Paper 352 Starting at 11:35 AM, Ending at 11:43 AM**

**Stroke in Parenteral Subutex Abuse: DW MR Pattern of Infarction**

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¹National Neuroscience Institute, Singapore, SINGAPORE, ²National University Hospital, Singapore SINGAPORE

**Purpose**

To describe the intracranial MR imaging (MRI) findings in parenteral buprenorphine abuse amongst drug addicts being treated for opiate dependence.

**Materials & Methods**

Eight patients who were prescribed sublingual buprenorphine for treatment of opiate dependence were admitted to hospital with suspicion of parenteral buprenorphine abuse. Chart review and retrospective examination of MRI, including diffusion-weighted MR imaging (DWI) was performed for patterns of cerebral infarction.

**Results**

Five patients were admitted after loss of consciousness, and all either had injection marks on the neck or admitted to injecting a buprenorphine mixture into the neck. Diffusion-weighted imaging showed multiple scattered hyperintense lesions in the deep nuclei, white matter and cortex, predominantly or exclusively within a single cerebral hemisphere. Conversely, MRI in three patients who were admitted for suspicion of infective endocarditis did not show this pattern.

**Conclusion**

Sublingual buprenorphine preparations are abused by drug addicts who inject into the neck, probably puncturing the carotid artery and causing a characteristic pattern of multiple scattered unilateral DWI lesions in the cerebral hemisphere.

**Key Words:** Subutex, stroke, MRI pattern

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**Paper 353 Starting at 11:43 AM, Ending at 11:51 AM**

**Vascular Steal Phenomenon in Normal Brain on BOLD MRI of Cerebrovascular Reactivity**

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¹Toronto Western Hospital, Toronto, ON, CANADA, ²Toronto General Hospital, Toronto, ON, CANADA

**Purpose**

BOLD MRI (blood oxygen level dependent magnetic resonance imaging) signal response to inhaled carbon dioxide (a
vasodilator) can be used to map cerebrovascular reactivity. Normally, the brain shows an increase in blood flow in response to carbon dioxide, that is, positive cerebrovascular reactivity. In patients with a variety of underlying cerebrovascular pathologies, we often observe negative cerebrovascular reactivity in the hemispheric deep white matter. Unexpectedly, normal subjects have also shown negative reactivity in the cerebral white matter. We hypothesize that this is a normal finding caused by a “steal” phenomenon. If this hypothesis is true, then the tissue most significantly affected should be in the vascular watershed zones of the white matter.

**Materials & Methods**

Ten healthy male volunteers (age range 25 - 42 years) were imaged four times each for a total of forty studies over two weeks. Cerebrovascular reactivity mapping was performed on a GE Signa 1.5T scanner using a BOLD MRI pulse sequence with spiral acquisition (repetition time 2240 ms, echo time 40 ms, flip angle 85 degrees, number of slices 28, slice thickness 4.5 mm, scan duration 12 minutes). We used a unique gas sequencer and rebreathing circuit to allow near square wave changes in end tidal CO2 between 30 mm Hg and 50 mm Hg. We obtained quantitative maps of cerebrovascular reactivity by r value correlations of the end-tidal CO2 waveform with the BOLD MRI signal. Using the AFNI software package, we then transformed each dataset into Talairach space. A composite cerebrovascular reactivity map derived from all 40 examinations was generated, displaying mean reactivity.

**Results**

The mean cerebrovascular reactivity map showed regions of negative reactivity in the watershed territory of the centrum semiovale bilaterally. Figure 1 shows this negative cerebrovascular reactivity (black) overlaid on the corresponding anatomical T1WI.

**Conclusion**

Normal subjects show negative cerebrovascular reactivity in the deep hemispheric white matter bilaterally, identical to the “string of beads” pattern of ischemic injury seen in patients with acute carotid occlusion. It appears that CO2-induced global reduction of vascular resistance in the gray matter preferentially shunts blood away from white matter, particularly in the watershed zones. This vascular “steal” phenomenon may play a similar role in patients suffering ischemic injury from carotid occlusion. In these patients, autoregulatory cerebrovascular dilatation to maintain gray matter perfusion may steal blood from the white matter, resulting in the white matter string of beads pattern observed in some of these cases.

**Key Words:** Magnetic resonance imaging, cerebrovascular reactivity, carotid artery stenosis

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**Thursday Morning**

10:15 AM – 12:00 PM

**Grand Ballroom B**

(52d) TRAUMA: Head and Spine
(Scientific Papers 355 – 366)

See also Parallel Sessions
(52a) INTERVENTIONAL: Aneurysms II
(52b) INTERVENTIONAL: New Devices and Equipment
(52c) ADULT BRAIN: Cerebrovascular Occlusive Disease II and Epilepsy

Moderators: Brian C. Bowen, MD, PhD
Jaya Nath, MD

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**Paper 355 Starting at 10:15 AM, Ending at 10:23 AM**

**Preliminary Results of Functional Anesthetic Diskography**

Wong, W. H. M.
University of California San Diego Medical Center
La Jolla, CA

**Purpose**

To assess a new technique for evaluating diskogenic pain by relieving the original pain as a result of injecting anesthetic into the suspected disk after the patient reproduces the original pain by functionally reenacting the pain-provoking activity.
**Materials & Methods**

Patients who had positive level disks (considered suspected disks) according to ISIS criteria on diskography were selected for functional anesthetic diskography (FAD) which involved inserting and anchoring a double lumen balloon tipped catheter into the suspected disk. This would allow patient mobility to regenerate the original pain and anesthetic access to remove the pain. Retrospective correlation of diskographic and FAD results were compared with treatment outcomes.

**Results**

Five patients with five positive disk levels by diskography were selected for FAD. Of two patients with ISIS unequivocally positive disk levels, one was FAD positive and this patient went on to have surgery with good results. The other had FAD negative results which led to further evaluation and discovery that the original pain was actually due to facet arthropathy (false positive diskogram). One patient with ISIS definitely (lower level positive than unequivocal) had a positive FAD. This patient was treated with intradiskal electrothermal therapy (IDRT) resulting in an excellent response. Two patients with ISIS probably positive disk levels had FAD positive results. Both became surgical candidates with favorable outcomes.

**Conclusion**

Functional anesthetic diskography is an important adjunctive technique that can help to confirm the results of diskography and improve the accuracy of disk evaluation.

This paper was selected to receive the Western Neuroradiological Society (WNRS) 2006 Gabriel H. Wilson Award at the WNRS 38th Annual Meeting in Hawaii.

**Paper 356 Starting at 10:23 AM, Ending at 10:31 AM**

**Pediatric Unilateral Hypoxic-Ischemic Injury from Abusive Head Trauma Lacking Cranio cervical Vascular Dissection or Cord Injury**

McKinney, A. M. · Thompson, L. · Truwit, C. · Karagulle, A. · Velders, S. · Kiragu, A.

University of Minnesota/Hennepin County Medical Centers
Minneapolis, MN

**Purpose**

Children suffering from abusive head trauma (AHT) have a generally poor outcome, particularly if the inflicted injury includes hypoxic-ischemic encephalopathy (HIE). HIE in pediatric and adult patients is typically the result of a global and bilateral insult, such as cardiopulmonary arrest or anoxia. Previous literature has suggested that unilateral and hypoxic-ischemic cases may be related to cord injury or vascular dissection. In this regard, we sought to demonstrate that AHT must be a consideration by the radiologist when encountering a young pediatric patient with unilateral HIE, and provide a potential mechanism for this unilateral injury.

**Materials & Methods**

IRB approval was obtained. Two patients, one 14 months old, and the other 7 months old, were imaged in the early subacute phase (3-4 days) at our institution, after transfer from outside institutions. Both patients underwent dedicated cranial MR imaging, including diffusion-weighted imaging (DWI), pre and postcontrast T1-weighted (T1WI) and T2-weighted (T2WI) images, and dedicated cervical and skull base thin-section T1WI and T2WI with fat saturation, as well as cranial and cervical MR angiography (MRA), to evaluate for vascular dissection or cord injury.

**Results**

Both patients were evaluated initially by CT, followed immediately by MR imaging on presentation to our institution, demonstrating largely unilateral white matter insults on DWI, consistent with early subacute (3-4 days) HIE, with relatively small subdural hematomas. Cranio cervical MRA and dedicated cervical imaging for cord injury and dissection were negative in both. In both patients, follow-up imaging (10-14 days) was also consistent with HIE, and retinal hemorrhages, body bruises, and clinical histories suspicious of inflicted trauma were noted. Questioning by authorities led to a confession in one case, while the other child is in protective custody and the case remains pending.

**Conclusion**

Atypically, HIE in AHT is unilateral, with cerebral swelling out of proportion to the size and mass effect of the subdural hematoma. The predominately white matter injury on DWI in the subacute phase in these two cases is deemed to arise from abusive head trauma, without evidence of vascular dissection or spinal cord injury on dedicated cranio cervical MR imaging or MRA. Hence, unilateral HIE in a young child may be a sign of AHT from direct cervical vascular compression, either by the offender, or compression from vascular kinking related to hyperextension/hyperflexion from shaking.

**Key Words**: Abuse, head trauma, hypoxic-ischemic
Correlation of Frontal Lobe White Matter Volumes with Quantitative Diffusion Tensor Imaging in Children without and with Closed Head Injury

Ghosh, A.¹ · Wilde, E. A.² · Yallampalli, R.³ · Ramos, M. A. ⁴ · Chu, Z.¹ · Bigler, E. D.¹ · Li, X.¹ · Levin, H. S.⁵ · Hunter, J. V.⁴
¹Texas Children’s Hospital, Houston, TX, ²Baylor College of Medicine, Houston, TX, ³Brigham Young University, Provo, UT

PURPOSE
To test the null hypothesis that the diffusion tensor imaging (DTI) measure of fractional anisotropy (FA), correlates with frontal white matter (WM) volume in children without closed head injury (CHI), but that this relationship breaks down following traumatic brain injury (TBI).

MATERIALS & METHODS
Utilizing established techniques, white matter volumes were measured in the prefrontal lobes of 22 orthopedically injured, (OI) (M = 17, F = 5, age range 7.05-16.55 years, mean: 12.38 years, 20 right handed and 2 left handed) controls matched for age, gender, handedness and socio-economic status with 23 TBI children, (M = 18, F = 5, age range 7.82 - 16.78 years, mean: 12.91 years, 22 right handed and 1 left handed), approximately 3 months following CHI. This was correlated with FA measures using 15 direction DTI performed on a 1.5T magnet, (Philips Intera, Best, Netherlands). Frontal white matter volumes were calculated using Analyze 7.0 software. Analysis of the frontal white matter FA was performed by two raters using PRIDE version 4.1 fiber tracking software in the same regions. Inter and intrarater reliability was established (intraclass correlational coefficients > 0.9) for both techniques.

RESULTS
There was a statistically significant correlation between FA and volume of both the left, (r = 0.73, p = 0.0001) and right frontal white matter, (r = 0.50, p = 0.0177), in the OI controls but no correlation was demonstrated in TBI children, (Figs1a and b). This is presumably on the basis of diffuse axonal injury (DAI), with associated volume loss. Of note was the more significant correlation of the left frontal WM volume with FA in this predominantly right-handed group with left hemispheric dominance.

CONCLUSION
The anticipated correlation between frontal WM volumes and FA was confirmed in children with extracranial injury but not in children who had sustained TBI. We postulate that this disrupted correlation between frontal WM volume and FA is due to DAI.

KEY WORDS: Diffusion tensor imaging, volumetrics, closed head Injury
and experienced only transient neurologic symptoms. Nevertheless, the patient clearly suffered a neurologic injury. This case suggests the utility of brain MRI in the evaluation of electrocution - even when these injuries are accompanied by only minor neurologic symptoms. Brain MRI following electrical injury may provide additional insight into symp- toms and provide a baseline from which to monitor subse- quent recovery.

**KEY WORDS:** Electrical shock injury, MR imaging

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**Paper 359 Starting at 10:47 AM, Ending at 10:55 AM**

**Subpial Hemorrhage: A Distinct Pattern of Brain Injury**

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¹Jacobi Medical Center/Albert Einstein College of Medicine, Bronx, NY, ²Westchester Medical Center/New York Medical College, Valhalla, NY

**PURPOSE**

Intracranial hemorrhage usually is classified as intraventricular, parenchymal, subarachnoid, subdural, or epidural in location. We recently saw a case of extensive postrau traumatic cerebral hemorrhage confined to the brain surface (Fig). The pattern of injury did not fit the common descriptions of intracerebral or extracerebral hemorrhage, but was consistent with subpial hemorrhage.

**MATERIALS & METHODS**

We reviewed the CT scans performed on 180 brain trauma patients over the past 5 years. The patients were part of a multiinstitutional study of traumatic brain injury. Criteria for subpial hemorrhage were blood density confined to the brain surface gyri, not involving the underlying white matter.

**RESULTS**

We identified 11 patients with subpial hemorrhage according to the above criteria. All were males. The age range was 12 to 76 years (mean 43, standard deviation 20). Because of the small numbers, preliminary analysis showed no definite relation of subpial hemorrhage to mechanism of injury, nor could subpial hemorrhage be shown to be an independent predictor of outcome following traumatic brain injury. The subpial space is not a true potential space between adjacent membranes like the pleural or peritoneal space. Rather, the subpial space consists of small intracellular clefts located between astrocytic processes and between the glial footplates and the basement membrane coating the brain (1). Nonetheless, that study reported the existence of subpial hemorrhage in a histopathologic study of nine neonates and young infants. In addition, a recent report documented spontaneous superficial parenchymal and leptomeningeal (subpial and subarachnoid) hemorrhage in seven term neonates following atraumatic deliveries (2). Recently, a number of authors have pointed out that there is no true subdural space in the sense of a potential space between the arachnoid and the dura (3). Rather, subdural hemorrhage results from tissue damage and most often occurs as a result of cleavage of the dural cell border. In this respect, the concept of a subpial space is entirely analogous to that of a subdural space.

**CONCLUSION**

Subpial hemorrhage is an easily recognized pattern of brain injury, distinct from the common descriptions of intracranial hemorrhage. When possible, imaging-histopathologic correlation is needed to confirm the precise ultrastructural location of cases of superficial hemorrhage. Further study also is needed to determine whether subpial hemorrhage is related to specific mechanisms of injury or can serve as an independent predictor of outcome.

**REFERENCES**

3. Anat Rec 1991;230:3-21

**KEY WORDS:** Brain, trauma, hemorrhage

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**Paper 360 Starting at 10:55 AM, Ending at 11:03 AM**

**Spinal Cord Injury without Radiographic Abnormality: A Mimic of Nonaccidental Injury**

Krasnokutsky, M. V.¹,² · Barnes, P. D.¹,² · Monson, K. L.³ · Ophoven, J.⁴

¹Lucile Packard Children’s Hospital, Palo Alto, CA, ²Stanford University Medical Center, Stanford, CA, ³University of California San Francisco, San Francisco, CA, ⁴St. Louis County Medical Examiner’s Office, Woodbury, MN

**PURPOSE**

To describe the findings in a child with spinal cord injury without radiographic abnormality who presented as a mimic of an alleged nonaccidental injury (NAI).

**MATERIALS & METHODS**

Case report: A 21-month-old boy with steroid-dependent...
RESULTS
Spinal cord injury without radiographic abnormality involving respiratory centers was likely the culprit event in this case leading to immediate hypoxia. Onset of hypoxia lead to ischemia of the brain parenchyma. Retinal hemorrhages (RH) were documented. Skeletal survey showed T5-T12 vertebral wedging. The diagnosis of NAI was presumed. The patient expired 44 hours later. Autopsy revealed partial transaction of the cord at the cervicomedullary junction, scalp contusion site, and hypoxic-ischemic injury (HII) of the brain parenchyma.

CONCLUSION
In cases of HII without a well established cause, MR imaging of the cervical spine should be performed to evaluate for spinal cord injury without radiographic abnormality. Physicians should be aware of the growing body of evidence that provides valid alternatives to findings that previously were considered characteristic of NAI.

KEY WORDS: Child abuse, cord injury

MATERIALS & METHODS
Adult female Sprague-Dawley rats (N = 23) received a right-sided moderate contusion using an Infinite Horizons impactor set at 175 kdyne. These animals were divided into four groups. Groups 1 and 2 received a placebo (saline) and then were sacrificed at day 1 (N = 6) or day 28 (N = 5) postinjury. Groups 3 and 4 received 15 nmol NBQX and then were sacrificed at day 1 (N = 6) or day 28 (N = 6) postinjury. All animals were perfusion fixed with 4% formaldehyde and the spinal cords removed. Ex vivo DTI then was performed on a 9.4T magnet. The following DTI metrics were evaluated up to 4 mm rostral and caudal to the injury site: longitudinal diffusion (first eigenvalue), transverse diffusion (average of second and third eigenvalues), fractional anisotropy, and trace diffusion.

RESULTS
Significant changes in each of the DTI metrics were found on the injured side compared to the uninjured side with this injury model. DTI metrics of fractional anisotropy (Fig), and trace diffusion/transverse diffusion values significantly increased between day 1 and day 28. The only significant difference found between the two treatment groups was reduced longitudinal diffusion values at day 28 just caudal to the level of injury in the NBQX treated group.

CONCLUSION
NBQX has been shown to ameliorate the effects of experimental spinal cord injury by inhibiting the effects of excitatory amino acids which contribute to secondary injury. Only minor differences in the white matter, however, were seen between the two treatment groups; this finding may not be entirely surprising as previous work has shown that despite improved functional findings, there were not significant changes in white matter sparing. We did see significant changes in DTI values between day 1 and day 28, which suggest that DTI may be able to monitor evolution of pathologic changes that occur in white matter following cervical contusion injury.

KEY WORDS: Spinal cord injury, diffusion tensor MR imaging (DTI), experimental

PAPER 361 Starting at 11:03 AM, Ending at 11:11 AM
Ex vivo Diffusion Tensor Imaging of the Spinal Cord following Cervical Hemi-Contusion Injury

Schwartz, E. D. · Stackhouse, S. · Hsu, O. · Sandrow, H. R. · Shumsky, J. S.

· University of Pittsburgh Medical Center, Pittsburgh, PA, · Drexel University College of Medicine, Philadelphia, PA, · University of Pennsylvania School of Medicine, Philadelphia, PA

PURPOSE
To evaluate treatment effect with diffusion tensor imaging (DTI) in the spinal cord 1 day and 1 month following a cervical contusion injury and administration of NBQX, an AMPA receptor antagonist.
Paper 362 Starting at 11:11 AM, Ending at 11:19 AM

MR Imaging Assessment in Spinal Cord Injury: Experience from a Phase II Randomized Controlled Trial

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PURPOSE
To determine short-term changes in imaging characteristics of acute spinal cord injury, and correlate with 6 and 12 month follow-up examinations. Design: Blinded, imaging component of a Phase II study for subjects with acute, complete spinal cord injuries.

MATERIALS & METHODS
As part of prescreening for an acute spinal cord injury trial, routine spinal MRI examinations were reviewed for patients scanned within 5 days of cord injury who underwent repeat MRI between 6-14 days postinjury. Cranio-caudal extent of cord edema and contusion were measured by fellowship-trained neuroradiologists. Findings on these studies then were compared to follow-up examinations performed 6 - 12 months postinjury.

RESULTS
Initial MRI (n = 35) exams were performed on average 1.3 days postinjury. Cord contusion measured an average of 2.0 ± .5 cm in length, (range 0.9 -2.9). Follow-up exams were performed an average of 9.8 days postinjury, with average contusion length 2.6 cm ± 1.2 (range 1.1-6.2). At longer term follow up, chronic area of cord injury measured an average of 2.4 and 2.7 cm at 6 and 12 month examinations. Paired Student’s t test showed a significant difference between length of contusion on the initial and follow-up examinations (p = 0.014) and between initial and 6-month examinations (p = 0.010). No significant difference was noted between short-term follow up and 6 month examinations (p = 0.11).

CONCLUSION
Extent of cord injury as detected by MRI changes in the first 2 weeks following traumatic spinal cord injury. Measured length of contusion shows a a significant increase during this interval. The contusion length measured at short-term follow up reflects the length of injury seen on longer term follow-up images. These findings have implications for treatment methodologies and enrollment in clinical trials in acute spinal cord injury.

KEY WORDS: Spinal cord

Paper 363 Starting at 11:19 AM, Ending at 11:27 AM

Report of a Case with Occult Cerebrospinal Fluid Leak Identified with Intrathecal Gadolinium-Enhanced MR Imaging

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Montreal Neurological Institute and Hospital
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PURPOSE
Identifying the exact site of cerebrospinal fluid (CSF) fistula in the intracranial hypotension syndrome is challenging. CT myelography and radionuclide cisternography are the standard imaging procedures used for this purpose. We present a case of spontaneous CSF leak causing intracranial hypotension syndrome with associated cervical spinal extraarachnoid collection, in which the dural defect was identified using intrathecal gadolinium-enhanced MR imaging (MRI).

MATERIALS & METHODS
A 35-year-old male with a 6-year history of intracranial hypotension syndrome and a persistent cervico-thoracic spinal anterior extraarachnoid collection had undergone multiple radiologic investigations that did not localize the site of CSF leak. During his more recent episode of headaches, an MRI with intrathecal injection of 0.3 cc of gadopentetate dimeglumine was performed in a 1.5T MRI unit, showing the findings described below.

RESULTS
Multiplanar MR images revealed a dural defect at T1-2 spinal level, communicating with anterior extraarachnoid collection.

CONCLUSION
Intrathecal gadopentetate dimeglumine-enhanced MRI is a valuable tool in the difficult search of dural defects underlying CSF leaks. The case will be discussed in the context of the available literature.

KEY WORDS: Diagnostic techniques, neurologic, gadolinium, MR imaging

Paper 364 Starting at 11:35 AM, Ending at 11:43 AM

MR Imaging Presentation of Vertebral Clefts in Patients with Osteoporotic Fractures

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¹Taipei Veterans General Hospital, Taipei, TAIWAN, ²National Yang Ming University, Taipei, TAIWAN

PURPOSE
To understand the MR imaging presentation of vertebral clefts on different pulse sequences.

MATERIALS & METHODS
Eighty vertebral clefts were found in 95 vertebral fractures in 40 patients. Patient ages ranged from 54 to 90 years (mean 74.6). Typically the clefts were gaps or cavities filled with fluid (hyperintensity) or gas (signal ovoid) on T2-weighted and STIR images. On contrast-enhanced MR images, the clefts were nonenhanced area surrounded by the enhanced areas of the vertebral body.

RESULTS
Three different compositions were found in these 80 clefts: serous fluid presenting with hyperintensity on both T2-weighted and STIR images in 42 (53%), gas presenting with signal loss on all pulse sequences in 25 (31%), and both gas and fluid in 13 (16%). Individual pulse sequences may have false positive or false negative in detecting clefts. For example, false negative may be caused by the following reasons: 1. Thin clefts at endplates stimulated annulus fibrosus on T2-weighted and STIR images; 2. Hyperintensity inside clefts
simulating edematous bone marrow on STIR image. 3. No obvious enhancement in the adjacent bone marrow or with contrast enhancement at the cleft on contrast-enhanced MR images. False positive may be caused by: 1. Intraosseous disc herniations with hyperintensity on STIR images; 2. Sclerosis from collapsed endplates showed hypointensity simulating gas-filled clefts on T2-weighted images and STIR images; 3. Linear fat islands presented with hyperintensity simulating fluid-filled clefts on T2-weighted images; 4. Linear fat islands presented with hypointensity stimulating gas-filled clefts on STIR images; 5. Focal fat island surrounded by enhancement on contrast-enhanced MR images.

**CONCLUSION**

Individual pulse sequences may have false positive or false negative in detecting clefts. Careful evaluation of different MR pulse sequences together can reduce false positive or false negative in detecting clefts inside vertebral fractures.

**KEY WORDS:** Fracture of spine, avascular necrosis, osteoporosis

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**Paper 366 Starting at 11:51 AM, Ending at 11:59 AM**

**Rapid Lumbar Spine Imaging with Isotropic Multiplanar Fast Spin-Echo Imaging**

Hackney, D. B. · McKenzie, C. · Peri, N. · Busse, R.

Beth Israel Deaconess, Boston, MA, GE Healthcare, Madison, WI

**PURPOSE**

Current imaging approaches to the spine include sagittal and axial acquisitions. The large number of separate acquisitions leads to prolonged imaging times, limitations in registration between the image sets, and motion artifacts. We present initial evaluation of an approach that acquires a single three dimensional isotropic fast spin-echo dataset, with reformatting into axial projections.

**MATERIALS & METHODS**

We employed the 3D-FSE eXtended Echo Train Acquisition (XETA) technique to obtain overlapping 1 mm sagittal images of the spine with T2-weighted contrast. XETA uses refocusing flip angle modulation to generate T2 contrast with very long readout trains (>100 echoes), making 3D T2 weighted imaging possible with reasonable acquisition time. The XETA images had intrinsic resolution of 1mm3. The data were reformatted into 3 mm sagittal and axial images for review. XETA images were compared to conventional 2D fast spin echo sagittal and axial 3mm images. We assessed image quality for noise, sharpness, and contrast characteristics.

**RESULTS**

The differences in the images were obvious, and it was not possible to blind the radiologists to the image acquisition technique. The contrast characteristics of the XETA images were similar to routine 2D fast spin-echo acquisitions. The 1mm thick acquired images were noisier than the conventional images, but when reformatted to comparable section thickness, the apparent noise was similar to the 2D images. There was an increase in apparent edge enhancement at interfaces between CSF and short T2 structures such as ligaments and nerve roots, presumably due to the long echo train. The XETA images demonstrated less pulsation artifact, likely due to the long echo train and cardiac gating. Since the XETA axial images were generated from the sagittal set, there was no time penalty to produce axial images throughout the entire lumbar spine. Reformatted images also could be properly angled at each level, regardless of lordosis or scoliosis. Axial reformatted images were exquisite with clear demonstration of the nerve roots throughout their intradural course. Acquisition time was similar to a single 2D run, but since thin-section XETA also produced axial images without further imaging, this strategy reduced overall imaging time.

**CONCLUSION**

XETA produces diagnostic quality sagittal images and outstanding axial images of arbitrary section thickness without further acquisition, thus saving imaging time. Due to the isotropic acquisition, we retrospectively display images in any desired orientation without loss of quality, thus overcoming limitations of spinal deformities.

**KEY WORDS:** Imaging technique

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**Thursday Afternoon**

12:10 PM – 1:10 PM

**Grand Ballroom A**

American Society of Spine Radiology (ASSR) Annual Business Meeting (Members Only)
Vertebroplasty and Kyphoplasty
Afshin Gangi, MD, PhD

LEARNING OBJECTIVES
Upon completion of this presentation, participants will be able to:
1) Identify indications of vertebroplasty and kyphoplasty.
2) Evaluate the advantages and limits of each technique.
3) Review complications of the procedures and how to avoid them.

PRESENTATION SUMMARY
Vertebroplasty and kyphoplasty are percutaneous techniques in which cement is injected into a fractured vertebra to internally splint and stabilize it. Both are well recognized as efficient procedures for management of pain and kyphosis. Percutaneous injection of acrylic cement has been utilized for the treatment of symptomatic vertebral hemangiomas, painful vertebral body tumors, and severe painful osteoporosis with loss of height and/or compression fractures of the vertebral body. Percutaneous vertebroplasty can be combined with RF ablation or ionization for treatment of solitary vertebral metastasis and debulking of large tumors with paraspinal and epidural invasion. Indications of both procedures are very similar. In our department, percutaneous kyphoplasty is used especially in treating traumatic vertebral fractures in nonosteoporotic patients, in whom phosphocalcic cement is used for consolidation. Percutaneous vertebroplasty is performed under conscious sedation in 90% of cases, while kyphoplasty requires general anesthesia. Vertebroplasty allows for good pain relief, but is often inefficient in correcting persistent spinal kyphosis. The aim of kyphoplasty is to reduce kyphosis. The clinical results of both procedures are similar and the reduction of kyphosis is controversial with kyphoplasty. The major complication during acrylic cement injection is leakage, which is thought to be caused by injection of too much fluid cement and use of high cement injection pressure. Creation of a cavity inside the vertebral body, with kyphoplasty is thought to offer less resistance to cement injection, the possibility of injecting more viscous cement like phosphocalcic cement and thus reduce the risk of leakage. The most devastating complication is epidural and/or foraminal leak of cement causing permanent neurologic sequelae as a result of spinal cord and nerve root compression. Venous leakage resulting in pulmonary embolism is another important complication. These risks can be minimized by monitoring bone filling with excellent fluoroscopic guidance, injecting pasty cement with adapted injection sets and utilizing sufficiently radio-opaque cement. Further, many of the serious complications related to multilevel vertebroplasty are thought to be caused by marrow fat emboli. Risk of infection should be considered and strict sterility is mandatory. The risk/benefit ratio appears to be favorable in carefully selected patients when treated by a well trained operator. Advantages: Vertebroplasty: cost effective, less invasive, performed under local anesthesia and sedation, fast procedure. Kyphoplasty: less leakage, allows injection of phosphocalcic cements. Both procedures are largely safe. However, cost issues and other complications should be considered in the indications for each technique. Vertebroplasty and kyphoplasty are minimally invasive percutaneous procedures with great potential to relieve pain rapidly and in a durable fashion. During this lecture, the authors will describe the indications, technique, and results of both procedures with the advantages and limitations of each technique. Patient selection for each technique will be detailed. Complications will be reviewed and illustrated with tips on how to reduce them discussed.

REFERENCES
Diagnosis and Treatment of Facet Arthropathy
Blake A. Johnson, MD

Learning Objectives
Upon completion of this presentation, participants will be able to:
1) Review the anatomy, radiographic and clinical features of facet arthropathy.
2) Discuss image-guided diagnostic blocks for the evaluation of neck and back pain.
3) Describe percutaneous therapeutic modalities for the treatment of facet arthropathy.

Presentation Summary
Degenerative arthropathy of the zygapophyseal (facet) joints is an important source of neck, head and back pain. Isolating facet joints as the cause of symptoms is difficult, however, because there are no specific markers of facet joint related pain. Further, imaging studies do not always correlate with clinical findings. Diagnosis and treatment of facet joint syndrome is most accurately accomplished using fluoroscopic or CT-guided procedures. Diagnostic blocks can be performed targeting either the facet joint or the median branch of the dorsal ramus (facet nerve). Before an intraarticular injection, facet arthrography is performed to document needle position and to evaluate the morphology of the facet joints. Following arthrography and filming, a local anesthetic and steroid are injected into the joint being investigated and the patient is monitored for relief of symptoms. As an alternative to injecting the joint space itself, the facet nerve (medial branch of the dorsal ramus) can be anesthetized. A facet nerve block is preferred to a joint injection for patients who are candidates for radiofrequency neurotomy, because a positive response to a facet nerve block best correlates with subsequent improvement following radiofrequency lesioning at the same location. For this procedure, the needle is directed to the facet nerve using reliable bony landmarks. In the cervical spine, this is along the center of the articular pillar. In the lumbar spine, it is at the junction of the superior articular process and the transverse process. After needle placement, a small dose of contrast (.3-.5 cc) is injected to exclude venous opacification. Contrast should remain localized adjacent to the needle tip. Following injection of contrast and filming in at least 2 planes, 0.5 - 1.0 cc’s of local anesthetic/steroid mixture are injected. The patient is monitored thereafter for response and assessed at 20-30 minutes post-injection. The technical aspects of facet blocks, radiofrequency neurotomy and radiographic anatomy will be emphasized in this session.

References

CT-Guided Pain Management: A New Level of Success
Allan L. Brook, MD

Learning Objectives
Upon completion of this presentation, participants will be able to:
1) Review the decision tree to where the pain generator is originating.
2) Identify the source of pain with image guidance.

Presentation Summary
Back pain is the number one cause of disability. The benefits of pain management are well documented. The risks and lack of good outcomes are also well documented. The stratification into axial and radicular pain syndromes is not unique and not without overlap. With any classification system and with any therapeutic algorithm there is a basic premise that the underlying abnormality is being addressed. My talk will be concentrating on a practical approach that is based on targeting the anatomic pain generator. Utilizing the best image guidance, theoretically should improve outcomes. My presentation will follow a cases based presentation on this principle, and how to do it safely and effectively. Many different types of percutaneous therapies are in the literature, and have become part of everyday pain clinics. Highlights of these include epidural steroid injections, facet and disc therapies. Vertebral augmentation with many methods and newer tools will be a focus of this lecture. Percutaneous injection of (PMMa) polymethylmethacrylic cement into the spine is a well established treatment for painful vertebral compressions. Implanting the acrylic cement into the weakened bone is thought to act as an internal cast that stabilizes the vertebral body and allows for weight bearing and mobilization. After the initial descriptions in the 1980’s many innovative ideas and procedures have developed over the last two decades. These procedures augment the skeletal structures and decrease the motion that leads to severe pain and disability. Novel approaches into the sacrum have been shown to significantly reduce pain. The further introduction of stabilizing cement into other weight bearing bones has yet to be performed on such a large scale to this point in time. There are multiple case reports of PMMA, as well as other acrylics and sclerosing agents injected into lytic bone lesions with favorable results. Biological material injected into bone to help facilitate bone healing and reducing pain has been approached and discussed more recently and clearly would be desirable in certain patient populations. The specific agent to fortify the weakened bone will clearly evolve as
experience grows within each practice, along with the published literature. Oncologic patients have an ongoing need for pain management, that is poorly treated, up to this point in time. The risks and rewards for treating this type of bone lesions has many challenges and is a works in progress. Pain management for weakened bone from osteoporosis or from neoplastic etiologies is a major health concern. Novel approaches that are clearly efficacious will be pushed forward as long as the risks are understood and kept minimal.

Thursday Afternoon
1:15 PM – 2:45 PM
Grand Ballroom C-F

(54) Subarachnoid Hemorrhage and Aneurysms (ASITN)

(370) Imaging Algorithms for Evaluation of Subarachnoid Hemorrhage
— Joshua A. Hirsch, MD

(371) CT Perfusion for Vasospasm Management
— Ansaar T. Rai, MD

(372) Aneurysm Screening: Who, When & How?
— Phillip M. Meyers, MD

Moderator: Robert W. Tarr, MD

CT Perfusion for Vasospasm Management
Ansaar T. Rai, MD

Current Position: Director Interventional Neuroradiology, Assistant Professor of Radiology, Neurology and Neurosurgery, West Virginia University, Morgantown, WV. Qualifications: Board Certification from the American Board of Radiology with Certificate of Added Qualification Neuroradiology. Training: Internship in General Surgery followed by Residency in Diagnostic Radiology and Fellowship training in Neuroradiology and Interventional Neuroradiology. Interests: Diagnosis and management of acute stroke.

Aneurysm Screening: Who, When & How?
Phillip M. Meyers, MD

Learning Objectives
Upon completion of this presentation, participants will be able to:
1) Analyze the available data on the incidence and prevalence of unruptured cerebral aneurysms.
2) Identify the risk factors for the development of cerebral aneurysms.
3) Define the limitations inherent in the methods available for identification of unruptured cerebral aneurysms.

Presentation Summary
Screening for cerebral aneurysms remains a topic of interest in the neurosciences. Identification and treatment of cerebral aneurysms prior to rupture with resultant subarachnoid hemorrhage could theoretically prevent catastrophic illness from
one perspective. However, the indications for screening and its cost effectiveness remain unclear. While there may be particular applicability to certain high risk groups, the benefits of screening in the general population remain to be proved. This presentation will review the factors involved in the management of at-risk populations.

Thursday Afternoon
3:15 PM – 4:45 PM
Grand Ballroom C-F

(55a) ADULT BRAIN: Cerebrovascular Occlusive Disease III (Scientific Papers 373 – 382)

See also Parallel Sessions
(55b) INTERVENTIONAL: Stroke and Arteriovenous Malformations/Fistulae
(55c) SPINE: Spinal Cord and Degenerative Inflammatory Infections
(55d) ADULT BRAIN: Neoplasms II and New Techniques Post-Processing

Moderators: Robert A. Koenigsberg, DO, FACR
Ronald L. Wolf, MD, PhD

Paper 373 Starting at 3:15 PM, Ending at 3:23 PM
Simple Classification by Imaging Predicts Outcomes in Acute Ischemic Stroke

Torres-Mozqueda, F. · Gonzalez, R. G. · He, J. · Yeh, I. B. · Lev, M. · Schaefer, P.
Massachusetts General Hospital
Boston, MA

Purpose
Despite major developments in imaging acute ischemic stroke, a simple classification instrument based on modern CT and MR imaging that reliably predicts clinical outcome is lacking. Our purpose was to test a neuroimaging-based classification scheme to predict clinical outcome in patients presenting to the emergency room with acute ischemic stroke.

Materials & Methods
Two hundred thirty-five consecutive patients presenting to the emergency department with acute stroke symptoms, admitted to the hospital and discharged with a primary diagnosis of ischemic stroke were evaluated. Imaging findings by CT, CT angiography (CTA), MR imaging (MRI) and/or MR angiography (MRA) at presentation were used to classify patients. Patients with central artery occlusions (basilar artery, ICA, or proximal MCA) on CTA or MRA or imaging evidence of >1/3 MCA territory severe ischemia on NCCT or diffusion-weighted imaging were classified as having major strokes by imaging criteria, and all others were classified as having minor strokes by imaging criteria. Outcome measures were death during hospitalization, length of hospitalization and discharge to rehabilitation facilities or to home.

Results
Fifty-nine patients were found to have major strokes of whom 50 had central artery occlusions observed by CTA or MRA, while 176 had minor strokes by imaging criteria. All nine deaths occurred in the major stroke group (p < 0.001). Seventy-two percent of the major stroke patients who survived were discharged to a rehabilitation facility, compared to 18% of those patients with minor strokes (p < 0.001). The mean length of hospitalization was 14.0 vs 3.2 days for the major and minor stroke groups, respectively (p < 0.001). The odds ratio for a poor outcome (defined as death or discharge to a rehabilitation facility) was 15.0 (95% CI = 7.4 to 30.7) for the major stroke by imaging group compared to the minor stroke group.

Conclusion
The neuroimaging-based classification of patients presenting to the emergency department with acute ischemic stroke is highly effective in predicting clinical outcome. This information may be important for prognostication and in guiding therapy.

Key Words: Stroke, classification, neuroimaging

Paper 374 Starting at 3:23 PM, Ending at 3:31 PM
CT Angiography Source Image Hypoattenuation Predicts Clinical Outcome in Posterior Circulation Strokes Treated with Intraarterial Therapy

Massachusetts General Hospital
Boston, MA

Purpose
Posterior circulation infarction is associated with a high mortality rate. Intraarterial therapy (IAT) is used to treat vertebral and basilar occlusions in an attempt to improve survival. CT angiography (CTA) source image (CTA-SI) hypoattenuation is thought to represent infarct core and CTA-SI ASPECT scores have improved prediction of final infarct size and clinical outcome in anterior circulation strokes. However, little is known with respect to pretreatment imaging correlation with outcome in posterior circulation strokes. Our purpose was to correlate the degree of parenchymal hypoattenuation on initial CTA-SI, using a novel score, with clinical outcome, in patients with vertebral and basilar emboli, treated with IAT.

Materials & Methods
We retrospectively analyzed the imaging and outcome of 16 patients with pretreatment CT angiograms (CTA) showing vertebral and/or basilar artery occlusions who underwent IAT from 2003-2006. We graded CTA-SI for parenchymal
hypoattenuation in eight regions bilaterally: medulla, midbrain, pons, thalamus, cerebellum, occipital lobe, inferior parietal lobe, medial temporal lobe. Each side of a region was graded on a scale of 0-2 (0: no hypoattenuation, 1: <50% involvement, 2: >50% involvement). On the CTA, we also assessed clot location, presence or absence of vessel hyperdensity, presence or absence of vascular calcification, and collateralization (presence of absence of posterior communicating arteries). Degree of recanalization was assessed on digital subtraction angiography following thrombolysis. Outcome was dichotomized into death during hospitalization versus survival and was also characterized by the modified Rankin score (mRS) at 3 months.

**RESULTS**

Nine women and seven men with an average age of 68 years (47-86) were treated. Mean time from symptom onset to CTA was 5.2 hours (0.7-15.8), and to procedure conclusion was 10.2 hours (3.5-19). Four patients had basilar, two had vertebral, and 10 had combined vertebral and basilar artery occlusions. Eleven patients had complete, four had partial and one had no recanalization. Mean NIHSS on admission was 28 (11-40). When examining all eight regions, the seven surviving patients (44%) had a mean CTA-SI score of 3.29 (1-7) and the nine deceased patients had a significantly higher mean CTA-SI score of 9.1 (5-14) (p = 0.0003). The total CTA-SI score highly correlated with mRS at 3 months (r² = 0.78, p = 0.0007). When examining just brainstem/diencephalon, surviving patients had a mean CTA-SI score of 2.86 (1-6) while deceased patients had a significantly higher mean CTA-SI score of 7.89 (5-11) (p = 0.0002). The brainstem/diencephalon score also highly correlated with mRS at 3 months (r² = 0.79, p = 0.0005). Furthermore, the admission NIHSS correlated strongly with survival (p = 0.006) and mRS at 3 months (r² = 0.73, p = 0.002). No other variables examined (age, sex, time to treatment, clot location, presence of vessel hyperdensity, presence of collaterals, presence of calcification) correlated with outcome.

**CONCLUSION**

The degree of hypoattenuation on pretreatment CTA-SI correlates highly with outcome in patients with posterior circulation stroke treated with IAT. The strength of this correlation increases by examining just the brainstem/diencephalon (medulla, pons, midbrain, thalamus). In spite of recanalization, patients with a brainstem/diencephalon score of >6 died, while those with a score of <5 survived, with a follow-up mRS of 1-4. This information may be important for selecting which patients will benefit most from intraarterial recanalization.

**KEY WORDS:** Posterior circulation stroke, CT angiography, intraarterial therapy
Cerebral Vasculitis: Imaging Signs Revisited

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PURPOSE
Inflammatory stenoses of the cerebral blood vessels are an important cause of cerebral ischemia. The diagnosis is difficult even with brain biopsy. The purpose of this study was to establish the value of MR imaging for the direct identification of vessel wall inflammation.

MATERIALS & METHODS
Thirty-one patients were retrieved from the files of two University hospitals. Ten patients were children (2 to 9 years, 9 female, 1 male, mean age 4.1 years) and 21 adults (18 to 76 years, 12 female, 9 male, mean age 45.4 years). Diagnosis was based on histologic or serological proof of vasculitis or on clinical and imaging criteria (Calabrese). In total 97 MR imaging examinations, mostly including TOF MRA, diffusion-weighted imaging and contrast-enhanced images were reviewed. The MR scans were assessed for the presence of ischemic brain lesions and vessel wall abnormality. Presence and location of stenoses was evaluated on MRA and DSA. Patients were classified according to the location of the vasculitic changes (large, medium and small brain arteries) and the presence of vessel wall thickening and contrast uptake.

RESULTS
Twenty-six patients were found to have large vessel disease, four medium vessel vasculitis and one small vessel involvement. Twenty-eight patients had brain abnormalities on T2 images, 18 on diffusion-weighted imaging and 25 on MRA. Vascular abnormalities comprised focal or disseminated stenoses, mainly of the basal brain vessels. In 24 patients, thickening of the vessel wall in areas of stenosis was seen and in 19 patients severe mural contrast enhancement was demonstrated. Vessel wall contrast uptake was a feature of large vessel vasculitis.

CONCLUSION
Intramural contrast uptake may be the most reliable imaging sign of large cerebral vessel inflammation. Inflammatory changes of medium-sized vessels are better demonstrated on DSA whereas the diagnosis of small vessel vasculitis has to rest on biopsy.

KEY WORDS: MR imaging, vasculitis, stroke

Diagnostic Accuracy of CT Perfusion in Vasospasm

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PURPOSE
The purpose of this study is to prospectively evaluate the diagnostic accuracy of CT perfusion (CTP) parameters and to determine a threshold value for vasospasm diagnosis in aneurysmal subarachnoid hemorrhage (A-SAH) patients.

MATERIALS & METHODS
A total of 30 patients with A-SAH were enrolled prospectively in an IRB-approved study protocol and were monitored according to clinical exam, transcranial Doppler ultrasound (TCD) and digital subtraction angiography (DSA) during hospitalization. CTP was performed between days 4-9 following aneurysm rupture. Standard and uniform technique was employed in postprocessing CT perfusion data. Mean quantitative cerebral blood flow (CBF), cerebral blood volume (CBV), and mean transit time (MTT) values were obtained using standard region-of-interest (ROI) placement sampling the cortical gray matter in the anterior, middle and posterior cerebral artery territories. The reference standard used for determination of vasospasm is a composite criterion incorporating information from clinical, TCD, DSA, treatment and outcome.

RESULTS
Receiver operating characteristic (ROC) curves were performed to determine diagnostic accuracy of each CTP parameter. CBF had the highest diagnostic accuracy of 97%, followed by MTT of 83% and CBV of 78%. Several methodologic approaches were used to select a CBF threshold value in the detection of vasospasm based on the prevalence of vasospasm, test characteristics of CTP (sensitivity and specificity), ROC curve analysis (maximizing correctly classified subjects), as well as the net benefit and cost of treatment of patients with vasospasm (population utility). Using these different methods, the CBF threshold value may range from 30.22 - 43.32 mL/100gm/min.

CONCLUSION
The diagnostic accuracy of CBF, CBV and MTT for detection of vasospasm in A-SAH patients was determined with CBF having the highest diagnostic accuracy. Choosing a methodologic approach to select the CBF threshold value should be determined according to the physician’s desired goals in managing patients with A-SAH. The authors support using the population utility method with a CBF threshold value of 38.06 mL/100gm/min.

KEY WORDS: CT perfusion, vasospasm
Determining the Extent of the Infarct Core with an Exclusively Visual Assessment of Perfusion CT Cerebral Blood Volume Color Maps: Comparison with Delayed Diffusion-Weighted Images in Patients with Arterial Recanalization

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PURPOSE
Perfusion CT (PCT) has demonstrated to be a valid technique to image ischemic penumbra in acute stroke patients. Patients with large spatial mismatch between areas of reduced cerebral blood volume (CBV) and areas of increased mean transit time (MTT) are considered better candidates for thrombolyis. CBV quantitative measurements are validated to differentiate infarcted from ischemic tissue. Nevertheless quantitative CBV assessment relies on complex mathematical processes, requires sophisticated software, often not commercially available, and might be influenced by the venous reference choice, partial-voluming, and the physiologic gray-white matter difference in CBV. We sought to determine whether exclusively visual (eye-balling) assessment of PCT-CBV color maps might represent a valid technique to recognize the area of infarct-core, within the hypoperfused brain region.

MATERIALS & METHODS
In a larger series of acute stroke patients underwent PCT study at admission, we considered a subgroup of 12 consecutive patients, with admission CT angiography evidence of intracranial arterial occlusion, and whose MRI-MRA, performed 24-48 hours later, showed vessel recanalization. In 6/12 patients iv r-TPA thrombolysis was administered. PCT was performed with a multidetector-CT, with a double-level acquisition technique, allowing total axial coverage of 40 mm. MRI (1.5T), included an axial-oblique DWI b0-1000 sequence, with slices oriented similarly to the PCT acquisition, and a 3D-TOF-MRA sequence. PCT data were post-processed with a commercially available deconvolution-based software; the venous reference was chosen from the superior sagittal sinus. MTT and CBV color maps were generated and visually evaluated with flexible window setting. ROIs were drawn to measure areas of visually assessed reduced CBV, indicating infarct-core, and the areas of increased signal in the corresponding sections of the b1000-DWI images. The sum of the areas of the ROIs with reduced CBV was compared with the sum of the areas of the ROIs with increased signal on DWI images. Linear regression analysis was used to compare infarct size on the corresponding sections of the PCT and DWI-MR.

RESULTS
There was significant correlation (p<0.05; r²=0.822) between the extent of areas of visually assessed reduced CBV on the admission PCT color maps and the extent of areas showing restricted diffusion on the delayed DWI-MR images, in our series of patients with recanalization, spontaneous or following thrombolysis. There was a trend toward larger areas of infarct visible on DWI-MR compared to the areas of reduced CBV on PCT maps, indicating very high specificity of PCT-CBV maps. Only in 1/12 case the PCT-CBV map failed to detect a CBV abnormality, in a patient whose subsequent DWI-MR showed a lacunar infarct.

CONCLUSION
Subjective visual assessment of reduced CBV on admission PCT color maps in acute stroke patients seems to be a valid approach for the evaluation of the extent of the infarct-core. Areas of visually assessed reduced CBV correlate with areas of delayed DWI-MR abnormality in patients with arterial recanalization. Computation of quantitative measurements of CBV, complex and not easily achievable in clinical setting, although more rigorous and precise, might not be necessary for assessment of ischemic penumbra, for selection of stroke patients candidate to thrombolysis.

KEY WORDS: Stroke, perfusion CT
CONCLUSION
In conclusion, CASSL provides individual perfusion maps of the brain. These maps provide important information for diagnosis and therapy of cerebrovascular disease.

KEY WORDS: Continuous artery-selective spin labeling (CASSL), stroke, individual brain perfusion maps

Paper 380 Starting at 4:11 PM, Ending at 4:19 PM
Association of Pretreatment Diffusion-Weighted Imaging Abnormality with Outcome for Intraarterial Stroke Therapy

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Boston, MA

PURPOSE
Factors relating to outcome after intraarterial (IA) stroke therapy have been studied but are not fully elucidated. Clinical and angiographic findings have been associated with outcome. We sought to evaluate the prognostic significance of pretreatment diffusion-weighted imaging (DWI) abnormality on clinical outcome in acute anterior stroke patients treated with IA therapy.

MATERIALS & METHODS
This retrospective study examined all anterior circulation stroke patients from 2005 to the present, who had pretreatment MR imaging and who underwent IA stroke therapy. Baseline clinical variables were gathered. Success of IA treatment was evaluated with the Mori scale for reperfusion. The DWI abnormalities were visually segmented using a semiautomated commercial analysis program by raters blinded to the clinical outcome. Also, the ASPECTS (Alberta Stroke Program Early CT Score) grading system and a modified version (m-ASPECTS) were applied to the DWI images. In m-ASPECTS, each region of the ASPECTS system was subdivided into less than 50% (one point) or greater than 50% (two points) involvement. For both grading systems, points for abnormal regions were added to calculate a final score, as opposed to subtracted from the total number of points as in the original system. Outcomes were evaluated by the modified Rankin Score (mRS) at 3 months and were dichotomized into favorable (mRS 0-2) or unfavorable (mRS 3-6). Differences between these two groups were analyzed with respect to DWI volumes, ASPECTS and m-ASPECTS scores by the t-test with unequal variances. In addition, correlation coefficients were calculated between the DWI volumes and the ASPECTS and m-ASPECTS scores.

RESULTS
Twenty-two patients were studied (9 males, 13 females). The average age was 68.7 years (range 24-92). The average NIHSS was 18.4 (8-30). The average time from symptom onset to IA treatment was 6:57 hours (4:15-17:27). There were 11 ICA occlusions and 11 M1 or M2 occlusions. The average Mori score was 1.7 (0-4). The average mRS at 3 months was 4.0 (1-6), and five patients had favorable outcome. The average DWI volume for patients with favorable versus unfavorable outcome was 20.4 mL versus 56.7 mL (p=0.03). No patients with a DWI volume greater than 26 mL had a favorable outcome. The only other factor that had statistical significance was Mori score (p=0.04). The difference in m-ASPECTS score approached statistical significance (p=0.053). There was a trend towards worse outcome for patients with higher NIHSS (p=0.09), longer time from onset (p=0.13), and proximal level of occlusion (p=0.14). The DWI volume strongly correlated with both m-ASPECTS (R^2=0.76, p=0.00002) and ASPECTS (R^2=0.70, p=0.0001).

CONCLUSION
For patients with anterior circulation strokes who undergo IA therapy, those with a favorable outcome have a smaller pretreatment DWI volume than those who do not. This difference in DWI volume had the strongest significance among all factors analyzed. This study demonstrates that pretreatment imaging, specifically DWI abnormality, may be an important prognostic tool for patients undergoing IA stroke therapy. Furthermore, a simple grading system such as ASPECTS or m-ASPECTS may be a useful surrogate for DWI volume.

KEY WORDS: Stroke, MR diffusion imaging, intraarterial therapy

Paper 381 Starting at 4:19 PM, Ending at 4:27 PM
Diffusion-MR Angiography Mismatch: A Novel Diagnostic Approach to Ischemic Penumbra

Rovira, A. · Auger, C. · León, A. · Huerga, E. · Molina, C. · Granados, A. · Frascheri, L. · Alvarez-Sabin, J. · Munuera, J.
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PURPOSE
Thrombolytic therapy in acute ischemic stroke requires an adequate selection strategy. This selection can be made according to the MR-based diffusion-perfusion mismatch (DPM) concept, which indicates the presence or absence of potentially salvageable ischemic brain tissue. However, perfusion-weighted imaging (PWI) is a complex, time-consuming, and not well standardized technique, which limits the use of MR imaging in selecting acute stroke patients for this purpose. Moreover, the visual estimate of DPM is not reliable among observers and should be used with caution as the deciding factor in treatment. Therefore, an alternative method for identifying ischemic penumbra seems necessary. It is known that the volume of a PWI abnormality can be predicted by the presence and location of the arterial occlusion shown by MR angiography (MRA). Thus, we investigated the diagnostic properties of a mismatch between the presence of a proximal vessel occlusion (ICA and/or M1 segment) and the extension of the diffusion-weighted imaging (DWI) lesion (DWI-MRA mismatch) for predicting the presence of a DPM.

MATERIALS & METHODS
The study was performed in consecutive acute stroke patients candidates to receive intravenous rTPA referred to our department for MR imaging evaluation. Inclusion criteria for this study were: (a) No MR imaging evidence of acute
intraparenchymal hemorrhage; (b) Presence of an acute infarct within the MCA territory demonstrated at initial or follow-up imaging; and (c) MR examination carried out within the first 6 hours after symptoms onset, including DWI, PWI (time-to-peak maps) and MR angiography (MRA). Volume measurements of the extension of the tissue abnormality on DWI and time-to-peak (TTP) maps were done with a manual tracing technique by a single investigator. DWI-MRA mismatch (DMM) was defined as presence of an occlusion of the ICA and/or M1 segment associated with an ischemic volume on DWI of ≤90 mL. Positive DPM was defined as PWIvol-DWIvol/DWIvol x 100 > 20% associated with an ischemic volume on DWI of ≤90 mL.

RESULTS
Two hundred four patients were included in this study (115 female, mean age: 71.7 years; range 16-97). Arterial occlusion was identified in 192 patients (94.1%) (ICA 20.6%, M1 42.2%, M2 19.1% and both ICA and M1 12.3%). Mean DWI volume was 47 mL (range 0 to 366 mL), while mean PWI volume was 188 mL (range 0 to 439 mL). One hundred twenty-five patients (61.3%) had a positive DMM and 169 patients (82.8%) had a positive DPM. The diagnostic properties of presence of DMM with regard to presence of DPM showed a sensitivity of 72.8%, a specificity of 94.3% and an accuracy of 76.4%.

CONCLUSION
DMM predicts the presence of DPM with very high specificity. This novel approach to ischemic penumbra may simplify the MR imaging diagnostic workup for selecting candidates for thrombolytic therapy in a high percentage of cases.

KEY WORDS: Stroke, diffusion, MR angiography

Paper 382 Starting at 4:27 PM, Ending at 4:35 PM
Fate of CT-Perfusion Matched and Mismatched Defects following Intraarterial Thrombolysis: Are We Accurately Defining Salvageability and Futility?

Bellon, R. J. · Frei, D. F. · Huddle, D. C. · Baker, K. · Chen, R. P. · Smith, D.

1 Radiology Imaging Associates, Englewood, CO, 2 Blue Sky Neurology, Denver, CO

PURPOSE
It has been proposed that “matched defects” on CT perfusion (CTP), with diminished cerebral blood volume (CBV) as well as prolonged mean transit time (MTT) and diminished cerebral blood flow (CBF), represent areas of irreversible ischemic injury, whereas lesions with abnormal CBF and MTT but preserved CBV (mismatched defects) are potentially salvageable tissue if they can be revascularized in a timely fashion. We test this hypothesis by examining the eventual fate (infarction vs noninfarction) of matched and mismatched defects as a function of revascularization.

MATERIALS & METHODS
A retrospective review of our intraarterial (IA) stroke data base over a 2-year period from September 2004 to September 2006 was performed so as to identify patients in whom technically adequate preoperative CTP data were available who subsequently went for emergent IA thrombol-

y. All CTP data were acquired with a 40 cc contrast bolus of Isovue 370 on a GE Lightspeed 16 CT scanner and processed on a GE Advantage workstation. Two observers reviewed the CTP data, the angiographic images, as well as follow-up neuroimaging, reaching a consensus decision. The presence/absence of matched/mismatched defects was determined. Initial angiographic and final post-thrombolysis images were graded using the Mori(1) recanalization scale. Clot locus was determined. Postoperative imaging was determined to review what percentage of both the matched and mismatched defects went on to infarction, as well as assessed for the presence of hemorrhage.

RESULTS
We identified 34 patients (mean age 66 years). Ten patients had mostly matched defects and 24 had mostly mismatched defects. A recanalization score (RS) was calculated by subtracting the initial Mori score from the final Mori score; a cutoff RS of two or more defined “recanalizers” (23 patients) vs “nonrecanalizers” (11 patients). The percentage of the mismatched defect that ultimately infarcted was significantly greater in nonrecanalized patients as compared to those who did reanalyze (P = 0.026). On the other hand, the percentage of the matched defect that infarcted was not different for those who reanalyzed vs those who did not (P = 0.94). In almost all cases a mostly matched deficit went on to infarction, whether or not recanalization occurred.

CONCLUSION
Matched defects almost always completely or near-completely infarct, regardless of whether or not they are recanalized. In contradistinction, mismatched defects show an inverse correlation between the degree of recanalization and degree of infarction. This supports the use of CTP as a triage tool in acute stroke to determine salvageability vs futility.

REFERENCES

KEY WORDS: CT perfusion, intraarterial thrombolysis
Thursday Afternoon

3:15 PM – 4:45 PM
Columbus I-L

(55b) INTERVENTIONAL: Stroke and Arteriovenous Malformations/Fistulae
(Scientific Papers 384 – 394)

See also Parallel Sessions
(55a) ADULT BRAIN: Cerebrovascular Occlusive Disease III
(55c) SPINE: Spinal Cord and Degenerative Inflammatory Infections
(55d) ADULT BRAIN: Neoplasms II and New Techniques Post-Processing

Moderators: Joshua A. Hirsch, MD
Frank C. Tong, MD

Paper 384 Starting at 3:15 PM, Ending at 3:23 PM
Effect of Multitechnique Intraarterial Therapy on Clinical Outcomes in Acute Anterior Circulation Ischemic Stroke: Experience at a Large Academic Hospital

Yoo, A. J. · Barak, E. R. · Dabus, G. · Preciado, C. V. · Barrocas, A. M. · Nogueira, R. G. · Rabinov, J. D. · Pryor, J. C. · Schaefer, P. W. · Gonzalez, R. G. · Hirsch, J. A.
Massachusets General Hospital
Boston, MA

PURPOSE
The variables affecting clinical outcome in anterior circulation stroke patients undergoing intraarterial (IA) therapy have been studied but are not fully elucidated. There are few published single-center experiences employing multiple recanalization techniques. We present one such experience at a large academic hospital.

MATERIALS & METHODS
We studied 43 patients with anterior circulation strokes who underwent IA recanalization via chemical and/or mechanical means between 2004 and 2006. Baseline clinical and demographic data were collected. Reperfusion was classified according to the Mori scale. Outcomes were measured using modified Rankin Score (mRS) at 3 months, and were dichotomized into good outcome (mRS 0-2) and poor outcome (mRS 3-6).

RESULTS
Twenty-one men and 22 women with a mean age of 66 years (range 19-93) were studied. Twenty-one patients received systemic IV tPA prior to IA therapy. Thirteen (30.2%) patients had ICA occlusions, all of whom had clot in the MCA. Thirty (69.8%) patients had M1 and/or M2 occlusions. Twenty-three (53.5%) patients received urokinase. Six (14.0%) patients received eptifibatide. One (2.3%) patient received abciximab. Thirty (69.8%) patients underwent wire manipulation. Twenty-one (48.8%) patients were treated with the Merci device. Ten (23.3%) underwent balloon angioplasty. Thirty-one (72.1%) patients received a combination of IA recanalization techniques. Eleven of 43 (25.6%) patients had good outcome and 32/43 (74.4%) patients had poor outcome. On average, patients with good outcome were younger (56 versus 70, p=0.05), had lower initial NIHSS (15.1 versus 20.3, p=0.003), had a smaller percentage with a history of atrial fibrillation (18% versus 50%, p=0.05), had a smaller percentage of ICA occlusions (9% versus 34%, p=0.05), and had higher rates of reperfusion (Mori 2.9 versus Mori 1.2, p=2x10^-6) versus those with poor outcome. None of 16 patients with no reperfusion (Mori 0-1) had good outcome. Four of 11 (36%) patients with good outcome and 13/32 (41%) patients with poor outcome received IV tPA prior to IA therapy (p=0.81). Nine of 11 (81.8%) patients with good outcome and 22/32 (68.8%) patients with poor outcome received a combination of IA recanalization techniques (p=0.39). No significant difference was found between good and poor outcome with respect to time from symptom onset to end of IA therapy, side of infarction, diabetes mellitus, admission glucose and systolic blood pressure.

CONCLUSION
In our study population, good clinical outcome was strongly associated with success of reperfusion. All patients without any reperfusion (Mori 0-1) had poor outcome. A higher percentage of patients with good outcome received a combination of IA recanalization techniques, although this was not statistically significant. In this population, IV tPA prior to intraarterial thrombolysis did not improve outcomes. Younger age and lower initial NIHSS were associated with good outcomes. Atrial fibrillation and ICA occlusion were associated with poor outcome.

KEY WORDS: Stroke, intraarterial therapy, outcomes

Paper 385 Starting at 3:23 PM, Ending at 3:31 PM
Factors Associated with a “Lazarus Phenomenon” 24 Hours following Intraarterial Thrombolytic Treatment in Acute Ischemic Stroke

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PURPOSE
To identify factors which are associated with a significant improvement in clinical outcome within 24 hours following intraarterial thrombolytic treatment for acute ischemic stroke.

KEY WORDS: Stroke, intraarterial therapy, outcomes
**Materials & Methods**

This study reviewed prospectively collected clinical information, arteriograms and CT scans obtained 24 hours following treatment, from 102 consecutive patients who underwent intraarterial thrombolysis within 6 hours following symptom onset. Lazarus phenomenon (LP) was defined as a decrease in National Institutes of Health Stroke Scale score (NIHSS) score by at least 50% 24 hours following treatment. Arteriograms were reviewed to assess reperfusion on the basis of TICI (thrombolysis in cerebral infarction) score and to assess pial collateral formation. Logistic regression analysis for LP used the following predictors: pretreatment NIHSS score, thrombolytic agent, age, time to treatment, sex, presenting systolic blood pressure, admitting glucose value, admitting platelet level, site of occlusion (distal vs proximal), and good pial collateral formation. All factors with p < .05, were entered into the final model as predictors of clinical outcome using backward selection.

**Results**

LP occurred in 25 (24.5%) of patients. Logistic regression analysis identified time to treatment (estimate 0.00784 per min, p = 0.0079) and TICI score of 2 or 3 (estimate -1.91, p = 0.0019) as statistically significant predictors for LP. Mean time to treatment was 208 minutes [standard error (SE) = 31] vs 306 minutes (SE = 17) in patients with vs without LP (p < 0.0067 ANOVA). LP was associated with 42% of patients with a TICI score of 2 or more (at least 50% reperfusion) and 7.7% of patients with a TICI score of 0 or 1 (p < 0.0001, Pearson).

**Conclusion**

Immediate improvement in NIHSS score by at least 50% following symptom onset (Lazarus phenomenon) occurred in 24.5% of patients undergoing intraarterial thrombolytic therapy and occurred with shorter time to treatment and a reperfusion of at least 50% following intraarterial thrombolytic treatment.

**Key Words:** Stroke, thrombolysis, intraarterial

**Paper 386 Starting at 3:31 PM, Ending at 3:39 PM**

Tandem Stenosis/Occlusion in the Interventional Management of Stroke Studies

Greeley, A. L. · Tomskill, T. A. · Broderick, J. · The IMS Investigators

University of Cincinnati

Cincinnati, OH

**Purpose**

Good outcomes of tandem ICA and MCA occlusions have been suggested to be 18.2% (1) with IV rtPA treatment. We report clinical outcomes of subjects with tandem occlusions in the Interventional Management of Stroke (IMS) I and II trials.

**Materials & Methods**

We retrospectively reviewed angiography data, clinical modified Rankin score (mRS) outcomes, baseline NIHSS, and mortality from a subset of patients with cervical ICA stenosis or occlusion and intracranial occlusion from IMS trials. Subjects, ages 18-80 with a baseline NIH Stroke Scale ≥ 10, were administered IV rtPA (0.6 mg/kg, 60 mg maximum over 30 minutes) within 3 hours of stroke onset. Subjects with eligible clot in extra or intracranial cerebral vessels were subsequently administered up to 22 mg IA rtPA at the clot site, using standard microcatheters or the EKOS ultrasound catheter, for a maximum of 2 hours infusion, or until thrombolysis was achieved.

**Results**

Thirty-five of 153 (23%) IMS subjects presented with acute ischemia and severe cervical ICA stenosis (n = 21) or occlusion (n = 14). Mean baseline NIHSS for all subjects with ICA stenosis/occlusion was 17.7. Tandem proximal arterial occlusive lesions (AOL) accompanying cervical ICA disease at arteriography included 10 (28%) ICA terminus, 20 (57%) M1 or M2 occlusions. Five instances of no or distal M3, M4 occlusion may have had tandem AOL at onset, subsequently recanalized. Mean baseline NIHSS for the 30 subjects with tandem ICA stenosis/occlusion was 17.6. Functional clinical outcome (mRS ≤ 2 at 90 days) was achieved in 10 (33.3%) of the 30 tandem occlusion subjects, with 20% (6/30) mortality. mRS ≤ 2 outcomes were achieved in 3/17 (17.6%) of the atherosclerotic stenosis and in 2/8 (25%) of the occlusion groups. Mortality was nonsignificantly lower in the stenosis group (17.6% vs 37.5 %, p = 0.34 ). Of eight subjects with atherosclerotic occlusions, four were stented in nonprotocol, off-label fashion, with two achieving mRS ≤ 2, with one death. The two patients with good outcomes had individual NIHSS of 10 and 12, respectively. None achieved mRS ≤ 2, and there were two deaths, in the nonstented group. There were five ICA dissections in the tandem group. One subject with ICA dissection was stented. mRS 0-2 outcome was more favorable for those with ICA dissection compared to atherosclerotic disease (5/5 vs 5/25, p = 0.002).

**Conclusion**

A trend toward better outcomes with an IV/IA thrombolysis paradigm in acute ischemia with tandem ICA and MCA lesions, compared to IV tPA alone, may be suggested in the IMS studies. ICA dissections exhibited better outcomes than atherosclerotic stenoses or occlusions, with or without ICA stenting.

**References**


**Key Words:** Thrombolysis, internal carotid artery, tandem
**Paper 387 Starting at 3:39 PM, Ending at 3:47 PM**

**Intravenous Infusion of Eptifibatide as Adjunctive Therapy to Intraarterial Thrombolysis in Acute Stroke Patients**

Shaltoni, H. M. · Martin-Schild, S. · Illoh, K. · Hallevi, H. · Barreto, A. · Supsupin, E. · Khaja, A. M. · Gonzales, N. R. · Weir, R. U. · Noser, E. A. · Grotta, J. C. · Cacayorin, E.

University of Texas Health Science Center Houston, TX

**PURPOSE**

Intravenous tissue plasminogen activator (IV TPA), the only approved drug for treatment of acute ischemic stroke patients has limited action on large vessel thrombi in addition to reocclusion occurring in one third of treated patients. Recanalization of the occluded vessel is considered one of the strongest predictors for good outcome in stroke patients. Our objective is to assess the safety of a dose-escalating protocol of Eptifibatide, a glycoprotein IIb/IIIa platelet inhibitor, following intraarterial thrombolitics (IAT) with or without IV TPA in acute stroke. We hypothesized that Eptifibatide could potentially enhance recanalization of the arteries and maintain patency of opened and only partially recanalized vessels and the existing collaterals after IAT.

**MATERIALS & METHODS**

Patients with acute ischemic strokes who are qualified for IAT per protocol in our institution were treated with Eptifibatide if maximum dose of IAT or time window were reached and complete recanalization was not achieved. For IAT, seven patients received Reteplace, four had Urokinase, and two had Tenecteplase. Three patients that required emergent stenting also were included in the study. Two patients also had received IV TPA. The usual dose protocol for Eptifibatide was a loading dose 75-135 microgram/kg followed by continuous infusion 0.75-1.35 microgram/kg/minute for 24-48 hours. Dosage was increased to 180 microgram/kg loading and 2 microgram/kg/minute infusion in the last seven patients. Patients were loaded with aspirin and clopidogrel 6 hours prior to Eptifibatide discontinuation. Platelet count and hemoglobin (Hb) were monitored every 6 hours. The infusion was stopped if platelet count was < 100 or Hb decreased by 3 g/dl. All patients had CT or MRI postinfusion to assess for intracranial hemorrhage (ICH) and extent of infarction.

**RESULTS**

From 8/2005-11/2006, a total of 13 patients, eight males, five females, age 36-70 years were included in the study. NIHSS ranged from one to 29 (median 15). Eptifibatide was given in seven patients during the IAT and to the other six patients within 2 hours of the procedure for duration of 2.5-48 hours. Major vascular occlusions were localized in the basilar artery in six patients, proximalICA in three, and “T” internal carotid occlusions in two, and M-1 middle cerebral segments in two. Ten of the 13 patients (77%) had recanalization of the major vascular occlusions and with sustained patency on follow-up studies. One patient had occlusion of the stent attributed to early termination of infusion and prior to attainment of maximal effects from oral antiplatelets. Two of the patients failed to recanalize. None of the patients had ICH. Four patients were discharged home, four to rehabilitation and three to a nursing facility. Mortality in two. NIHSS at discharge ranged from 0 to 17 (median 5).

**CONCLUSION**

Intravenous infusion of Eptifibatide appears safe and may improve outcomes as an adjunctive therapy to IAT in selected patients with acute ischemic stroke.

**KEY WORDS:** Stroke, eptifibatide, intraarterial thrombolysis

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**Paper 388 Starting at 3:47 PM, Ending at 3:55 PM**

**Transarterial Treatment with Onyx® in Intracranial Dural Arteriovenous Fistulas: Experience in 30 Patients**

Tahon, F.1 · Belmar, A.1 · Salkine, F.1 · Torrico, A.2 · Teva, J.2 · Turjman, F.1

1Hopital Neurologique et Neurochirurgical, Bron, Lyon, FRANCE, 2Hospital Clinico P. Universidad Catolica de Santiago de Chile, Santiago, CHILE

**PURPOSE**

To evaluate effectiveness and safety of Onyx® in the transarterial endovascular treatment and to determine the place of Onyx® in the current therapeutic strategies.

**MATERIALS & METHODS**

Retrospective study of 30 consecutives patients treated by transarterial embolization with Onyx, between September 2004 and August 2006, in two centers: eight patients at Santiago, Chile and 22 patients at Lyon, France. Patients were between 7 and 81 years old (mean 55.7), 16 females and 14 males. We included all consecutive intracranial dural arteriovenous fistulas; the cavernous fistulas have been excluded.

**RESULTS**

The complete cure was obtained in 25 cases (83.3%), in 23 cases with transarterial embolization only (92%). Onyx® was the unique embolic agent in 21 cases, 15 cases were performed in one session. The mean number of embolizations was 1.5 In the five remaining cases: four treatments are in progress and one treatment was stopped (asymptomatic patient with benign fistula). The percentage of complete occlusion was higher in superior sagittal sinus and posterior fossa fistulas. The percentage of complete occlusion was higher in type IV and V (Cognard’s classification). Two clinical complications occurred: one patient experienced a thalamus ischemia with subsequent clinical improvement and one patient had a cardiac arrest with complete recovery secondary to an allergic reaction. Three technical complications: two microcatheters broke during removal from the external carotid artery and one catheter was stuck and left in place in the patient with the first clinical complication.

**CONCLUSION**

Onyx® transarterial embolization is effective and safe in the intracranial dural arteriovenous fistulas, is suitable for complex fistulas. In our experience, Onyx® transarterial embolization is the first treatment to perform in intracranial dural arteriovenous fistulas.

**KEY WORDS:** Intracranial dural arteriovenous fistula, embolization, management
**Purpose**
To evaluate efficacy of N-butyl cyanoacrylate (NBCA) vs Onyx for the embolization of cranial dural arteriovenous malformations. Background: Treatment algorithms for cranial dural AVMs often include embolization of external carotid branches followed by surgery to disconnect remaining supply from internal carotid or verteobasilar branches and external carotid branches inaccessible by microcatheter. Radiotherapy is an alternative or adjunct in some cases. Another approach includes dural venous sinus coil occlusion in lesions along the transverse or sigmoid sinuses. N-butyl cyanoacrylate mixed with ethiodol has been used for embolization, and currently, our group has transitioned to the use of Onyx.

**Materials & Methods**
Thirty-six patients with dural AVMs of the skull base and calvarium from November 2003 through November 2006. Exclusion criteria: anterior cranial fossa lesions (1), combined lesions with pial or parenchymal AVM components (1), complex cranio cervical lesions (3). Cavernous carotid fistulas also were not included in the group. The remaining 31 patients had planned embolization of 32 lesions to as complete as possible followed by surgery as needed. In case of complete embolization, close interval angiographic follow up at 2-3 months is nearly complete and follow up at 1 year is planned.

**Results**
The embolization group included 23 males and 8 females. All patients had Cognard type 3 or 4 lesions except for two cases in the Onyx group one of which was Cognard 2A+B and one was type 2A with severe tinnitus and shunting with CHF. Twenty patients were treated with NBCA embolization including one with additional venous sinus occlusion with coils. Twelve patients were treated with Onyx embolization. Initial complete occlusion was achieved in seven NBCA cases and nine Onyx cases. Recanalization was seen in one of the NBCA cases which was treated further with proton radiotherapy and one of the Onyx cases which will undergo a third embolization. There is a trend but no statistical significance of initial cure rates using two-tailed Fisher’s exact test with p < .0659. Short-term and long-term follow-up studies are pending in some cases. Complications occurred in the diagnostic angiogram of one patient with colon cancer and a small left posterior cerebral artery embolus. Hypercoagulability may have contributed to this event. This 83-year-old patient presented with and died of uncontrolled status epilepticus despite 98% closure of the lesion with NBCA. One patient in the Onyx group developed a mild right facial palsy. Surgical complications include a mild right trigeminal sensory deficit and a bone flap infection.

**Conclusion**
Initial cure rates for embolization of cranial dural arteriovenous malformations show a trend for higher efficacy with Onyx compared to NBCA, but this is not yet statistically significant.

**Key Words:** Dural AVM, embolization
Paper 391 Starting at 4:11 PM, Ending at 4:19 PM

Ear Arteriovenous Malformations Management

Yakes, W. F.
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Englewood, CO

PURPOSE
To determine the efficacy of ethanol endovascular repair of ear arteriovenous malformations (AVMs).

MATERIALS & METHODS
Six patients (5 female, 1 male; age range 6-39 years; mean age: 22 years) with ear AVMs presented for therapy. Two patients had failed prior embolizations (PVA/coils/nBCA/steroids) and two patients had other therapies (laser/excisions/grafting). All presented with grossly enlarged painful ear with intermitten bleeding. All patients underwent transcatheter and direct puncture ethanol Rx (77 procedures).

RESULTS
All six patients were cured of the AVM at long-term follow up (mean follow up: 39 months). One patient had transient partial VII nerve palsy. Two patients had minor blisters.

CONCLUSION
Ethanol endovascular repair of ear AVMs can effect cures in this vexing lesion.

KEY WORDS: Ethanol, arteriovenous malformations, ear

Paper 392 Starting at 4:19 PM, Ending at 4:27 PM

Endovascular Treatment of Brain Arteriovenous Malformations Using Onyx®18

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Paris, FRANCE

PURPOSE
To report our experience in intracranial arteriovenous malformations (AVMs) treatment using Onyx®18.

MATERIALS & METHODS
From January 1999 to August 2006, we treated 201 patients (M:108 and F:93) with intracranial AVMs using Onyx®18. The neurologic status has been evaluated before and after each procedure. The control angiogram was done 6 months after the complete anatomical exclusion had been achieved.

RESULTS
The average age was 31 years (range 6-67 years). Ninety-two (45.7%) patients had a hemorrhage at clinical presentation, progressive neurologic deficit in 39 (19%) patients, seizure in 51 (25%) patients, and 19 cases which were asymptomatic. According to the Spetzler and Martin classification, 15 (7.4%) AVMs were grade I, 78 (38.8%) were grade II, 75 (37.3%) were grade III, 30 (14.9%) were grade IV and 3 (1.4%) were grade V. Four hundred ten endovascular procedures were performed (average 2.04 procedure/patient). Onyx was used as a liquid embolic agent in at least one of the procedures which benefited each patient. Three hundred seventy-nine procedures were performed using only Onyx. AVM treatment has been finished in 149 patients and is still undergoing in 52 (25.8%) patients. AVM treatment has been achieved in 83 (55.7%) patients with only endovascular treatment. Thirteen (8.7%) patients benefited from a surgical resection of the residual nidus, and 27 (18.1%) patients underwent radiosurgical treatment after embolization nidus reduction to a suitable size (< 2 cm). Seven of all patients had endovascular treatment before in another department. Arterial aneurysms were found in 10 patients. When an aneurysm was believed to be responsible for a hemorrhage, it was treated before the arteriovenous malformation was treated. Fourteen (9.3%) patients had neurologic deficits as a result of endovascular treatment of AVMs. The complications were separated into two groups: hemorrhage (7 patients with hematomas and 6 patients with SAH) and ischemic (2 cases). Four patients died. Death was not related to Onyx injection in any of them.

CONCLUSION
Onyx is a safe liquid embolic agent which allows treatment of voluminous AVMs with low hemorrhagic risk.

KEY WORDS: Brain AVMs, endovascular, treatment

Paper 393 Starting at 4:27 PM, Ending at 4:35 PM

Follow Up in Treatment of Carotid Cavernous Fistula with Covered Stent

Escobar, W. · Gomez, F.
Centro Medico Imbanaco
Cali, COLOMBIA

PURPOSE
Present the mid-term follow-up results of carotid cavernous fistula (CCF) treated with covered stents, demonstrating that covered stents occlude the fistula, preserve the artery and produce minimal intimal hyperplasia. The treatment of CCF using detachable balloons is an effective method to occlude the fistulas in most instances. There are however, cases that pose technical difficulties for the use of detachable balloons. Various therapeutic alternatives have been described, including the use of detachable coils, bare stents and covered stents. There are only a few reports describing the use and follow up of covered stents in the treatment of CCF.

MATERIALS & METHODS
A total of 46 CCF were treated in our angiography unit at the Centro Medico Imbanaco between November first 1998 and November first 2006; 39 were posttraumatic and seven spontaneous. Sixteen patients were treated using the traditional transluminal detachable balloon technique. The rest were treated as follows: transluminal coils in six patients, one of them with remodeling technique; Transvenous coils in three patients; transluminal coils and histoacryl in four patients; transvenous coils and histoacryl in eight patients; bare stent plus coils in two patients; and coronary balloon expandable stent-graft in seven patients. The covered stents were delivered using a triaxial system with 10F introducer, 7F shuffle catheter and 6F Envoy guide catheter with 300 centimeters extrasupport choice microwire. The patients were premed-
icated with clopidogrel 75 mg QD and aspirin 100 mg QD three days before the procedure. The clopidogrel was to be continued for 6 months and ASA for life. All procedures were performed under general anesthesia. Clinical follow up was programmed at 1, 3, 6, 12 and 24 months and angiography and angiotomography follow up was programmed at 3, 6, 12 and 24 months. The patients had a mean age of 35 years. None had recognizable endothelial disease.

**RESULTS**
In the seven patients who underwent treatment with balloon expandable stent-grafts the CCF were occluded successfully without immediate morbidity or mortality. All patients had clinical and angiographic follow up between 2 and 42 months (mean of 15 months). Clinical follow up was satisfactory in all cases without new symptoms or deficit. The angiographic follow up revealed an asymptomatic arterial occlusion at 1 month possibly due to noncompliance with the prescribed antiplatelet regimen. Two patients had minimal intimal hyperplasia without hemodynamic repercussion. Five patients chose to stop the medication, but only one of them demonstrated artery occlusion.

**CONCLUSION**
1) Endovascular repair with covered stents is a safe and effective treatment option for carotid-cavernous fistulas. 2) Antiplatelet therapy is mandatory prior to complete stent endothelization. 3) The stent-grafts induced minimal intimal hyperplasia and there was no hemodynamically significant stenosis. 4) The intimal hyperplasia never progressed. 5) In our series of CCF occlusion using covered stent there was no mortality and only low morbidity.

**KEY WORDS:** Follow up, covered stent

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**Thursday Afternoon**

**3:15 PM – 4:45 PM**

**Grand Ballroom A**

**(55c) SPINE: Spinal Cord and Degenerative Inflammatory Infections**

(Scientific Papers 395 – 405)

See also Parallel Sessions
(55a) **ADULT BRAIN: Cerebrovascular Occlusive Disease III**
(55b) **INTERVENTIONAL: Stroke and Arteriovenous Malformations/Fistulae**
(55d) **ADULT BRAIN: Neoplasms II and New Techniques Post-Processing**

Moderators: Wendy A. Cohen, MD
John L. Go, MD

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**Paper 394 Starting at 4:35 PM, Ending at 4:43 PM**

**Management of Anterior Spinal Artery Syndrome with Direct Heparin and Dexamethasone Infusion**

Ugurel, M. S. · Bozlar, U. · Ustunsoz, B.
Gulhane Military Medical Academy
Ankara, TURKEY

**PURPOSE**
To present an extraordinary case of anterior spinal artery syndrome treated by direct heparin and steroid infusion into arteria radicularis magna (Adamkiewicz artery).

**MATERIALS & METHODS**
Elderly female admitted to neurology wards with diagnosis of anterior spinal artery (ASA) syndrome (dissociated sensory loss and pain in upper extremities) suddenly presented with declining blood oxygen saturation most likely owing to involvement of cervical spinal cord innervating the secondary respiratory muscles of chest wall. ASA supply to lower cervical and upper thoracic cord was not visualized in angiography. Over a period of 30 minutes, 7000 units of heparin and 32 mg of dexamethasone were given by direct infusion into Adamkiewicz artery through a 4F Cobra catheter positioned in the left T-10 intercostal artery.

**RESULTS**
Patient’s blood oxygen saturation immediately rose from 75% to over 90% while she was on the angiography table. ASA supply to C5-T6 segment was better visualized angiographically as well. She made a good recovery overall and was discharged within a week.

**CONCLUSION**
In many cases of ASA syndrome, nothing but a neurointerventionalist familiar with spinal vasculature is needed, who can safely resolve the stagnation and inflammation along the ASA axis by using heparin/steroid duet.

**KEY WORDS:** Anterior spinal artery syndrome, direct heparin infusion

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**Paper 395 Starting at 3:15 PM, Ending at 3:23 PM**

**Spinal and Paraspinal Infection: Value of Diffusion-Weighted Imaging**

Moritani, T. · Smoker, W. R. K. · Okon, A.
University of Iowa Hospitals and Clinics
Iowa City, IA

**PURPOSE**
To evaluate the utility of diffusion-weighted imaging (DWI) in spinal and paraspinal infection.

**MATERIALS & METHODS**
We reviewed DWI findings in 52 patients (36 male and 16 female; age range: 22 - 84 years, mean age: 56.6 years) with spinal and paraspinal infections, including epidural, paraspinal and psoas abscesses, diskitis, osteomyelitis and meningitis. The diagnosis was made based on clinical, laboratory and imaging findings. Causal organisms were proved...
by biopsy and/or blood cultures in 37 patients. Clinical symptoms were fever, neck pain, low back pain, weakness, and mental status changes. Underlying diseases and predisposing factors included IV drug user, surgery, diabetes, liver cirrhosis, renal/liver transplant, and epidural steroid injection. Eleven patients sustained infection after spine surgery or spine tumor resection. Conventional MRI and DWI with ADC maps (b = 0, 1000 sec/mm², 3 orthogonal orientations) were acquired. Regions of interest (0.2-1.8 cm²) were placed manually on the ADC map and ADC values were calculated.

**RESULTS**

There were epidural abscess in 24 patients, paraspinal abscess in 16, iliopsoas abscess in 16, diskitis in 33, osteomyelitis in 34, and meningitis in five. Postcontrast T1-weighted images showed epidural, psoas and paraspinal abscesses as rim-enhancing cystic lesions, which are occasionally difficult to differentiate from postsurgical seromas, pseudomeningoceles, granulation tissues, disk herniations and residual/recurrent tumors. DWI showed pus collection and abscesses as hyperintense with decreased ADC, which can be differentiated from phlegmons, postoperative changes or other pathologies. DWI was useful for application of surgical drainage and decision of a biopsy site. Decreased ADC values were observed in the cystic areas of abscesses: epidural abscess (0.92 ± 0.27 × 10⁻³ mm²/s, mean ± standard deviation); and psoas and paraspinal abscess (0.82 ± 0.31 × 10⁻³ mm²/s), in comparison with the CSF (2.42 ± 0.32 × 10⁻³ mm²/s), muscle (1.44 ± 0.24 × 10⁻³ mm²/s), postoperative fluid collections (2.28 ± 0.54 × 10⁻³ mm²/s). Although ADC values of residual or recurrent tumor were low (0.86 ± 0.12 × 10⁻³ mm²/s), they represented the solid portion of tumors. DWI showed pleural empyema and subcutaneous pus collection as hyperintense lesions, which was also useful for decision of a biopsy site.

**CONCLUSION**

DWI is useful in the detection of epidural, paraspinal and psoas abscesses, and in differentiating them from postsurgical fluid collections, recurrent/residual tumors and other pathologies. DWI is useful for application of surgical drainage and decision of a biopsy site.

**KEY WORDS:** Diffusion-weighted imaging, spine infection, abscess

**Paper 396 Starting at 3:23 PM, Ending at 3:31 PM**

**Imaging Findings in Early Disk Space Infection**

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¹The Cleveland Clinic, Cleveland, OH, ²Barrow Neurological Institute, Phoenix, AZ

**PURPOSE**

Early disk space infection (DSI) may be difficult to distinguish from type I degenerative marrow changes. It was our intention to determine if there are any consistent imaging findings that could be used to help differentiate these entities early in the course of the disease. Early confirmation of suspicion is critical as it would support confirmatory needle biopsy and early antibiotic therapy prior to the onset of bony destruction.

**MATERIALS & METHODS**

We retrospectively reviewed 1455 patients with DSI during the last 7 years. We selected 51 patients with sequential exams within 3 months, the first of which were performed early in the course of clinical symptoms suspicious for DSI. Routine imaging of the spine included sagittal T1, T2 and IR and axial T1 and T2-weighted pulse sequences without or with and without intravenous gadolinium. Forty-two studies had obvious imaging findings of DSI on initial imaging and were eliminated from the review. The preliminary studies of the remaining nine patients were reviewed by two neuroradiologists for the classic MR triad of DSI (low signal marrow changes and indistinct endplates on T1, nonanatomical high signal changes on T2 within the disk space and increased signal on T2 and STIR images in the adjacent marrow). Other changes such as degenerative disk and marrow changes, enhancement pattern and soft tissue abnormalities also were noted. Clinical parameters of these patients also were reviewed to confirm the clinical suspicion of infection at the time of the preliminary study.

**RESULTS**

In the nine patients, seven had back pain and local tenderness, four had fevers, and six had elevated ESR and CRP. On initial MR imaging, there was reduced disk height in seven, marrow T1 hypointensity on at least one side of the disk space in six, IR marrow abnormalities in six, nonanatomical T2 hyperintensity in the disk space in three, equivocal or very mild loss of end-late definition on T1 in three, gadolinium enhancement in the disk space in three, contiguous paraspinal soft tissue in eight, and contiguous epidural soft tissue in nine of nine patients. The second imaging studies demonstrated obvious MR evidence of DSI in all patients.

**CONCLUSION**

In early DSI, the most consistent differentiating sign from type I degenerative marrow changes is the presence of contiguous paraspinal or epidural soft tissue that was disproportionate to the degree of degenerative disk disease. C reactive protein is complimentary.

**KEY WORDS:** Spine, infection, osteomyelitis

**Paper 397 Starting at 3:31 PM, Ending at 3:39 PM**

**Spinal Infection Due to Enteric-Spinal Fistulas: MR and CT Findings with Clinical-Pathologic Correlation**

Pearce, A. A. · Casillas, V. J. · Sklar, E. M. L. · Green, J. · Post, M. J. D.

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**PURPOSE**

To characterize the imaging findings that would aid in the diagnosis of spinal-enteric fistulas, an often elusive and unusual source of spinal infections.

**MATERIALS & METHODS**

Three proved cases of enteric-spinal fistulas were reviewed retrospectively. All three patients had both MR and CT imaging. Imaging findings were correlated with clinical and laboratory data.
RESULTS
The identification of the enteric-spinal fistula as the cause of the spinal infection was delayed in two of the three cases. In the first case, it was delayed 1 year, and in the second case 3 months. Symptoms were nonspecific in these two females and one male, (ages 52-63 years), and did not pinpoint the etiology of the spinal infection. While two patients had fever and all three patients had pain in the region of the spinal infection, none of the patients experienced significant abdominal pain. The diagnosis of an enteric-spinal fistula was established in 2 cases by surgical exploration and in the third case the imaging findings were pathognomonic. Organism identification was established in the two cases and pelvis is more helpful in identifying the source of the infection. While MR imaging of the spine optimally demonstrates the spinal infection, CT of the chest, abdomen and pelvis is more helpful in identifying the source of the infection.

KEY WORDS: Fistula, spinal, infection

PAPER 398 STARTING AT 3:39 PM, ENDING AT 3:47 PM
Spinal Epidural Aspergillosis in an HIV Positive Patient Resulting from Long-Standing (3 Years) Lung Infection

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PURPOSE
To describe the serial MR imaging (MRI) findings in a rare case of severe cord compression due to epidural extension of invasive aspergillus of the right upper lobe in a patient with well controlled HIV.

MATERIALS & METHODS
This is a 41-year-old male who has been HIV positive for 10 years. He presented in 2003 with symptoms of cough and right arm pain. He was well controlled on his antiretroviral medications, with undetectable viral load and CD4 count of 535. At the time of presentation he was found to have right upper lobe opacity on chest X-ray. Computed tomography (CT) of the chest was performed, showing a right upper lobe mass without definite chest wall or mediastinal invasion. Two CT-guided biopsies were performed in December 2003, both of which revealed only chronic inflammation without malignancy or infectious agent. He was followed over a 2-year period, at which time he presented with increasing right shoulder and arm pain. MRI was performed in February of 2006, showing an invasive mass in the right lung apex with involvement of the T1 and T2 vertebral bodies and minimal extension into the ventral epidural space. The mass was isointense on both T1- and T2-weighted images and enhanced avidly. There was no cord compression at that time. He returned in September of 2006 with severe back pain and myelopathic symptoms. MRI showed extension into the epidural space with severe cord compression. He underwent emergent T1-3 laminectomy. Pathology demonstrated large amounts of dense connective tissue with marked acute and chronic inflammation, as well as fungal organisms with pseudohyphae. Special staining and culture revealed A. fumigatus species.

RESULTS
Pulmonary aspergillosis, both invasive and semiinvasive, is being seen with increasing frequency due to rising numbers of immunocompromised patients. We present a case of long-standing pulmonary aspergillosis in an HIV positive patient causing direct epidural cord compression. Of particular interest is the presence of isointense T2 signal intensity in the epidural mass. We postulate that this might be explained by the large amount of dense connective tissue seen on pathologic examination. This is likely a result of this HIV positive patient being able to mount a sufficient inflammatory response because of his well controlled HIV infection.
CONCLUSION
We conclude that fungal disease should be included in the differential diagnosis of a spinal epidural lesion in a well controlled HIV positive patient.

KEY WORDS: Aspergillosis, epidural

Paper 399 Starting at 3:47 PM, Ending at 3:55 PM
Spontaneous Thoracic Spinal Cord Herniation: Does Occult Disk Pathology Play a Role?
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PURPOSE
Spontaneous thoracic spinal cord herniation is being recognized increasingly as a cause of Brown-Sequard syndrome and occult myelopathy. A number of hypotheses explaining the etiology of this abnormality have been presented. One hypothesis suggests erosion of the dura by an occult herniated or calcified disc may play a role. We present data which support this hypothesis and evaluate the common imaging findings of this entity.

MATERIALS & METHODS
We present three patients with surgically proved spontaneous thoracic spinal cord herniation. Furthermore, we review the literature of the 20 cases of spontaneous thoracic spinal cord herniation for which imaging is available. The proximity to the disc space, thoracic level, direction of cord herniation, and cord signal abnormalities were independently assessed by two reviewers.

RESULTS
Twenty-one of the 23 patients (91%), including all three of the patients we present, demonstrate the location of the thoracic cord herniation to lie directly at the disc level. The two remaining cases are adjacent to, though not directly overlying the disc space. These 23 cases confirm prior reports which note the high frequency of ventral vs dorsal herniation (100% in this study), propensity for upper thoracic spine involvement (all cases seen between T2-8). We also note a high frequency of thinning of the cord at the level of the herniation with a frequent absence of associated cord signal abnormality.

CONCLUSION
The etiology of spontaneous thoracic spinal cord herniation remains to be fully elucidated. However, our cases and those available in the literature indicate that spontaneous thoracic spinal cord herniation commonly occurs at the disc space level. These findings support the hypothesis that occult disc pathology may play a role in the pathogenesis of spontaneous thoracic cord herniation. In addition, we evaluate and present the commonly seen imaging findings of spontaneous thoracic spinal cord herniation.

KEY WORDS: Cord herniation, Brown-Sequard syndrome

Paper 400 Starting at 3:55 PM, Ending at 4:03 PM
Safety and Efficacy of 98 Weight Percent Oxygen-2 Weight Percent Ozone in the Treatment of Self-Contained Herniated Lumbar Disks
Muto, M.² · Murphy, K.¹ · Steppan, J.³ · Bracken, S.³ · Meaders T, T.³ · Boxley, C.³
¹The Johns Hopkins Medical Institutions, Baltimore, MD, ²Ospideli Carderelli, Naples, ITALY, ³Active O, Salt Lake City, UT

PURPOSE
This single-center, nonrandomized, single-arm clinical investigation was designed to determine the safety and efficacy of 98 weight percent (wt %) oxygen (O2)-2 wt % ozone (O3) in the treatment of self-contained herniated lumbar disks.

MATERIALS & METHODS
All patients enrolled in this study were evaluated 1 month
after the oxygen-ozone treatment to quantify improvement in pain and function and to monitor for potential adverse events. Another objective was to confirm the consistency and accuracy of a commercially available ozone generator and the ability to deliver 1-3 mL of 98 wt % oxygen-2 wt % ozone into the nucleous pulposus, and 7-9 mL into the epidural or foraminal space. The oxygen-ozone treatment was followed immediately by a periganglionic injection of corticosteroid and bupivacaine. Fifty patients were enrolled based on exclusion/inclusion criteria, treated with oxygen-ozone, and evaluated for treatment effectiveness using the Visual Analog Scale (VAS), Oswestry Disability Index (ODI), and the Modified MacNab criteria.

RESULTS
After 1 month following treatment, 80% of the patients whose disks were treated with O2-O3 showed a significant improvement in pain based on the VAS scale (VAS improvement >1.8), 70% showed a significant improvement in function based on the Oswestry disability index (ODI) (ODI improvement > 15), and 80% showed improvement based on the Modified MacNab criteria (Modified MacNab improvement 1). None of the 50 patients had any adverse events associated with the treatment.

CONCLUSION
The safety and efficacy of the oxygen-ozone treatment in contained herniated lumbar disks and the ability to consistently produce and deliver 98 wt % oxygen-2 wt % ozone using an oxygen-ozone generator and a syringe were demonstrated successfully. Literature results and histology results from our animal trial lead us to believe that the primary mechanism of action of the oxygen-ozone mixture injected into the herniated disk is reduction in size of the herniated disk through dehydration.

KEY WORDS: Herniated lumbar disks, treatment, 98 weight % oxygen -2 weight % ozone

Paper 401 Starting at 4:03 PM, Ending at 4:11 PM
Axial-Loaded Weight-Bearing MR Imaging of the Lumbar Spine: Utility of Nonweight-Bearing Sequences
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Ang, R.
Center for Diagnostic Imaging, St. Cloud, MN

PURPOSE
The purpose of this study was to evaluate wherether there is any clinical value to a nonweight-bearing sequence when performing an axial loaded/weight-bearing MRI. While it is accepted that pathology can worsen with weight bearing, there have been no studies showing pathology that may be seen better without weight bearing.

MATERIALS & METHODS
Fifty patients who underwent both standard and axial-loaded weight-bearing lumbar spine MRI were randomly selected and evaluated for progression of disk disease or stenosis both with and without axial-loaded weight bearing. Weight bearing was performed by the application of a commercially available axial-loaded weight-bearing device that applies a full physiologic load onto the lumbar spine. A routine MRI of the lumbar spine was performed initially followed by sagittal and axial sequences with axial-loaded weight bearing applied. Both sets of images were obtained in a 1.5T Siemens Symphony MRI unit. Exams were interpreted by a radiologist who is subspecialized in spine radiology.

RESULTS
Twenty-eight patients showed no change in findings after application of axial-loaded weight bearing while 22 patients showed definite progression of pathology. No patients showed worsening of findings on nonweight-bearing sequences. The nonweight-bearing images did not provide any information that could not be seen also on the axial-loaded weight-bearing images. Axial-loaded weight-bearing images did provide additional information on lumbar spine pathology.

CONCLUSION
Axial-loaded weight-bearing lumbar MRI performed on a high-field system provides additional information on lumbar spine pathology that is not seen on routine nonweight-bearing images. There is no additional information gained by performing nonweight-bearing sequences prior to axial-loaded weight bearing.

KEY WORDS: Weight bearing, axial loaded, MR imaging

Paper 402 Starting at 4:11 PM, Ending at 4:19 PM
Provocation Lumbar Diskography Using Intradiskal Lidocaine: Preliminary Results of Lumbar Surgery and Operative Fusion
Bartynski, W. S. · Rothfus, W. E. · Gerszten, P. · Welch, W. · Moossy, J. · Silvaggio, V.
Presbyterian University Hospital Pittsburgh, PA

PURPOSE
To assess the postoperative response/improvement of patients with positive lumbar levels documented at intradiskal lidocaine-assisted provocation lumbar diskography.

MATERIALS & METHODS
Provocation lumbar diskography supplemented by intradiskal lidocaine administration for pain control at provoked levels was performed in 33 patients who ultimately were treated by lumbar surgical intervention. Diskograms and clinical outcomes were assessed retrospectively. Disk spaces were classified as either “contained” or demonstrating diskographic contrast “leakage” as demonstrated by diskogram images and postdiskogram CT. Response to intradiskal lidocaine was recorded during the procedure and classified as: 1) complete/substantial pain relief, 2) partial pain relief and 3) no significant pain relief. Clinical records were reviewed and type of surgical procedure performed and postoperative outcome were assessed.

RESULTS
Seventeen patients had operative intervention at a single level (leaking disk:10; contained disk: 7) with single level diskectomy in one patient. Twelve patients had fusion at multiple levels (2 levels: 10 patients; 3 levels: 2 patients). In
three patients, percutaneous diskectomy/nucleoplasty was performed. In contained disks with single level fusion, good to excellent postoperative recovery was present in six of seven patients (complete lidocaine response: 2; partial lidocaine response: 1, no improvement with lidocaine: 3). In leaking disks with single level fusion, good to excellent postoperative recovery was present in six of 10 patients (complete lidocaine response: 5; partial lidocaine response: 1) with otherwise partial improvement or poor outcome. Patients with multilevel had a more mixed result with good to excellent outcome in five, some improvement in five and poor outcome in two patients.

CONCLUSION
Preliminary results suggest some potential differences between the surgical outcome of contained disks and leaking disks after fusion. Of importance, contained disks can be positive at provocation lumbar diskography and not improve after intradiskal lidocaine administration but demonstrate a positive at provocation lumbar diskography and not improve after intradiskal lidocaine administration and demonstrate a good to excellent postoperative outcome.

KEY WORDS: Provocation diskography, degenerative disk disease, low back pain

Paper 403 Starting at 4:19 PM, Ending at 4:27 PM
Lidocaine-Treated Significantly Painful Disks at Provocation Lumbar Diskography: Comparison of Pain Response and Associated Post-Diskogram CT Imaging Features
Bartynski, W. S. · Rothfus, W. E.
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PURPOSE
To evaluate the postdiskogram CT imaging features of significantly painful disks in comparison to their response to intradiskal lidocaine administration during provocation lumbar diskography.

MATERIALS & METHODS
Intradiskal lidocaine was injected at 182 significantly painful disk levels in 111 patients during provocation lumbar diskography. Disks were assessed by diskogram fluoroscopic images and postdiskogram CT and classified as either: “contained” (no evidence of contrast leakage) or “leaking” (leakage of contrast from the disk into the epidural space). Response of diskogenic pain provoked by disk stimulation was recorded and graded as: 1) complete/substantial improvement, 2) partial improvement and 3) no improvement after intradiskal lidocaine administration. Postdiskogram CT images were evaluated for the imaging characteristics of the intervertebral disks. Features were assessed and itemized to include: 1) radial annular tears, 2) circumferential annular tears, 3) annular/nuclear degeneration and fragmentation, 4) annular/nuclear herniation. Features were referenced to Dallas Discogram characteristics.

RESULTS
Eighty-two disks were contained with 100 disks demonstrating evidence of diskographic contrast leakage. In 69% of contained disks, no improvement occurred after lidocaine administration while in leaking disks, 74% demonstrated complete/substantial pain improvement after intradiskal lidocaine. Contained significantly painful disks demonstrated severe disk degeneration (Dallas grade 3), internal and peripheral circumferential annular tears (Dallas grade 3) or both in most instances (92%) with 30% demonstrating evidence of peripherally projecting but contained radial tears of the annulus. No significant difference in CT imaging features was noted based on response to intradiskal lidocaine. Leaking disks that completely/substantially improved after intradiskal lidocaine primarily demonstrated evidence of radial tear (60%) along with severe disk degenerative changes and circumferential annular tears (Dallas grades 3) with or without herniation of annular or nuclear components. Radial tear alone was present in 20% and severe degenerative changes with nonspecific annular leak or leak through a circumferential annular tear seen in 20%. Leaking disks with no improvement after intradiskal lidocaine typically demonstrated severe disk degeneration (Dallas grade 3) with annular thinning.

CONCLUSION
Contained significantly painful lumbar disks typically demonstrate severe degenerative changes with circumferential annular tears but are not responsive to intradiskal lidocaine. Leaking significantly painful lumbar disks demonstrate radial tears, radial tears and circumferential annular tears +/- disk herniation and typically improve substantially after lidocaine administration. The limited response of contained severely degenerative disks to intradiskal lidocaine suggests that provoked pain in these disks is primarily related to abnormality of the peripheral annulus. Complete/substantial pain improvement in leaking discs with similar severe degenerative features therefore suggests that pain from these discs may be related to a different mechanism such as leakage of degenerative disc byproducts and a resultant chemical effect.

KEY WORDS: Provocation lumbar diskography, degenerative disk disease, low back pain

Paper 404 Starting at 4:27 PM, Ending at 4:35 PM
Magic Angle Effect in MR Neurography of the Sciatic Nerve in Extraspinal Sciatica versus Control Patients
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PURPOSE
Extraspinal sciatica/piriformis syndrome is challenging to diagnose. MR neurography (MRN) can demonstrate abnormal sciatic nerve signal at the sciatic notch in these patients. MRN in controls has not been studied. “Magic angle” effect recently has been demonstrated as increased T2/STIR signal in normal nerves imaged at varying orientations to the magnetic field, most prominent at 55 degrees. We measured the size, signal intensity and angle of the sciatic nerve with respect to the magnetic field in symptomatic and control groups to evaluate the magic angle effect in sciatic neurography.

MATERIALS & METHODS
Ten symptomatic patients with clinically proved sciatica and
abnormal ipsilateral sciatic nerves on MRN were identified (2003-2006); 7 females (mean age 50.6 years +/-10.8), 3 males (mean age 53.2 years +/- 14.7). Sciatic MRN also was performed in six asymptomatic controls; 4 females, 2 males (mean age 31 years +/- 1.5). MRN: Axial, coronal T1 and STIR sequences Philips 1.5T magnet TR 2530 TE 20 TI 160 3/3.5 mm. FOV 34 NEX 3, phased array body coil. All were imaged in neutral position (longitudinal spinal axis aligned with magnetic field B0). Additional sciatic MRN imaging at 10° oblique to B0 was performed in three of the controls. A neuroradiologist analyzed all images on an Agfa workstation, measuring regions of interest (ROI) for size and STIR signal intensity (SI) of the sciatic nerve at the sciatic notch in the axial plane on STIR images. The sciatic angle (SA-angle of the nerve at the sciatic notch with respect to B0) was measured on coronal T1 images. All symptomatic patients underwent a complete neurologic examination by a neurologist and electrodiagnostic studies were obtained in five of the symptomatic patients.

RESULTS
In the ten symptomatic patients with clinically proved sciatica, the percent signal increase of the symptomatic sciatic nerve compared to the contralateral normal nerve was 30% +/- 13.6. The mean increase in nerve size was 1.0 mm +/- 0.4. The mean SA was 49.8° +/- 4.5. In controls, the mean difference between right and left sciatic nerve signal intensities was 4.5 +/- 2.3. The mean size in difference was 0.4 mm +/- 0.4. The mean sciatic angle was 43.6° +/- 4.4. The mean SI was 250.9 +/- 34.5 when the SA was at the magic angle and 202.8 +/- 28.3 with the SA greater than the magic angle. Five of the 10 symptomatic patients underwent piriformis decompression with clinical improvement.

CONCLUSION
The sciatic nerve is larger and demonstrates increased signal intensity on MRN in patients with extraspinal sciatica compared to controls, possibly reflecting intraneural edema. The sciatic angle is greater in symptomatic patients compared to controls, perhaps reflecting anatomical variation in the orientation of the sciatic nerves in patients at risk for developing extraspinal sciatica. In controls, the sciatic nerve demonstrates relative increased signal on MRN when the sciatic angle is oriented at 55 degrees to the magnetic field, the “magic angle” effect. Recognition of “magic angle” effect is important for accurate diagnosis of sciatic nerve pathology.

KEY WORDS: MR neurogram, magic angle, sciatic nerve

Paper 405 Starting at 4:35 PM, Ending at 4:43 PM
High Sensibility of MR Angiography in the Recurrence of Spinal Dural Arteriovenous Fistulas

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PURPOSE
To assess the specificity and sensibility of spinal contrast-enhanced MRA angiography (MRA) versus digital subtraction angiography (DSA) in the recurrence of spinal dural arteriovenous fistulas recurrences after endovascular or surgical treatment.

MATERIALS & METHODS
We reviewed six MRA performed between September 2005 and November 2006. MRA was compared with DSA in six patients previously treated for a spinal dural arteriovenous fistula. MRA was performed between 1 month and 9 years after the last endovascular treatment. All MRA had been performed on a Siemens 1.5T MRI, two phase contrast-enhanced MRA were performed with the use of centric k-space filling scheme synchronized to the contrast bolus arrival, bolus test localized on the descending aorta. MRA were analyzed with coronal curved using maximal intensity projection.

RESULTS
In three patients without recurrence of the fistula, MRA was in agreement with DSA. In three patients recurrences of spinal dural arteriovenous fistulas were noted on MRA, but only one DSA was in agreement with the diagnosis. A second DSA was necessary in this two patients to reveal the recurrence.

CONCLUSION
According to our limited experience contrast-enhanced MRA can detect a recurrence of spinal dural arteriovenous fistula with a higher sensibility than DSA.

KEY WORDS: Spinal dural arteriovenous fistula, MR angiography, recurrence

Paper 365 Starting at 4:43 PM, Ending at 4:51 PM
Magnetoencephalography: A Feasibility Study

Schwartz, E. S. · Dell, J. · Magee, R. · Roberts, T. P. L. The Children’s Hospital of Philadelphia Philadelphia, PA

PURPOSE
To determine the technical feasibility of performing magnetoencephalography of the cervical spinal cord, or magnetoencephalography (MMG). To our knowledge, this has not been reported previously in humans.

MATERIALS & METHODS
MMG was recorded from the cervical spine region of six healthy adult volunteers using a 275-channel whole-head biomagnetometer, positioned over the cervical spine, as opposed to its conventional position over the head. Motion detection and reference fiducial markers were placed at the level of the mastoid bones (left/right) and the Cz position of the head. Stimulation consisted of electrical stimulation of the head. Motion detection and reference fiducial markers were placed at the level of the mastoid bones (left/right) and the Cz position of the head. Stimulation consisted of electrical stimulation of the head. Motion detection and reference fiducial markers were placed at the level of the mastoid bones (left/right) and the Cz position of the head. Stimulation consisted of electrical stimulation of the head. Motion detection and reference fiducial markers were placed at the level of the mastoid bones (left/right) and the Cz position of the head. Stimulation consisted of electrical stimulation of the head. Motion detection and reference fiducial markers were placed at the level of the mastoid bones (left/right) and the Cz position of the head. Stimulation consisted of electrical stimulation of the head.
RESULTS
In all subjects, the first peak was seen to occur between 6.7 and 7 ms, as indicated by the red vertical line in the Figure. Subsequent resolvable events occurred at 10 ms and 12 ms. The magnetic field pattern in the map display indicates the central location of the current. Propagation millisecond-by-millisecond indicates the ascending current path along the cervical spine.

CONCLUSION
MMG was successfully and reproducibly performed in this cohort of adult volunteers. This may have applicability in the future for the evaluation of function in the setting of numerous spinal cord pathologies, including traumatic injury, myelopathies, and demyelination. Future work includes correlation with volumetric magnetic resonance imaging for source localization.

KEY WORDS: Spinal cord, magnetoencephalography

Paper 417 Starting at 4:51 PM, Ending at 4:59 PM
Evaluating Tonsil, Spinal Cord, and CSF Motion in Symptomatic and Asymptomatic Patients with Chiari I Malformation
Cousins, J. P. · Haughton, V.
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PURPOSE
Chiari I malformation poses a diagnostic dilemma for both the clinician and spine radiologist. The goal of imaging is to determine which patients may benefit from intervention and those which would not. About a third of patients with tonsillar ectopia do not have symptoms referable to the malformation. The pathogenesis of syringomyelia in the symptomatic patients is not known. The Gardner "water hammer" hypothesis (1) that CSF is forced into the central spinal canal because of anomalous development of the obex has been abandoned. Ball and Dayan hypothesize that the CSF is driven into the Virchow-Robin spaces of the spinal cord when the spinal subarachnoid pressure is increased, especially during coughing or straining (2). Heiss et al. postulate that a piston-like movement of the herniated tonsils produces downward pulse waves in the subarachnoid space, which force water into the spinal cord (3). Stoodley et al. (4) suggest that altered compliance in the spinal subarachnoid space increases CSF flow into the Virchow-Robin space. To reconcile some these different theories, we have begun studies of CSF flow, spinal cord and tonsil movement with new and conventional gated MR imaging.

MATERIALS & METHODS
For this study, Chiari I patients are characterized independently by a specialist on the basis of conventional clinical criteria into symptomatic or asymptomatic Chiari I malformations. Tonsilar motion is evaluated with a sagittal cardiac gated 2D FIESTA sequence and a five slice axial PC MR acquisition through the foramen magnum and cerebellar tonsils. The MR protocol includes: Sagittal T1 FLAIR, propeller axial T2, coronal T2 FLAIR, diffusion-weighted series and axial T1 3-D SPGR. CSF flow through the foramen magnum is evaluated with cardiac gated sagittal T2 FRFSE, sagittal cine phase contrast, axial fast-card PC using single slice and multislice technique. Volunteers without CNS pathology or cervical cord symptoms have been recruited as control subjects. The study has been approved by the local internal review board.

RESULTS
The spinal cord and tonsils demonstrate no motion through most of the cardiac cycle. At one point during systole the cord moves downward with a velocity of about 1 mm/sec and at one point during diastole it moves upward with about the same velocity. Displacement of the tonsils, evaluated by 2D FIESTA is about 1 mm (Fig 1 A and B), best appreciated on the cine loops. Velocities of the CSF exceed those of the cord and tonsils by an order of magnitude. Differences in the displacement of tonsils between the two patient groups and the controls are small.
CONCLUSION
Movement of the cerebellar tonsils does not appear sufficient to generate a pressure wave. Tonsilar and spinal cord motion may not be a significant factor in the pathogenesis of neurologic signs and symptoms in the Chiari I malformation.

REFERENCES

This paper was selected to receive the American Society of Spine Radiology (ASSR) 2007 Mentor Award for giving the best presentation during the Mentor Program at the ASSR 2007 Annual Symposium in Marco Island, Florida.

Thursday Afternoon
3:15 PM – 4:45 PM
Grand Ballroom B

(55d) ADULT BRAIN: Neoplasms II and New Techniques Post-Processing (Scientific Papers 406 – 416)

See also Parallel Sessions
(55a) ADULT BRAIN: Cerebrovascular Occlusive Disease III
(55b) INTERVENTIONAL: Stroke and Arteriovenous Malformations/Fistulae
(55c) SPINE: Spinal Cord and Degenerative Inflammatory Infections

Moderators: John J. Wasenko, MD
Nathaniel D. Wycliffe, MD

Paper 406 Starting at 3:15 PM, Ending at 3:23 PM
Utility of Apparent Diffusion Coefficients in Predicting Therapeutic Outcome in Patients with Recurrent Glioblastoma Multiforme Treated with Convection-Enhanced Delivery of IL 13-PE39QQR

Lee, B. C. · Khayal, I. · Chang, J. S. · Butowski, N. A. · Chang, S. M. · Nelson, S. J. · Cha, S.
University of California San Francisco
San Francisco, CA

PURPOSE
Convection-enhanced delivery (CED) of therapeutic drugs is a novel technique for more precise treatment of brain tumors. CED of interleukin (IL) 13-PE38QQR, a recombinant cytotoxin consisting of human IL-13 with a truncated pseudomonas exotoxin, has been under investigation as part of multiinstitutional study for treatment of recurrent glioblastoma multiforme (GBM). Conventional MR imaging to assess tumor progression traditionally has looked at changes in tumor size or enhancement patterns. With CED, changes on MR imaging (MRI) may be related to catheter placement, infusion, or the therapeutic drug itself rather than actual tumor progression. Diffusion-weighted imaging (DWI) may show changes related to therapy that may be missed or misdiagnosed by conventional MRI and has been suggested to be helpful in predicting therapeutic success or failure, which would be important in clinical practice to optimize therapy. The goal of this project was to determine if the change in ADC values correlates with survival.

MATERIALS & METHODS
We performed a retrospective analysis of 27 recurrent GBM patients that have undergone treatment utilizing CED of IL13-PE38QQR. All patients had resection of recurrent GBM prior to catheter placement for CED. MR imaging was obtained after resection but prior to IL13-PE38QQR. Drug therapy was infused for 4 days and the patients were imaged 4-6 weeks later. Patients were divided into two groups: 1) survival less than 12 months from start of CED treatment and 2) survival greater than 12 months. We assessed the ADC values by drawing regions of interest (ROI) on the ADC maps corresponding to areas of T2 prolongation surrounding the resection cavity prior to CED therapy and on the 4-6 week follow-up scans, and correlated the findings to patient survival times.

RESULTS
The median ADC values were calculated in the ROIs for both patient groups and no significant differences were found in the pre or posttreatment ADC values. Assessment of the net change in ADC values between the pretreatment and 4-6 week posttreatment scans in both groups also did not demonstrate a significant difference.
CONCLUSION
DWI provides additional information demonstrating variations in water content in tumors and tissues surrounding tumors. Others have shown potential for DWI and assessment of ADC values in the treatment of brain tumors. However, in our cohort of patients with recurrent GBM treated with IL 13-PE38QQR by CED, we have been unable to demonstrate the utility of DWI in predicting treatment outcomes as assessed by survival times.

KEY WORDS: Apparent diffusion coefficient, glioblastoma multiforme, convection-enhanced delivery

A Multiparameter Dynamic Susceptibility Contrast Study Demonstrates the Best Predictor of Brain Tumor Grade

Bedekar, D. · Wagner-Schuman, M. L. · Kvasnica, K. · Fishman, M. · Paulson, E. · Rand, S. D. · Krouwer, H. G. J. · Schmainda, K. M.
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Milwaukee, WI

PURPOSE
We analyzed brain tumor angiogenesis for the diagnosis of glioma using dynamic susceptibility contrast (DSC) MR imaging to estimate various parameters such as relative cerebral blood volume (rCBV), cerebral blood flow (CBF), mean vessel diameter (MVD) and mean transit time (MTT). The goal of this study was to determine the efficacy of each of these parameters in predicting brain tumor grade.

MATERIALS & METHODS
Fifty-two subjects with confirmed diagnosis of glioma were studied. Two were diagnosed with grade I tumor, 10 with grade II tumor, 10 with grade III tumor and 30 with grade IV tumor. To reduce T1 leakage effects a loading dose of gado-diamide (0.10 mmol/kg, Omniscan) was administered. Next, simultaneous GE/SE-EPI images were acquired for 1 minute before and 2 minutes after a 0.2 mmol/kg bolus injection of gadodiamide. Five, 7 mm slices were acquired (TE(GE)/TE(SE)=30 ms/109.1 ms, fat suppression ON, TR=1s, FOV=4 cm², matrix=64x64). Finally, conventional postcontrast T1-weighted images were acquired (SE,

TE/TR=11 ms/500 ms, matrix=256x256). Estimates of rCBV, CBF, MVD, and MTT were obtained using AFNI. rCBV was calculated as previously described (1). CBF estimates were determined as the maximum point of the residue function, derived by deconvolving the tissue concentration time curves with a manually selected arterial input function. MTT was estimated as CBV/CBF, and MVD was estimated as the ratio of the GE and SE concentration-time curves. Uninvolved white matter and tumor were considered regions of interest. Statistical analysis was performed using GraphPad Prism version 4.0a for Mac OS X (GraphPad Software, San Diego, CA). A Spearman rank correlation test was employed to analyze the correlation of tumor grade with CBV, CBF, MTT, and MVD. p-value < 0.05 was considered statistically significant.

RESULTS
The Figure shows the correlation of GE rCBV, GE CBF, and MVD with tumor grade. The parameters GE rCBV (p-value = 0.0007), GE CBF (p-value = 0.0002), GE MTT (p-value = 0.0227), SE MTT (p-value = 0.0058), and MVD (p-value < 0.0001) show significant correlation with the tumor grade.

CONCLUSION
The results of this study support the hypothesis that monitoring changes in DSC MR parameters, such as GE rCBV, GE CBF, MTT and MVD, could be useful in determining therapeutic effectiveness in patients with malignant brain tumors (2).

REFERENCES

KEY WORDS: Dynamic susceptibility contrast, glioma, MR imaging

This work was supported by NIH/NCI and GCRC grants CA082500 and M01-RR00058.
Paper 408 Starting at 3:31 PM, Ending at 3:39 PM

MR Permeability Imaging in Brain Tumors: Correlating Maximum Signal Intensity Maps with MR Perfusion and MR Spectroscopy: Analysis of 21 Patients

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PURPOSE
The objective of this study was to analyze the patterns of maximum signal intensity maps in diverse brain tumors and to correlate these with CBV (cerebral blood volume) MR perfusion maps and MR spectroscopy.

MATERIALS & METHODS
Twenty-one consecutive patients with 22 biopsy-proved brain tumors were evaluated retrospectively from January 2005 to December 2006. Histopathology revealed glioblastoma multiforme (n=8), metastases (n=6), radiation necrosis (n=2), ependymoma (n=2), lymphoma (n=1), oligoastrocytoma (n=1), pleomorphic xanthoastrocytoma (n=1), and meningioma (1). MR permeability maps were obtained in all 22 tumors following contrast-enhanced T1 dynamic MR scans (TR 500, TE 12) using 0.1mmol/kg Gd-chelate at a rate of 1cc/sec. MR perfusion scans [dynamic susceptibility contrast imaging (DSC)] and MR spectroscopy sequences (point resolved spectroscopy, TR=1500, TE=45) were analyzed using Func Tool software (GE Health Care, Milwaukee, WI) and correlated with the permeability maps in all patients.

RESULTS
Three MR permeability patterns were observed. A. The most common pattern (15/22, 68%) was a smooth rapid, continuous rise in MR signal intensity with time. This pattern was noted in glioblastoma multiforme (8), metastases (4), lymphoma (1), oligoastrocytoma (1), and pleomorphic xanthoastrocytoma (1). B. Slow, discontinuous rise in MR signal intensity was noted in six patients (27%) with radiation necrosis (n=2), ependymoma (n=2) and metastases (n=2). C. An initial steady signal increase followed by a steady decrease was noted in one meningioma (5%) found incidentally in a patient with glioblastoma. All 15 tumors (100%) with the pattern of "smooth rapid continuous rise" showed high CBV, increased choline, decreased NAA (mean NAA/choline ratio of 0.37) and the presence of either lipid or lactate. All six patients (100%) with the pattern of "slow discontinuous rise" showed no increase in CBV, mild increase in choline, mild decrease in NAA (mean NAA/choline ratio of 0.92) and variable presence of lipid/lactate.

CONCLUSION
The MR permeability patterns in brain tumors include "smooth rapid continuous rise," "slow discontinuous rise," and "initial rise then steady decrease." These patterns help to differentiate among high-grade and low-grade tumors, radiation necrosis and meningioma. The pattern of "smooth rapid continuous rise" correlated in all cases with high CBV, increased choline, decreased NAA and the presence of lipid/lactate. These data suggest that MR permeability may be a rapid, cost-effective alternative to MR perfusion and MR spectroscopy for the initial diagnosis and posttreatment surveillance of patients with brain tumors.

KEY WORDS: Brain tumors, MR permeability, MR perfusion

Paper 409 Starting at 3:39 PM, Ending at 3:47 PM

High-Resolution Contrast-Enhanced, Susceptibility-Weighted MR Imaging at 3T in Patients with Brain Tumors

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PURPOSE
To demonstrate susceptibility effects (SusE) in various types of brain tumors with 3T HR-CE-susceptibility-weighted (SW)-MR imaging and to correlate SusE with PET and histopathology.

MATERIALS & METHODS
Eighteen patients with brain tumors, scheduled for biopsy or tumor-extirpation, underwent high-field (3T) MR imaging. In all patients an axial T1-SE sequence and a HR-SW (SW)-MR imaging and to correlate SusE with PET and histopathology. Correlation between intralesional SusE in 90% (Fig 3a). Low-grade lesions demonstrated low density of SusE or no SusE. Correlation between intralesional SusE and histopathologic as well as PET tumor grading was statistically significant. Contrast enhancement was equally visible in both SW (Fig 3b) and SE sequences. Side-to-side comparison of tumor areas with high frequency of SusE and histopathology revealed that intralesional SusE reflected conglomerates of increased tumor microvascularity.

RESULTS
High-grade lesions demonstrated either high or medium frequency of SusE in 90% (Fig 3a). Low-grade lesions demonstrated low density of SusE or no SusE. Correlation between intralesional frequency of SusE and histopathologic as well as PET tumor grading was statistically significant. Contrast enhancement was equally visible in both SW (Fig 3b) and SE sequences. Side-to-side comparison of tumor areas with high frequency of SusE and histopathology revealed that intralesional SusE reflected conglomerates of increased tumor microvascularity.
CONCLUSION
3T HR-CE-SW-MR imaging shows both intratumoral SusE not visible with standard MR imaging and contrast enhancement visible with standard MR imaging. As frequency of intratumoral SusE correlates with tumor grade determined as by PET and histopathology, this novel technique is a promising tool for noninvasive differentiation of low-grade from high-grade brain tumors and for determination of optimal area of biopsy for accurate tumor grading.

KEY WORDS: Susceptibility-weighted MR imaging, high field (3T), primary malignant brain tumors

Paper 410 Starting at 3:47 PM, Ending at 3:55 PM
Assessment of Early versus Late-Delayed Radiation Necrosis Using 1H-MRSI in Patients with Malignant Glioma

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PURPOSE
The aim of this study was to evaluate metabolite ratios using 1H-MRS as function of radiation dose pre and postradiation treatment (RT) in patients with malignant glioma and early acute radiation injury. Second, to compare metabolite ratios (Ch/NAAp, Ch/Cr, NAA/Cr) as a function of radiation dose and region irradiated in patients with late-delayed radiation injury versus matched case-controls.

MATERIALS & METHODS
Sixteen patients with WHO Gr II-IV gliomas treated with 3D CRT with radiation-induced injury were analyzed. Early RT group (ERT) included eight patients with pretreatment MRS and follow-up imaging 3, 6 and 9 months post-RT. Late RT group (LRT) included eight patients with MRS and biopsy/follow-up imaging confirmed radiation injury at a median 30 months post-RT (range: 24-90). Twenty-five matched-case controls with 1H-MRS in specific ROIs (basal ganglia, supratentorial white and gray matter) defined for comparison. Registration of the radiation treatment plan in reference to the MRS dataset was carried out in all patients. Metabolic ratios and RT dose received were computed separately for each voxel. A linear mixed model was used to calculate regression parameters for the effect of RT dose on metabolic ratios based on different ROI irradiated.

RESULTS
Spectral analysis demonstrated differences in the metabolic pattern between early and late radiation-induced effects in the normal-appearing white matter (NAA/Cr p < 0.001 and Ch/NAAp p < 0.002). Overall, there was also a greater dose-dependent effect noted in late radiation injury in the normal-appearing white matter. These changes may reflect acute RT effects from blood barrier disruption, edema and demyelination with decline in NAA and increase in Ch that is dose dependent. Late-delayed RT effect due to neuronal loss, axonal disruption, and chronic ischemia appear to have a greater dose-dependent effect on NAA.

CONCLUSION
1H-MRS is an invaluable noninvasive tool that allows us to monitor in vivo changes in chemical metabolites to assess for early radiation injury in normal-appearing white matter. Longitudinal prospective studies with correlative neurocognitive testing of memory and language function are on going.

KEY WORDS: Radiation necrosis, proton MR spectroscopy, malignant glioma

Paper 411 Starting at 3:55 PM, Ending at 4:03 PM
Treatment Based on Linking Intracellular Protein Translation to Total Choline Seen by 1H Spectroscopy

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PURPOSE
To document treatment can be initiated based on changes in total choline (tCHO) seen by 1H spectroscopy (1H MRS) before changes in tumor size/enhancement. Molecular biology offers an explanation linking translation to tCHO.

MATERIALS & METHODS
1H MRS monitored four patients with brain tumors during treatment (range 2-7.5 years; mean 4.5 years). Three patients were treated with cytotoxic therapies (radiation and/or chemotherapy). One patient received cytostatic therapies. Single or multivoxel regions of interest were positioned by a neuroradiologist to guarantee reproducibility. Short echo spectra were obtained in all patients. Total choline was quantified by choline to creatine ratios with change in 20% considered significant. Treatment response showed a decrease in tCHO; treatment failure showed an increase in tCHO.

RESULTS
In each of the four patients monitored for cancer treatment tCHO decreased/increased before change in tumor size/enhancement. Changes in tCHO can alter treatment. Patient #1 - decrease in tCHO documented lack of resistance to a new cytotoxic drug while tumor size remained unchanged. Patient #2 - increase in tCHO occurred before enhancement thereby indicating starting cytotoxic drug therapy. Patient #3 -increase in tCHO occurred before increase in size and initiated early surgical debulking. Patient #4 - decrease in tCHO indicated continuing cytotoxic drug therapy even though tumor size remained unchanged.

CONCLUSION
1) Treatment can be initiated because changes in tCHO can occur before changes in tumor size/enhancement. 2) Total
choline measures cell membranes with endomembranes equaling 90%, and plasma membranes equaling 10%. 3) Endomembranes are the machinery of protein translation, thereby linking translation to tCHO. 4) In treatment failure, organelles undergo rapid biogenesis to meet the demands of up-regulated translation. Since 90% of the tCHO is generated from endomembranes, and 10% from plasma membranes, changes in tCHO can occur before changes in size. 5) Signaling pathways initiate angiogenesis through translation and explain why increase in tCHO can occur before enhancement. 6) In treatment response (apoptosis) loss of organelles occurs before loss of plasma membranes and explains why tCHO can decrease before decrease size. 7) Since all cancer therapies interrupt amplified translation, and since translation occurs in all cells, tCHO is a valid molecular marker for monitoring cancer treatment. 8) Monitoring tCHO would be invaluable in cytostatic therapies causing tumor quiescence. 9) Francis Crick described transcription/translation as the central dogma of molecular biology. Total choline (tCHO) seen on 1H MRS is a valid reporter of translation.

**KEY WORDS**: Spectroscopy, total choline, protein translation

**Paper 412 Starting at 4:03 PM, Ending at 4:11 PM**

**Novel Techniques for Acquisition and Analysis of Metabolite Levels for H-1 MR Spectroscopic Imaging in Patients with Gliomas**

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**PURPOSE**
The goal is to design a new technique to allow acquisition of 2D J-resolved MRS data in three spatial dimensions within a clinically feasible scan time, and to apply novel postprocessing methods for interpretation and quantification of metabolites, as well as obtaining relaxation times of metabolites whenever possible.

**MATERIALS & METHODS**
PRESS spectra of Glu and Gln with TE starting at 35 ms in six steps of 40 ms, respectively, were simulated using GAMMA software. All empirical studies were performed using a 3T GE Signa scanner. A single-voxel 2D J-resolved acquisition was performed in the metabolite phantom. The 3D J-resolved MRS acquisition was incorporated with the flyback echo-planar gradient trajectory in the right/left direction. The spectral resolution was ~4.17 Hz in the F1 dimension and ~1.39 Hz in the F2 dimension. The 3D spectral array size was 16 x 12 x 8 and the spatial resolution was 1 cc. With a TR of 1.2 s and a NEX of 2, total acquisition time was 23 min. An MRS phantom, six healthy volunteers and four patients with different kinds of gliomas were examined in the study. The data were averaged in the t1 domain and then quantified using LeModel. The 2D spectra were generated by applying two FFTs with a 45° rotation. Metabolic T2 relaxation times were calculated from a single exponential fit.

**RESULTS**
TE-averaged spectra of GAMMA simulations and phantoms showed that the C4 protons of Glu were separated from Gln. J cross-peaks of Lac were separated from the overlapping lipid peaks in the phantom data. In vivo TE-averaged MRS images were obtained with good SNR. Glu/Cr and ml/Cr ratios were in 1.8 ± 0.7 and 1.6 ± 0.6 in segmented white matter, while 1.9 ± 0.8 and 1.4 ± 0.5 in gray matter. Figure 1 illustrates the TE-averaged spectra from a glioma patient. T2 values of Cho, Cr and NAA are shown in Table 1.

| Table 1: T2 values of metabolites (ms) |
|---|---|---|
| Cho | Cr | NAA |
| Phantoms | 194±14 | 296±26 | 550±72 |
| Normal White Matter | 209±62 | 161±45 | 284±82 |
| Normal Gray Matter | 264±71 | 150±27 | 222±40 |
| T2 lesions | 241±74 | 181±57 | 261±82 |

**CONCLUSION**
This study demonstrated a clinically feasible technique for simultaneous detection of Cho, Cr, NAA, Glu, ml and Lac at 3T. It also allows the evaluation of the T2 values of singlets.

**KEY WORDS**: 2D J-resolved MRS, gliomas, 3T

**Paper 413 Starting at 4:11 PM, Ending at 4:19 PM**

**Early Experience Using a High-Field Strength Intraoperative MR Imaging System for Neurosurgical Guidance in Tumor Resection**

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**PURPOSE**
To describe our initial clinical experience in the use of a high-field strength intraoperative MR imaging system (1.5T Espree™ Siemens magnet integrated into the BrainSUITE™, BrainLab, Feldkirchen, Germany).
MATERIALS & METHODS
A total of 25 patients so far were subjected to intraoperative MR resection of intracranial pathology (23 high-grade gliomatous lesions, 1 schwannoma and 1 lymphomatous lesion). All these patients underwent surgery in the BrainSUITE™ integrated MR-operative environment. All patients were imaged with standardized sequences including 3D T2-, FLAIR-, T1 pregadolinium- and (in most cases) T1 postgadolinium-weighted images along with diffusion tensor imaging. Intraoperative imaging was used to guide neurosurgical resection.

RESULTS
The MR imaging sequence parameters were optimized for this imaging environment. 3D versions of the traditional sequences were essential for surgical guidance, and also enabled multiplanar reformations, which were critical for image interpretation in this setting. The quality of imaging in the high-field strength system was felt to be comparable to conventional diagnostic high-field strength systems. Intraoperative MR imaging was universally felt to be useful in terms of determining the completeness of resection for intracranial lesions. We did find that the use of the intraoperative MR system added to operative time and expense.

CONCLUSION
We report on our early experience and optimizations in the use of integrated MR operative imaging environment. Early experience seems to indicate that for selected patients the expense and time added by intraoperative MR imaging is of great benefit in terms of gaining a more complete resection.

KEY WORDS: Intraoperative MR imaging, neurosurgical guidance, tumor resection

Paper 414 Starting at 4:19 PM, Ending at 4:27 PM
Expanding the Applications of Three-Dimensional Constructive Interference in Steady-State MR Imaging in Neuroimaging: A Prospective Study
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Medimagem
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PURPOSE
3D-CISS MR imaging can provide high-resolution images with excellent contrast between cerebrospinal fluid and solid structures. Taking into account this advantage, the purpose of our study was to develop new insights and expand the applications of 3D-CISS sequence in neuroimaging.

MATERIALS & METHODS
Over a period of 18 months, we performed 3D-CISS studies at 1.5T systems (GE, Medical System) in the following cases: suspected noncommunicating hydrocephalus, neurocysticercosis, evaluation of cystic lesions within CNS, assessment of prominent extraxial frontal spaces and for differentiating atypical extraaxial lesions from intraaxial ones. Cases of congenital horizontal gaze palsy (CHGP) were also included. Ninety-three patients were prospectively enrolled in this study. After conventional SE sequences were obtained, 3D-CISS imaging was undertaken (TR/TE=5.8/2.1, 80° flip angle, 256x256 matrix, 0.8mm section thickness). An axial, sagittal or coronal acquisition was used to cover ventricular system or the target lesion, according to the case. The examinations were analyzed by two experienced neuroradiologists.

RESULTS
Thirty-seven of 93 patients were assessed with suspicion of noncommunicating hydrocephalus. In 25 we identified aqueductal stenosis and in five stenosis at the foramen of Monro. 3D-CISS imaging could detect with great conspicuity the location of stenosis and was also useful to demonstrate aqueduct obstruction related to brainstem gliomas. In the seven remaining cases, 3D-CISS was able to rule out noncommunicating hydrocephalus. Among the 35 patients evaluated for neurocysticercosis, 3D-CISS imaging demonstrated significant superiority to detect either the cystic walls or the scolex in all cases (18 within the ventricular system, 10 within subarachnoid space and 7 in parenchyma), specially within subarachnoid sapac. The conventional SE sequences showed the scolex in only 17 patients and the cystic lesions in 25 cases. In six cases of microcystic subcortical lesions, 3D-CISS imaging was the only sequence able to distinguish atypical perivascular spaces (four cases) from the neoplastic lesions (DNETs) before surgery. The evaluation of epidermoid cysts also benefited from this sequence in three cases, because they are not isointense to CSF on 3D-CISS and the contours and involved structures were better delineated. In five cases, 3D-CISS imaging was essential to distinguish subdural hygromas from collections related to atrophic process. In four cases of CHGP, 3D-CISS was useful to illustrate the sixth and seventh cranial nerves: the seventh nerve had volume loss in Möbius syndrome, the sixth nerve was very thin in Duane Retraction and both cranial nerves had normal appearance in CHGP with progressive scoliosis. In another three cases, FIESTA was the only sequence to confirm that the atypical lesions were really extraaxial.

CONCLUSION
We recommend that 3D-CISS imaging should be used routinely in evaluation of noncommunicating hydrocephalus and cystic lesions within the ventricular system, subarachnoid space or brain parenchyma, especially in cases of neurocysticercosis, because it offers higher sensitivity and specificity in such cases. Our preliminary results also suggest that this sequence may play an important role in the assessment of microcystic subcortical lesions and epidermoid cysts. Other minor applications include differentiating atrophic process from subdural collections and atypical extraaxial lesions from intraaxial ones.

KEY WORDS: 3D-CISS, cystic lesions, neurocysticercosis

Paper 415 Starting at 4:27 PM, Ending at 4:35 PM
Role of Phase Contrast MR Imaging in Management of Cases of Normal Pressure Hydrocephalus
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PURPOSE
This investigation was undertaken to characterize and meas-
ure CSF flow at the level of the aqueduct by means of phase-contrast cine MR imaging and to determine as far as possible the parameters expressing hyperdynamic CSF flow. Changes in the hyperdynamic CSF flow with 50 ml lumbar CSF drainage (mimicking shunt) also were evaluated in clinically suspected normal pressure hydrocephalus (NPH) patients for deciding about the shunt surgery.

**Materials & Methods**

Thirty-seven patients with clinically suspected idiopathic NPH were included in this prospective study. Thirteen age-matched individuals, who did not have any neurologic disease, were included in the control group (Group III). Quantification of CSF flow was repeated within half an hour after drainage of 50 ml of CSF via lumbar route, simulating the effect of a shunt. On the basis of the change in peaked CSF flow velocity in the pre- and post-CSF tap condition, the patient population was divided into two group, group I (decrease of more than 1.5 cm/s in peak velocity after CSF drainage) and group II (decrease of less than 1.5 cm/s in peak velocity after CSF drainage). Based on the findings of positive phase-contrast CSF tap test, it was decided which patients should be referred for shunt surgery.

**Results**

Our study group included population in the 66-80 year range. Average ages in groups I, II, and III were 71.47, 68.36, and 64.9 years respectively. CSF peak flow velocity at the aqueduct: Group I, Group II, Group III, Average 14.40 ± 5.22, 8.76 ± 4.76, 8.51 ± 4.64 was observed in group II (statistically insignificant, p value 0.443). Radiologic: Average peaked CSF flow velocity: Group I and Group II, pre-tap 14.40, 8.76, post-tap 10.01, 8.21. Shunt Surgery: All the patients in group I were subjected to shunt surgery. Even though no patient in group II showed significant decrease in the peaked CSF flow velocity at the aqueduct (after drainage of 50 ml CSF) from 14.40 ± 5.22 to 9.94 ± 2.86 in group I (statistically significant, p value 0.00). Decrease in the peaked CSF flow velocity at the aqueduct (after drainage of 50 ml CSF) from 8.76 ± 4.76 to 8.51 ± 4.64 was observed in group II (statistically insignificant, p value 0.443). Radiologic: Average peaked CSF flow velocity: Group I and Group II, pre-tap 14.40, 8.76, post-tap 10.01, 8.21. Shunt Surgery: All the patients in group I were subjected to shunt surgery. Even though no patient in group II showed significant decrease in the peaked CSF flow velocity at the aqueduct (after drainage of 50 ml CSF) from 14.40 ± 5.22 to 9.94 ± 2.86 in group I (statistically significant, p value 0.00). Decrease in the peaked CSF flow velocity at the aqueduct (after drainage of 50 ml CSF) from 8.76 ± 4.76 to 8.51 ± 4.64 was observed in group II (statistically insignificant, p value 0.443). Radiologic: Average peaked CSF flow velocity: Group I and Group II, pre-tap 14.40, 8.76, post-tap 10.01, 8.21. Shunt Surgery: All the patients in group I were subjected to shunt surgery. Even though no patient in group II showed significant decrease in the peaked CSF flow velocity at the aqueduct (after drainage of 50 ml CSF) from 14.40 ± 5.22 to 9.94 ± 2.86 in group I (statistically significant, p value 0.00). Decrease in the peaked CSF flow velocity at the aqueduct (after drainage of 50 ml CSF) from 8.76 ± 4.76 to 8.51 ± 4.64 was observed in group II (statistically insignificant, p value 0.443). Radiologic: Average peaked CSF flow velocity: Group I and Group II, pre-tap 14.40, 8.76, post-tap 10.01, 8.21. Shunt Surgery: All the patients in group I were subjected to shunt surgery. Even though no patient in group II showed significant decrease in the peaked CSF flow velocity at the aqueduct (after drainage of 50 ml CSF) from 14.40 ± 5.22 to 9.94 ± 2.86 in group I (statistically significant, p value 0.00). Decrease in the peaked CSF flow velocity at the aqueduct (after drainage of 50 ml CSF) from 8.76 ± 4.76 to 8.51 ± 4.64 was observed in group II (statistically insignificant, p value 0.443). Radiologic: Average peaked CSF flow velocity: Group I and Group II, pre-tap 14.40, 8.76, post-tap 10.01, 8.21. Shunt Surgery: All the patients in group I were subjected to shunt surgery. Even though no patient in group II showed significant decrease in the peaked CSF flow velocity at the aqueduct (after drainage of 50 ml CSF) from 14.40 ± 5.22 to 9.94 ± 2.86 in group I (statistically significant, p value 0.00). Decrease in the peaked CSF flow velocity at the aqueduct (after drainage of 50 ml CSF) from 8.76 ± 4.76 to 8.51 ± 4.64 was observed in group II (statistically insignificant, p value 0.443). Radiologic: Average peaked CSF flow velocity: Group I and Group II, pre-tap 14.40, 8.76, post-tap 10.01, 8.21. Shunt Surgery: All the patients in group I were subjected to shunt surgery. Even though no patient in group II showed significant decrease in the peaked CSF flow velocity at the aqueduct (after drainage of 50 ml CSF) from 14.40 ± 5.22 to 9.94 ± 2.86 in group I (statistically significant, p value 0.00).

**Conclusion**

Phase-contrast MR imaging is a sensitive method to support the clinical diagnosis of normal pressure hydrocephalus. Phase-contrast MR imaging is very useful in the selection of patients of NPH who are likely to benefit from shunt surgery. Phase-contrast MR imaging is very useful in the selection of patients of NPH who are not likely to benefit from shunt surgery.

**Key Words**: NPH, phase contrast MR imaging, shunt surgery

**Purpose**

Human Herpesvirus 6 (HHV-6) has long been known to be pathogenic in lung transplant, liver transplant (14-82%), and human stem cell transplant (HSCT) recipients, causing a febrile illness, pneumonitis, hepatitis, bone marrow suppression, and a host of neurologic manifestations. Particularly devastating is HHV-6 encephalitis which typically localizes to the mesial temporal lobes, and presents early with confusion, memory loss or seizures. Autoologous or allogenic stem cell patients commonly have active HHV-6 infection, shown as high serum levels of viral DNA, irrespective of the source or the type of the graft. However, the prevalence of HHV-6 antibody in the general population is very high, in excess of 90% by 12 months of age (100% in some studies). Therefore, serological tests are of limited value due to the high seroprevalence of the general population, and an impaired serological response in transplant recipients, who receive immunosuppressive therapy. The purpose of this work is to: 1) clarify the incidence of HHV-6 encephalitis in a large series of stem cell transplant patients, 2) describe the typical MR imaging features of HHV-6 encephalitis in hematopoietic transplant recipients.

**Materials & Methods**

A retrospective review was made of medical records from 400 allogenic HSCT patients, transplanted between June 1995 and June 2006. Fifty patients (12.5 %) received umbilical cord blood transplants. Neurologic symptoms that prompted MRI evaluation of the brain were present in 67/400 (16.75%) patients. Of these, 28 (43%) had abnormal brain MRI findings. However, only eight patients (12%) had clinical and MRI findings that were consistent with limbic encephalitis. Five of these eight patients had CSF PCR studies which showed the pathogen to be HHV-6 (4 type B, 1 type A), one was negative, and two were not tested. MRI findings on T1, T2, FLAIR, postgadolinium T1, and diffusion-weighted imaging sequences were evaluated in these patients.

**Results**

The overall incidence of limbic encephalitis in our patient cohort was 2%. However, it was 10% in the subgroup of our patients that received a cord blood transplant. Of the patients who presented with neurologic signs, limbic encephalitis was the diagnosis in eight (12%), only one of whom remains alive past 1 year. In the other seven, average time between diagnosis and death was 95 days (range = 4-368 days). MRI findings associated with limbic encephalitis were: 1) hippocampal diffusion-weighted imaging and ADC abnormalities (early), 2) T2 and FLAIR hyperintensity in the hippocampus and amygdala (late), and 3) extension of T2 and FLAIR abnormalities to the lateral temporal lobes (late).

**Conclusion**

HHV-6 encephalitis following hematopoietic transplants has an overall incidence of 2%, and appears to be significantly...
more common after cord blood transplant. A high level of suspicion for mesial temporal pathology should be present for posttransplant or immunocompromised patients, as it is devastating, and early recognition will prompt appropriate drug therapy. Due to the ubiquitous nature of HHV-6 antibodies, and the suppressed serological response in these patients, MRI may be the most accurate test in suspected limbic encephalitis.

**Paper 354 Starting at 4:43 PM, Ending at 4:51 PM**

The Role of Pre-dose and Leakage Correction in Gd-based Cerebral Blood Volume Estimation Determined by Comparison to MION as a Gold Standard

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**PURPOSE**

Relative cerebral blood volume (rCBV) computed for gliomas with dynamic susceptibility contrast MRI (DSC) may be inaccurate due to contrast extravasation; pre-dose contrast administration and leakage correction algorithms are purported to minimize inaccuracy (1). To test the efficacy of these techniques, we compared Gd-based rCBV using pre-dose and leakage correction to “gold standard” rCBV using MION, an intravascular agent immune to leakage contamination.

**MATERIALS & METHODS**

Eight Fisher rats were implanted with 9L cerebral gliosarcomas. MR imaging was performed at 14 days (3T Signa Excite, quadrature birdcage coil, FOV=4cm, 4 slices, 2mm slice thickness). DSC (GE-EPI, TR=5s, TE=34.5ms, matrix=64x64, 60 seconds before and 60 seconds after injection) with both MION (MGH CMIR; single 2.0 mg Fe/kg bolus) and Gd-DTPA was performed in each rat, with randomly assigned order. Each DSC Gd-DTPA study had a 0.1 mmol/kg injection (“pre-dose”) succeeded by a 0.2 mmol/kg injection. For all MION and Gd-DTPA injections, rCBV maps were generated by trapezoidal integration over all time points of \( ?R2(t) \) derived from signal intensity data for each voxel, with and without leakage correction for Gd-DTPA injections. Therefore, four Gd-DTPA leakage correction permutations were tested: with and without pre-dose, and with and without leakage correction algorithm. Mean tumor rCBV was computed from each rCBV map using a ROI within enhancing tumor on T1-weighted images (spin echo, TE/TR=12/450ms, 256x256 matrix, NEX=16), and was normalized to contralateral brain. For each Gd-DTPA correction permutation, the ratio of normalized rCBV to MION rCBV was computed, and the mean and standard deviation of ratios for each correction scheme were calculated. The least squares linear fit of normalized rCBV for all rats versus MION rCBV was computed for each correction permutation.

**RESULTS**

Figure 1 demonstrates progressively improved approximation of Gd-DTPA rCBV to MION rCBV with increasing degrees of leakage correction. Gd-DTPA/MION rCBV ratios improve from 5.9±9.4 (no pre-dose or correction algorithm) to 0.99±0.2 (pre-dose plus correction algorithm). Although both pre-dose and leakage correction independently substan-
tially improve rCBV accuracy, leakage correction contributes significantly beyond pre-dose. In Fig 2, the linear fit of Gd-DTPA vs MION rCBV with leakage correction is much closer to identity (slope 0.98, R=0.77) than the linear fit without (slope 0.22, R=0.12).

**CONCLUSION**

Pre-dose contrast administration plus leakage correction algorithm effectively eliminates contamination of DSC rCBV estimates due to contrast extravasation. Although both factors play significant roles, there is substantial contribution by leakage correction algorithm beyond pre-dose administration alone.

**REFERENCE**


**KEY WORDS:** Cerebral blood volume, leakage correction, MION
Parallel Imaging

Timothy P. L Roberts, PhD

Time-Resolved Contrast-Enhanced MR Angiography

Frank R. Korosec, PhD

Dr. Korosec is a professor in the departments of Radiology and Medical Physics at the University of Wisconsin, Madison, WI. He is a medical physicist who has been developing and evaluating MR vascular imaging methods for over 15 years. He has co-authored over 50 scientific papers and seven book chapters and has presented over 60 educational lectures at national and international conferences worldwide. Professor Korosec is a co-inventor on nine MR vascular imaging patents; the most notable is a patent for a time-resolved, contrast-enhanced MR vascular imaging method called TRICKs, which allows the passage of an intravascular contrast agent to be observed.

LEARNING OBJECTIVES

Upon completion of this presentation, participants will be able to:
1) Identify the strengths and limitations of 3 dimensional time-resolved contrast-enhanced magnetic resonance angiography (CE MRA).
2) Identify diagnostic applications for which 3D time-resolved CE MRA would be beneficial.
3) Describe key differences between X-ray DSA and 3D time-resolved CE MRA.

PRESENTATION SUMMARY

Contrast-enhanced magnetic resonance angiography (CE MRA) is used widely for a number of diagnostic applications. Because of the long acquisition times associated with MRI, and the short transit times of the contrast material from arteries to veins, typically only a single 3D data set may be acquired during the arterial phase and another during the venous phase. Acquiring multiple arterial- or venous-phase MRA images using conventional data acquisition methods is not feasible. However, the benefits of time-resolved imaging are well understood from x-ray DSA. Therefore, in the last decade, there has been a great effort to improve time-resolved MRA methods. This work has resulted in a number of modifications to the conventional data acquisition approaches, which has made time-resolved MRA methods practical. One of these developments, and the focus of this presentation, is the formation of images from data that has been updated at different rates throughout the acquisition. It is well understood that certain data that are acquired in MRI are responsible for the contrast information in the images whereas other data are responsible for the detail information. In the more commonly-used time-resolved MRA methods, the contrast information is sampled more frequently than the detail information. During reconstruction, the contrast and detail data are strategically combined to form multiple arterial- and venous-phase image volumes that demonstrate the passage of the contrast material through the vascular system. Today, vascular territories throughout the body and in the head and neck are routinely imaged with 3D time-resolved CE MRA methods. Neurovascular applications include imaging arteriovenous malformations (AVMs) and subclavian steal, or simply imaging the carotid and vertebral arteries prior to enhancement of the jugular veins. As well as allowing imaging of an artery-only phase, the time resolution allows qualitative interpretation of the hemodynamics. Currently, the temporal and spatial resolutions of time-resolved MRA methods are inferior to those provided by x-ray DSA, but they continue to improve. In addition, MR provides three-dimensions of information, it uses a non-nephrotoxic contrast material, and it does not use ionizing radiation. Furthermore, MRI is capable of providing information beyond vascular anatomy. For example, phase contrast methods yield blood velocity and flow, conventional MRI methods show stationary tissues, perfusion and diffusion methods demonstrate the effects of stroke, and spectroscopic methods provide information about the metabolic composition of lesions.

HYPR-VIPR

Patrick A. Turski, MD, FACR

PRESENTATION SUMMARY

HYPR MRA is a novel and exciting contrast enhanced (CE) Magnetic Resonance Angiography (MRA) technique that provides whole brain three dimensional time resolved images of the arterial and venous systems with exceptional spatial and temporal resolution and flow physiology. HYPR MRA has the highly desirable ability to image the entire brain with one second frame rates and isotropic spatial resolution. Initially, our group explored the use of highly accelerated time resolved contrast enhanced MRA using radial k-space trajectories in 2D imaging where radial undersampling factors of 4-6 could be achieved. This work was extended to 3D radial acquisition using Vastly undersampled Isotropic PROjection imaging (VIPR) which permitted undersampling factors of more than 100 in the case of Phase Contrast (PC) MRA. We have recently started to investigate a reconstruction method called HighlY constrained back PROjection (HYPR) that significantly increases the achievable acceleration by exploiting the redundancy of data in a time series. HYPR reconstruction employs unfiltered backprojection constrained by a composite image to dramatically improve the signal to noise ratio (SNR) and suppresses artifacts for each image in the series. HYPR PC MRA extends this concept and combines a first pass 3D radial VIPR contrast-enhanced MR angiogram with a HYPR composite image formed from a separate 300s PC VIPR scan. The HYPR reconstruction increases the SNR of an individual time frame by a factor of 4 relative to VIPR CE MRA. Iterative HYPR algorithms and a HYPR LR (Local Reconstruction) will be presented that improve temporal contrast signal accuracy. Our initial objective is to acquire 3843 images of the entire brain at one 3D volume per second using first pass HYPR MRA. First pass HYPR Flow uses an angular undersampling factor of more than 300 and achieves spatial and temporal resolution and SNR not previously approached in CE-MRA. The phase contrast acquisition adds flow information to the VIPR CE-MRA time frames and provides velocity information suitable for the calculation of physiological parameters. HYPR MRA provides high resolution, velocity encoded serial 3D MR angiograms images of the entire brain and can be used to evaluate virtually any neurovascular disorder.
Thursday Afternoon
6:15 PM – 6:30 PM
Grand Ballroom C-F

Closing Remarks

(421) Closing Remarks
Purpose
Previous data have suggested that evolution of acute cerebral ischemic lesions on diffusion-weighted (DW) magnetic resonance imaging (MRI) may demonstrate growth of the ischemic lesion or resolution of the initial lesion over the first several days. We studied the evolution of DWI imaged lesions in a large prospective sample of acute ischemic stroke patients.

Materials & Methods
Each of the 217 patients presenting with acute stroke underwent two separate MR scanning sessions. Diffusion-weighted signals were classified as four types: Type A, positive at both baseline and follow-up scan; Type B, negative at baseline scan, but positive at follow-up scan; Type C, positive at baseline scan, but negative at follow-up scan; Type D, both scans were negative. Stroke volume from DW signal was measured. Comparisons of the DW features between different scanning sessions were performed using the Student's t test and Fisher's exact test.

Results
The median time to baseline scan was 15.2 ± 7.4 hours of symptom onset and the median follow-up scan was 4 ± 1 days from symptom onset. Thirty-three patients (15%) were treated with tPA and 25 (12%) were diagnosed as TIA. One hundred sixty-seven (77%) cases showed Type A signal, in which 143 (86%) cases demonstrated growth of the lesion. Mean stroke volumes at baseline and follow-up scan in this type without TIA were 16.9 and 32.7 cubic centimeters (cc) (p = .01), comparing with that with TIA (1.0 and 1.4 cc, p = .55). Occurrences showing interval decrease in stroke volume in cases treated with/without tPA were 13% and 14%, respectively (p > .05) (Fig 1). Ten (4%), two (1%), and 38 (18%) of patients were classified as Type B, C, and D, respectively. Mean time duration between baseline and follow-up scan in Type B was 65.2 hours. The DW volume in the two Type C lesions was .9 cc and .4 cc, respectively. Occurrences of Type D in cases with/without TIA were 48% and 14%, respectively (p < .05).

Conclusion
Though most imaged DWI lesions within the first 24 hours in acute ischemic stroke patients increase over the next several days, a small proportion of acute ischemic stroke patients decrease in size of their DWI lesion even without tPA therapy.

Key Words: Stroke, diffusion-weighted (DW), magnetic resonance imaging (MRI)
Poster 2

1H and 31P MRS Measurements of Changes in Cerebral Energy Metabolism and pH Following Carotid Artery Stent Placement

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Frankfurt, GERMANY

PURPOSE
The aim of this study was to evaluate a potential improvement in brain energy metabolism in vivo after carotid artery stent placement (CAS) in patients with high grade symptomatic ICA stenosis. For this purpose we employed 31P and 1H magnetic resonance spectroscopic imaging (MRSI).

MATERIALS & METHODS
Twelve patients with high grade ICA stenosis according to NASCET criteria were examined pre-interventional with a subsequent postinterventional scan within a period of 2-4 days. For comparison, 6 healthy subjects were scanned as a control group. MRS of the brain was performed on a 3T whole body system with a double tuned 1H/ 31P volume head coil. Axial slices including the basal ganglia were recorded with chemical shift imaging. Metabolite concentrations from 1H spectra were analyzed using LCModel, 31P spectra were analyzed with jMRUI. The tissue pH was estimated from the chemical shift difference between the inorganic phosphate (Pi) and the phosphocreatine (PCr) signal. The signal intensities of PCr from 31P MRS and the sum of creatine and phosphocreatine (tCr) were assumed to serve as an indicator for the status of energy metabolism while N-acetylaspartate (tNAA) may be an indicator of neuronal damage in the area ipsilateral to the stenosis.

RESULTS
For all metabolite of interest the signal intensity could be assessed with an accuracy better than 15%. Prior to stent implantation, the tissue pH of the ipsilateral side was significantly increased. Regarding metabolite concentrations, ipsilateral tNAA was significantly decreased compared to the controls while all other changes did not reach the level of statistical significance (p < 0.05). The decrease in tNAA clearly indicates neuronal damage in the hemisphere ipsilateral to stenosis, which is probably the result of a sustained perfusion deficit. This tissue reveals an increased pH, which seems to be reversed upon stent implantation. Such a finding contradicts the hypothesis that hypoperfusion induces acidosis due to increased anaerobic glycolysis. However, the examination was performed with patients at rest and may indicate an overcompensation under this condition. Such a rational would be consistent with the absence of a significant change in the PCr/tCr ratio.

CONCLUSION
31P MRSI shows a reversible increase in tissue pH of the ipsilateral hemisphere. This rather reflects an overcompensation in the resting brain than the actual perfusion deficit.

KEY WORDS: MRS, energy metabolism, carotid stent

Poster 3

The Effect of Statin Pre-Treatment on Infarct Volume in Ischemic Stroke

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PURPOSE
Treatment with HMG-CoA reductase inhibitors (statins) has been shown to reduce infarct volume in animal models of ischemic stroke. Additionally, we have shown in a group of 286 patients that the median infarct volume for a statin-pre-treated group was 26.5% smaller than the median for a no-statin group. Although these results suggest reduced infarct volume in the statin-pre-treated group, they were not statistically significant (p = .484). In a similar study of 143 patients (26.5% statin-pre-treated), Shook, et al.(1) also found that patients on statins had a tendency toward smaller infarct volumes. To explore this finding further, we analyzed several subgroups based on the co-morbidity of diabetes, infarct location, and infarct size. The purpose of this analysis was to determine whether the benefit of statins is restricted to a particular patient population or infarct characteristics.

MATERIALS & METHODS
Study design was a retrospective cohort analysis of all ischemic stroke patients admitted to our institution from March 2002 to March 2006 with 286 patients included in the primary analysis. Patients were divided into 2 groups based on statin-status with infarct volume as the primary outcome. Analyses of the whole group and a subgroup of patients with diabetes were performed. Additionally, in both the whole group and in the subgroup of patients with diabetes, analyses were performed excluding single subcortical infarcts and infarcts < 1.5 cm3.

RESULTS
Results of the primary analysis in the whole group indicate the median infarct volume for the statin-pretreated group was smaller than the median for the no-statin group but not significant (Table 1). In the subgroup of patients with diabetes, a much larger and statistically significant decrease in median infarct volume was found among the statin-pretreated patients. Analysis of patients without single subcortical infarcts suggested a tendency toward smaller median infarct volumes in the statin pretreated group. When both single subcortical and infarct volumes < 1.5 cm3 were excluded, results were not significant in either the whole group or the diabetes group (median was higher among statin-treated in the whole group and lower in the diabetes group).
with a recent TIA have an increased risk to develop a major neurologic symptoms lasting less than an hour (1). Patients infarction. Recent publications discussed a timeframe of symptoms lasting less than 24 hours without evidence of Transient ischemic attack (TIA) is defined by neurologic

<table>
<thead>
<tr>
<th>Total Whole Group</th>
<th>No-statin</th>
<th>Statin</th>
<th>p-value</th>
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<td>Median Infarct Volume cm³</td>
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CONCLUSION
Results of this study indicate that statin pretreatment is associated with a reduction in infarct volume in ischemic stroke patients. Additionally, the potential effect of statins on infarct volume may be particularly pronounced among patients with diabetes. Unlike Shook, et al., when we excluded small (< 1.5 cm³) and single subcortical infarcts, the observed difference between the groups was lost. Larger prospective studies are needed to confirm and characterize any potential neuroprotective effect of statins.

REFERENCES

KEY WORDS: Stroke, statin, infarct

Partial support for this project was provided by Pfizer grant #2004-0361

Poster 4
How Reasonable Is Immediately Performed CCT Imaging in Patients Presenting with Clinical Symptoms of TIA Lasting Less than an Hour?

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PURPOSE
Transient ischemic attack (TIA) is defined by neurologic symptoms lasting less than 24 hours without evidence of infarction. Recent publications discussed a timeframe of neurologic symptoms lasting less than an hour (1). Patients with a recent TIA have an increased risk to develop a major stroke most likely within the first week after symptom onset therefore requiring an extensive work-up for prevention (2). Recent recommendations for prevention of strokes do not discriminate TIA from stroke independent of the underlying cause (3). Cranial CT (CCT) as widely available imaging modality of choice is usually initially performed to rule out other causes of neurologic deterioration. According to the current literature there is no systematically performed study analyzing the possible underlying causes in patients presenting with TIA lasting less than an hour. Furthermore to justify radiation exposure CT should be sensitive enough to depict intracranial lesions.

MATERIALS & METHODS
Within one year we reviewed all CCT-requests of patients presenting with transient neurologic symptoms at our university hospital. CT scans, emergency notes, charts and other performed imaging modalities were reviewed. Cases with Todd paralysis due to seizure and other causes that would require immediate emergency imaging (i.e. anticoagulated patients with head trauma or acute hypertensive dysregulation) were excluded.

RESULTS
We reviewed 3580 requests for a cranial CT including 350 requests (9.8%) because of transient neurologic symptoms. Of these 112 with symptoms that lasted longer than an hour were excluded for further analyzes. From the remaining group 20 were excluded because of reasons requiring emergency imaging as described above, and 13 had to be excluded for other reasons. 205 patients (5.7%) presented with a transient neurologic deterioration lasting less than one hour. From these patients 5 cases (2.4%) had a pathological finding in the initial CT. One case of infarction on initial CCT turned out to be artificial in the follow up imaging. Two infarctions were found one of which showed hemorrhagic transformation. One case of metastasis (lung cancer) and one meningeoma with parenchymal edema were diagnosed respectively. From the remaining CCTs without pathological findings, 4 cases showed infarction on follow-up MRI.

CONCLUSION
Overall 8 cases (3.9%) with TIA had pathological findings, of which only 50% were detected by initial CCT. Both patients with tumor lesions as well as the patient with hemorrhagic infarction did not receive anticoagulation. Four strokes presenting as TIA were missed on initial CCT. Strokes can present as TIA especially when they affect clinically “silent” regions. Even though we found a small number of pathological findings, none of the patients required any immediate emergency treatment. In none of our cases an intracranial bleeding was detected. 50% of pathological findings were completely missed on CCT. Emergency imaging with CT in TIA lasting less than an hour remains questionable with regard to the benefit for the patient, costs and radiation exposure without significant improvement or changes in the treatment.

KEY WORDS: TIA, CCT, stroke

Poster 5
Luxury Perfusion Masking Subacute Infarcts on Dynamic CT Perfusion

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PURPOSE
Preliminary literature based on single photon emission computed tomography (SPECT) and positron emission tomography have noted that SPECT imaging can be misleading in subacute cerebral infarcts, due to mildly increased cerebral blood volume (CBV), and slightly decreased cerebral blood flow (CBF) (1). Our purpose is to describe this hyperperfusion phenomenon occurring in the subacute phase on dynamic CT perfusion (CTP), potentially obscuring the extent of infarction, and to propose tools to avoid this pitfall.
MATERIALS & METHODS
Dynamic perfusion CT was performed in 6 patients in the subacute phase (range 3-8 days, one with unknown exact infarct age, but deemed subacute based on progression and contrast enhancement). Three were performed to rule out progression of a known stroke due to worsening symptoms, and three to rule out acute stroke, but later found to be subacute insults based on further clinical history and imaging. Mean transit time (MTT), CBF and CBV were calculated in >2cm regions of interest in the area of infarction, and the contralateral unaffected hemisphere, using post-processing software.

RESULTS
In 5 of the 6 patients, diffusion-weighted imaging (DWI) MRI was performed in under 3 days relative to the CTP; one could not undergo MRI due to pacemaker and was followed by CT. In all 6 patients, compared to the nonaffected side, the CBV’s were mildly elevated (mean increase 42%) and the CBF’s were mildly decreased (mean decrease 34%), while MTT’s were severely elevated (mean increase >200%) in all but one case where the transit time was only mildly elevated. Hence, CBF and CBV were only mildly abnormal rather than being near zero in areas later shown to progress to infarction on DWI (n=5) or followup CT (n=1). Hence, MTT was the only measurement that corresponded well with the extent of DWI infarction in 5 of the 6 cases of subacute infarction (threshold >9 seconds).

CONCLUSION
Hyperemia (increased CBF and CBV) rather than oligemia in a territory of subacute phase infarction is likely related to the concept of luxury perfusion from capillary dysfunction, based on recent literature. Use of MTT measurements, DWI MRI, and appropriate clinical histories can prevent misinterpretation when this misleading imaging appearance occurs.

REFERENCES

KEY WORDS: CT perfusion, luxury perfusion, cerebral infarction

Poster 6
Vertebral Stump Syndrome
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The role of the carotid artery stump as an embolic source for cerebral ischemia has been well described. When there is occlusion of flow in an artery, further ischemic episodes are not expected because of lack of a flow conduit to carry the embolus. However, in the carotid stump syndrome, ongoing ischemic events may continue due to collateral flow via the external carotid artery branches. To our knowledge, there have been no reports of a parallel syndrome causing stroke in the posterior circulation after documented proximal arterial occlusion. Vertebral artery anastomoses are numerous in the neck. Collaterals often preserve antegrade flow distal to a vertebral artery occlusion and may serve as a path for persistent emboli. We report two patients who presented with posterior circulation strokes after documented vertebral artery occlusion, despite optimal medical therapy (antiplatelet and anticoagulation therapy). Due to failed medical therapy, an endovascular approach via the deep cervical artery collateral to the vertebral artery was undertaken to exclude the embolic source. We describe their histories, the anatomy of the cervical-vertebral anastomotic collaterals as a pathway for ongoing ischemia, and implications for management.

KEY WORDS: Vertebral stump, stroke, anatomy

Poster 7
Diffusion Tensor Imaging of Normal Appearing White Matter in Late-Life Depression
Shimony, J. S. · Epstein, A. A. · Snyder, A. Z. · McKinstry, R. C. · Mintun, M. A. · Price, J. L. · Christenson, J. · Moinuddin, A. · Sheline, Y. I.
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PURPOSE
Diffusion tensor imaging (DTI) can be used to evaluate white matter (WM) integrity and structural abnormalities in normal appearing white matter (NAWM). WM disruption in frontal emotional regulatory areas may be a contributing factor to late-life depression. The purpose of this study was to use DTI to assess the integrity of frontal subcortical and deep WM of depressed patients versus controls.

MATERIALS & METHODS
Structural imaging was performed in a sample of late life depressed (LLD) subjects (n=73) compared with controls (n=23). The groups were matched according to gender, age, and vascular risk factors. Anatomical imaging was performed using T1- and T2-weighted images. DTI was obtained on a 1.5T Sonata (Siemens, Erlangen, Germany) with 6 encoding directions and multiple b values (b = 0, 400, 800, 1200 s/mm²) using 2mm isotropic voxels. DTI parameters were computed from the raw data using linear least
squares algorithm. Each frontal hemi-cortex was subdivided into 10 regions of interest (ROI) according to anatomical criteria. Ten additional regions were selected in deep WM of the frontal, parietal, and temporal lobes. Anatomical regions were defined on an atlas, automatically individualized for each subject using a bispectral tissue segmentation of GM, WM, and white matter hyperintensity (WMH). Exclusion of WMH allowed assessment of DTI parameters in non-lesion WM adjacent to cortical ROIs.

RESULTS

LLD subjects had near uniform statistically significant increase in mean diffusivity (MD) in the deep WM regions as compared to the controls. Exclusion of WMH from these regions did not alter these results. The anisotropy (RA) was not significantly changed in the deep regions between groups. In the subcortical frontal regions as compared to the controls the LLD had statistically significant increase in MD in the superior, medial, and inferior frontal gyri and in the lateral orbito-frontal region. Some of these regions also exhibited significant decreases in RA. Strong positive correlations were seen between the MD in the deep WM regions and the clinical depression score. No such correlations were seen with the RA. Correlations were also noted between the depression score and the MD in the right frontal subcortical regions as compared to the left side.

CONCLUSION

The current study demonstrates evidence for differences in tissue integrity of NAWM (as demonstrated by DTI) between LLD and normal age matched controls. The decreased tissue integrity in these regions may be due to the disruption of networks important for emotional regulation and may be a cause or a contributor to the pathology of LLD. These result suggest that DTI measurements could be used as additional factor in the clinical assessment of LLD.

KEY WORDS: Diffusion tensor imaging, depression, white matter

We thank the following for their support: NARSAD, K24 (NIMH), NIMH RO1 MH 064821

Poster 8

White Matter Changes in Amyotrophic Lateral Sclerosis Investigated Using High-dimensional Diffusion-tensor Image Registration

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PURPOSE

Amyotrophic lateral sclerosis (ALS) is a degenerative disease of both upper and lower motor neurons. Several groups have reported the efficacy of diffusion tensor imaging (DTI) to evaluate the white matter tracts in the brain as a surrogate marker of upper motor neuron (UMN) disease, finding reduced fractional anisotropy (FA) in the corticospinal tracts. In this study, we evaluated the use of a high-dimensional diffusion-tensor image normalization algorithm to detect the location and magnitude of FA changes in patients with ALS.

MATERIALS & METHODS

DTI was performed on eight ALS patients and eight age-matched healthy controls on a 3.0-T scanner using a singleshot, spin-echo, diffusion-weighted EPI sequence with twelve gradient directions. Diffusion-tensor images were spatially normalized using a novel high-dimensional registration algorithm that explicitly optimizes tensor orientation for optimal alignment of white matter structures [1]. A population-specific tensor template was generated from the 16 subject images in an iterative process [2]. FA maps were derived from the normalized data. Statistical parametric mapping was applied for statistical inference on a voxel-by-voxel basis using SPM2 (Wellcome Department of Cognitive Neurology, London, UK) [3]. We report clusters exceeding an extent threshold of 10 voxels and a corrected p-value threshold of 0.05 at cluster-level.

RESULTS

Significant clusters of reduced FA in ALS subjects were found both in the expected locations of the corticospinal tracts (cerebral peduncle: size=25, p<0.000; bilateral centrum semiovale: 1) size=69, p<0.000, 2) size=22, p<0.000, 3) size=12, p<0.01, 4) size=10, p<0.026) and in two other locations (posterior corona radiata: size=10, p<0.026; corpus callosum midbody: 1) size=10, p<0.026, 2) size=16, p<0.002). Figure 1 shows the significant clusters overlaid with the FA map derived from the population-specific tensor template. No significant clusters of increased FA were found.

CONCLUSION

In this preliminary study, we used a high-dimensional DTI normalization algorithm to find clusters of significantly reduced FA that may reflect UMN damage in the brain. We believe that the high accuracy of the normalization process, by allowing the usual SPM smoothing step to be omitted, improves spatial specificity and increases the significance levels of the differences found. Normalized DTI shows promise as an MR-based biomarker of UMN disease, which may have future use in detecting early disease, monitoring of disease progression, and facilitating development of potential treatments.

REFERENCES


KEY WORDS: Amyotrophic lateral sclerosis, diffusion tensor imaging, spatial normalization
Poster 9

Relationship of Corticospinal Tract Abnormalities and Ankle Weakness in Multiple Sclerosis

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1Johns Hopkins University, Baltimore, MD, 2Kennedy Krieger Institute, Baltimore, MD

PURPOSE
To assess the relationship between muscle strength in multiple sclerosis (MS) and corticospinal tract (CST)-specific abnormalities detected with multimodality magnetic resonance imaging (MRI) of the brain.

MATERIALS & METHODS
In 36 individuals with MS (21 relapsing remitting, 9 secondary progressive, and 6 primary progressive), diffusion tensor imaging (DTI) at 3T was used to reconstruct the intracranial CSTs. Tract profiles depicted the variation in multiple MRI parameters - T1 and T2 relaxation times, magnetization transfer ratio (MTR), and DTI-derived indices including fractional anisotropy and mean diffusivity, as well as diffusivity parallel and perpendicular to the tract orientation - as a function of normalized position along the tract. The degree of abnormality in these tract profiles was related to quantitative measurement of ankle dorsiflexion strength obtained with dynamometry.

RESULTS
On average, individuals with MS were significantly weak, with average ankle dorsiflexion strength falling 2.0 standard deviations below the age-, handedness-, and gender-corrected mean. MTR tract profiles were markedly abnormal in MS but were not related to ankle strength. For diffusivities, stronger ankles were, on average, associated with more abnormal tract profiles, although correlations were weak.

CONCLUSION
Within the brain, MTR appears to be sensitive to the presence or absence of MS but does not change with disease severity. Possible explanations for our finding that weakness is associated with a more normal appearance of the MRI-derived corticospinal tract profiles include the following: (1) Some patients may have profound weakness due to extensive spinal cord disease, with relative sparing of the brain; (2) Measures of diffusivity may be particularly sensitive to inflammation, so that as inflammation gives way to neurodegeneration in weaker patients, the associated tract profiles appear to normalize. Direct comparison between spinal cord and brain, and longitudinal assessment of brain MRIs over time, could distinguish these two possibilities.

KEY WORDS: Corticospinal tract, multiple sclerosis, diffusion tensor imaging

Poster 10

Functional Correlates of Neuropsychological Impairment in Multiple Sclerosis

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PURPOSE
Cognitive impairment is common in multiple sclerosis (MS) and has a relevant impact on patients' social and occupational life. Abnormalities of cerebral blood flow have long been acknowledged in MS and advances in perfusion MRI allow their assessment in vivo. This study aimed to investigate the relationship between regional perfusion changes and neuropsychological dysfunctions in patients with relapsing-remitting (RR) and primary-progressive (PP) MS.

MATERIALS & METHODS
Absolute cerebral blood flow (CBF), blood volume (CBV) and mean transit time (MTT) were measured in the NAWM and deep GM of 32 MS patients and 11 healthy controls using dynamic susceptibility contrast enhanced (DSC) T2*-weighted MRI. A comprehensive neuropsychological (NP) test-battery was administered to all patients. Raw NP scores were normalized using published norms and then converted to z scores based on the normal distribution. A mixed model analysis of covariance was performed for group comparisons in terms of perfusion measures in normal-appearing white matter (NAWM) and deep gray matter (GM). Pearson correlations were used to describe the association of perfusion metrics with NP scores.

RESULTS
CBF and CBV values were significantly reduced in both NAWM and deep GM in MS patients compared to controls (p=0.01). In all patients, after adjusting for age, gender, disease duration and depression, deep GM CBF was significantly associated with Rey Complex Figure Test (RCFT)-Copy (r=0.5; p=0.001), deep GM CBV and NAWM CBV were significantly associated with Color-Word Interference Inhibition Switching test (D-KEFSIS) (r=0.4; p=0.008 and r=0.4; p=0.02). However, the only associations that remained significant after Bonferroni correction were between deep GM CBF and RCFT-Copy (r=0.5; p=0.006) and deep GM CBV and D-KEFSIS (r=0.5; p=0.04)

CONCLUSION
Our results suggest a role for tissue perfusion impairment (not only in NAWM but also in deep GM) in neuropsychological dysfunction in MS. Larger-scale studies are needed to better characterize this association.

KEY WORDS: Multiple sclerosis, perfusion MR imaging, cognitive impairment
Spatially Normalized Analysis of Diffusion Tensor Imaging in Clinically Isolated Syndrome and Multiple Sclerosis Patients

Jewells, V. L. · Chin, Y. · Sayad, C. · Smrtnka, J. · Markovic-Plese, S. · An, H. · Lin, W.
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PURPOSE
The principle pathology in multiple sclerosis (MS) is myelin and axonal loss, which can be measured with diffusion tensor imaging (DTI) as fractional anisotropy (FA), apparent diffusion coefficient (ADC), L1/axonal components, and L2/axonal components. Voxel/spatially normalized analysis (VA) was employed to delineate regional differences in diffusion parameters to compare MS and clinically isolated syndrome (CIS) patients to normal volunteers.

MATERIALS & METHODS
Following IRB approval and written informed consent, 28 normal subjects (15M, 13F, 34.39 ± 6.08 years old), 35 clinically isolated syndrome (CIS) patients (8M, 27F, 40.40 ± 9.85 years old), and 16 MS (3M, 13F, 39.88 ± 10.66 years old) patients were studied with a 3T Siemens’ head only scanner. Images were acquired via T1-weighted (1mm3 in voxel size) and DTI images (6 different encoding directions and 2mm3 in voxel size, total 46 slices). The data from the 28 normal subjects were utilized to build normal DTI statistics of scalar diffusion parameters to compare MS and clinically isolated syndrome (CIS) patients to normal volunteers.

RESULTS
Both CIS and MS patients demonstrated statistically significant differences compared to normals for FA, ADC, L1, and L2 parameters for gray and white matter (Fig 1) for both HA and VA, although the significance appears to be greater with VA. Additionally, many of the abnormal areas visualized with VA are not seen with cMRI. Such anatomical localization is not possible with histogram analysis.

<table>
<thead>
<tr>
<th>DTI Parameter</th>
<th>Mean ± SD of normal, CIS, and MS groups</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>WM FA NAV</td>
<td>(9.39±6.26) (16.91±7.31) (21.27±9.15)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>GM FA NAV</td>
<td>(1.68±0.72) (3.70±1.22) (4.18±1.58)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>WM ADC NAV</td>
<td>(17.56±6.45) (40.23±25.75) (40.16±29.50)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>GM FA NAV</td>
<td>(23.33±10.55) (39.99±18.84) (39.44±22.38)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>GM L1 NAV</td>
<td>(2.03±1.36) (4.72±3.57) (4.90±3.90)</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>GM L1 NAV</td>
<td>(22.51±9.68) (38.72±19.68) (37.18±21.35)</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>WM L1 NAV</td>
<td>(6.25±4.32) (9.55±4.85) (10.89±6.75)</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>WM L1 NAV</td>
<td>(16.52±7.34) (31.94±17.09) (28.77±16.14)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>GM L2 NAV</td>
<td>(16.63±9.33) (34.00±19.06) (37.79±25.13)</td>
<td>&lt;0.0001</td>
</tr>
</tbody>
</table>

CONCLUSION
Both HA and VA are capable of demonstrating abnormalities in CIS and MS patients compared to normal subjects while allowing whole brain assessment unlike ROI analysis. Previous authors have reported a lack of difference between CIS and MS patients using histogram analysis also. However, VA demonstrates additional anatomical information. Possibly, these abnormalities correlate to myelin and axonal loss in the normal appearing white matter and may correlate better with clinical symptoms than conventional MRI currently does. Additionally, further evaluation of individual patients using VA to compare specific brain regions over multiple time points may help assess therapy response and clinical changes in the normal appearing white matter in MS.

KEY WORDS: Multiple sclerosis, Clinically isolated syndrome, voxel analysis

Poster 12

Diffusion Tensor Imaging for Different Types of Ataxia

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PURPOSE
Diffusion tensor imaging (DTI) and probabilistic tract tracking (PTT) methods are new tools that could potentially be used to evaluate changes in white matter connections neurodegenerative diseases.

MATERIALS & METHODS
To determine the sensitivity and specificity of these tools for distinguishing cerebellar ataxias, DTI-, T1-, and T2-weighted magnetic resonance imaging (MRI) images from 24 ataxic and 10 control patients were examined. Specific regions of interest along the cerebellar inflow and outflow pathways were selected from DTI images and fractional anisotropy (FA) and apparent diffusion coefficient (ADC) values, were measured. PTT was also performed. Tracts with high confidence were chosen and their FA used as a metric.

<table>
<thead>
<tr>
<th>DTI Parameter</th>
<th>Mean ± SD of normal, CIS, and MS groups</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>WM FA NAV</td>
<td>(9.39±6.26) (16.91±7.31) (21.27±9.15)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>GM FA NAV</td>
<td>(1.68±0.72) (3.70±1.22) (4.18±1.58)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>WM ADC NAV</td>
<td>(17.56±6.45) (40.23±25.75) (40.16±29.50)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>GM FA NAV</td>
<td>(23.33±10.55) (39.99±18.84) (39.44±22.38)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>GM L1 NAV</td>
<td>(2.03±1.36) (4.72±3.57) (4.90±3.90)</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>GM L1 NAV</td>
<td>(22.51±9.68) (38.72±19.68) (37.18±21.35)</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>WM L1 NAV</td>
<td>(6.25±4.32) (9.55±4.85) (10.89±6.75)</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>WM L1 NAV</td>
<td>(16.52±7.34) (31.94±17.09) (28.77±16.14)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>GM L2 NAV</td>
<td>(16.63±9.33) (34.00±19.06) (37.79±25.13)</td>
<td>&lt;0.0001</td>
</tr>
</tbody>
</table>

Figure #1: Significant DTI and Histogram Data

Histiogram Parameters Mean ± SD of normal, CIS, and MS groups

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Mean ± SD of normal, CIS, and MS groups</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>GM FA 1st</td>
<td>(0.099 ± 0.007) (0.091 ± 0.013) (0.090 ± 0.012)</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>GM L1 1st</td>
<td>(1.224 ± 0.053) (1.274 ± 0.083) (1.265 ± 0.105)</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td>GM L2 1st</td>
<td>(0.998 ± 0.060) (1.049 ± 0.088) (1.048 ± 0.112)</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td>WM FA 1st</td>
<td>(0.224 ± 0.020) (0.212 ± 0.021) (0.201 ± 0.020)</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>WM ADC 1st</td>
<td>(0.824 ± 0.022) (0.846 ± 0.033) (0.845 ± 0.038)</td>
<td>&lt;0.02</td>
</tr>
<tr>
<td>WM L1 1st</td>
<td>(1.215 ± 0.030) (1.244 ± 0.039) (1.239 ± 0.041)</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>WM L2 1st</td>
<td>(0.705 ± 0.024) (0.722 ± 0.034) (0.728 ± 0.038)</td>
<td>&lt;0.05</td>
</tr>
</tbody>
</table>
of white matter integrity. Of the 24 ataxics, 7 had a clinical diagnosis of multiple system atrophy (cerebellar subtype; MSA-C), 4 had SCA1, 2 had SCA2, 2 had sporadic olivopontocerebellar atrophy, and the remainder had other or dual clinical diagnosis. Ataxia severity was measured using both a qualitative neurologic assessment and with the Inherited Ataxias Rating Scale (IACRS).

RESULTS
Features on traditional MRI, such as degree of pontocerebellar atrophy correlated with ataxia severity, but was neither sensitive nor specific for the ataxia subtypes. FA, ADC, and PTT measures in the cerebellar white matter tracts were more sensitive than traditional MRI measures of atrophy. Additionally these measures in MSA-C patients were decreased in the afferent pathway to the cerebellum but not the efferent pathways. SCA2 tended to affect both pathways. SCA1 patient showed efferent pathway abnormality.

CONCLUSION
Diffusion tensor imaging will be an useful tool to differentiate the involvement of the different pathway in the cerebellum.

KEY WORDS: Diffusion tensor imaging, ataxia, cerebellum

Poster 13

MRA Demonstrates Focal Arterial Hypertrophy in Status Epilepticus

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1AZ Klina, Brasschaat, BELGIUM, 2UZ Antwerpen, University of Antwerp, BELGIUM, 3UZ Gasthuisberg, Ku Leuven, BELGIUM

PURPOSE
In patients with status epilepticus (SE), reversible signal abnormalities have been reported on magnetic resonance imaging (MRI). These signal changes (which represent cytotoxic and vasogenic edema) can be misleading and are often misinterpreted as acute cerebral infarctions, or even tumors. Other findings include local hyperperfusion of the epileptic brain region, and alteration of the blood-brain-barrier. Local hyperperfusion associated with ictal activity was first observed by Penfield during neurosurgery and was subsequently demonstrated with angiography, SPECT and perfusion-weighted imaging. The purpose of this presentation is to document focal arterial hypertrophy during SE on MR angiography (MRA) in two patients.

MATERIALS & METHODS
Patient 1: A 42-year old-man was admitted with right temporal headaches of 1 week duration, and recent onset of nausea and vomiting since 2 days. Previous medical history was unremarkable. Neurologic examination upon admission revealed a photophobic patient, with speech difficulties, tremor and cramps of the left hand. There were no motor deficits. Laboratory findings were normal. Initial electroencephalography (EEG) displayed no ictal activity. Patient 2: An 18-year-old boy presented with left-sided hemianopia and episodic headaches since 2 weeks. The patient had a long medical history of epilepsy, which was under control with valproic acid. On the day of admission he experienced myoclonic jerking of the neck. Clinical examination confirmed left-sided hemianopia and revealed a right ankle clonus. Laboratory findings were normal. EEG registered an epileptic focus in the right occipital lobe.

RESULTS
Patient 1: The initial MRI demonstrated a small cavernous malformation in the right temporal lobe. T2-weighted images (T2-WI) showed extensive perilesional vasogenic edema. Diffusion-weighted images (DWI) displayed diffuse gyriform hyperintensities with a corresponding low apparent diffusion coefficient (ADC), indicating cytotoxic edema. A small hyperintensity in the ipsilateral pulvinar was also observed. On MRA we found thickening and increased signal intensity of the right middle cerebral (MCA) artery with obvious prominence of its M2 and M3 branches. After injection of gadolinium, leptomeningeal enhancement was observed. On follow-up imaging, the MRI abnormalities resolved, the caliber of the MCA returned to normal, and focal brain atrophy of the right temporal lobe was seen.

Patient 2: The initial MRI showed localized gyriform swelling of the right occipital cortex on FLAIR, T1- and T2-WI. Hyperintensity on DWI with corresponding low ADC was observed. On MRA, there was marked asymmetry of the posterior cerebral arteries (PCA) with increased conspicuity of the right PCA.

CONCLUSION
Reversible signal abnormalities on MRI have been reported in patients with both convulsive and non-convulsive SE. DWI abnormalities of the cerebral cortex and ipsilateral thalamus reflect cytotoxic edema, presumably caused by excessive release of excitatory amino acids such as glutamate (neuronal excitotoxicity). We have demonstrated that MCA can be used to document hypertrophy of the cerebral artery supplying the affected brain tissue in SE. Focal arterial hypertrophy reflects a temporary hyperperfusion state in response to elevated metabolic demands. This finding is useful to differentiate with acute arterial stroke.

KEY WORDS: Status epilepticus, cytotoxic edema, diffusion-weighted imaging

Poster 14

Prevalence of Asymmetry of Mamillary Body and Fornix Size on MR Imaging

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PURPOSE
To determine prevalence of the asymmetry of the fornix and mamillary body on magnetic resonance (MR) imaging in patients with or without seizures.

MATERIALS & METHODS
MR images were retrospectively evaluated for asymmetry of the mamillary body and fornix size in 190 patients who had a history of seizures of whom 47 patients had hippocampal sclerosis. Additionally 353 patients who had no limbic system pathology on their images or clinical history were also
RESULTS

In the patients who had no limbic system pathology or seizure history, 6.5% (23 of 353) had MR evidence of asymmetric mamillary bodies and 8% (28 of 353) had asymmetric fornical size. Asymmetry of the mamillary body and fornix size was found in 47% (22 of 47) and 49% (23 of 47) respectively of subjects with hippocampal sclerosis. Only one of the 47 subjects had a smaller mamillary body contralateral to the side of the hippocampal sclerosis. In the seizure patients without mesial temporal sclerosis, an asymmetry of mamillary body and fornix were found in 8% (11 of 143) and 8.4% (12 of 143) respectively.

CONCLUSION

The fornix and mamillary body may appear asymmetric for reasons other than limbic system abnormalities. While this asymmetry may suggest the possibility of mesial temporal sclerosis, the finding is present in a small proportion of patients without seizures or with seizures from causes other than hippocampal sclerosis.

KEY WORDS: Mamillary body, fornix, hippocampal sclerosis

Poster 15

Functional MR Imaging Reveals that Peak Activated Regions in the Primary Sensorimotor Cortex and Premotor Regions Are the Same for Multiple Sclerosis Patients and Controls During Complex Finger Tapping

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Cleveland, OH

PURPOSE

To evaluate differences, between MS patients and controls, in the spatial location of the maximally activated voxel within the primary sensorimotor cortex (SMC), dorsal premotor (PMd) and ventral premotor (PMv) cortex, supplemental motor area (SMA), superior parietal lobule (SPL) and inferior parietal lobule (IPL).

MATERIALS & METHODS

Prospectively motion-corrected gradient echo EPI fMRI exams at 3T were performed on 21 MS patients and 15 approximately age and gender matched controls during bilateral finger tapping (TE/TR/flip=29ms/2000m/90°, matrix=64x64, FOV=256x256mm, receive bandwidth=125kHz). All subjects were right handed as assessed by the Edinburgh Handedness Inventory. The Multiple Sclerosis Functional Composite (MSFC) exam was administered to all subjects prior to fMRI examination. Subjects tapped their fingers one at a time in the following sequence: thumb-middle-pinky-index-ring finger. Subjects were instructed to tap as fast as possible without making errors. Performance was recorded with a data glove (Fifth Dimension Technologies, Irvine, CA) and analyzed for tapping and error rates. Subject data was discarded if motion corruption was present upon visual inspection. For each subject, ROIs were drawn bilaterally around the SMC, PMd, PMv, SMA, SPL and IPL. The activation volume and xyz coordinates (in Talairach space) of the maximally activated voxel were determined for each ROI.

RESULTS

Ten healthy controls and 8 MS patients had motion free studies. Mean age was 41.1 +/- 9.6 (3 males) for MS patients and 40.5 +/- 8.4 (3 males) for controls. MSFC scores were 0.46 +/- 0.32 for patients and 0.65 +/- 0.29 for controls. All subjects performed the task well, and there was no difference in finger tapping or error rates between MS patients and controls. MS and control activation volumes and mean Student’s t scores were not statistically different. The mean displacement between controls and patients are as follows (LH-left hemisphere, RH-right hemisphere): PMd: 3.5 +/- 7.0 mm (LH), 5.0 +/- 8.3 mm (RH) PMv: 8.8 +/- 18.1 mm (LH), 8.9 +/- 19.0 mm (RH) SMC: 4.0 +/- 7.6 mm (LH), 3.0 +/- 8.3 mm (RH) IPL: 2.4 +/- 13.1 mm (LH), 4.1 +/- 10.7 mm (RH) SPL: 10.1 +/- 7.6 mm (LH), 3.7 +/- 11.0 mm (RH) SMA: 3.0 +/- 7.5 mm (LH), 2.7 +/- 5.6 mm (RH). None of the mean displacement between MS patients and controls represented a significant difference.

CONCLUSION

After carefully controlling for differences in head motion between MS patients and controls, xyz coordinates and Student’s t of the maximally activated voxel in the SMC, PMv, PMd, SMA, IPL were not significantly different. Intrasubject differences in location of peak amplitude were much larger than the observed displacement between controls and MS patients.

KEY WORDS: fMRI, motor, multiple sclerosis

Poster 16

Surgical Navigation Using fMRI and 3D T2-weighted Anatomical Data

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Phoenix, AZ

PURPOSE

fMRI data is typically provided in conjunction with a spatially-registered 3D structural dataset, allowing the neurosurgeon to avoid eloquent functional areas during surgery. Thus clear visualization of tumor margins during surgical planning and navigation on the 3D structural datasets is an important requirement[1]. Low grade tumors are often not readily visible on the standard T1w MP 3D SPGR images due the lack of intrinsic T1 contrast. Standard 2D multislice T2w FSE data suffer from poor slice resolution and reformatting limitations. In this work we tested a new volumetric T2w sequence capable of generating isotropic structural images, in conjunction with fMRI for the purposes of surgical planning and navigation.
MATERIALS & METHODS
For this study, where low T1 lesion-tissue contrast is expected, a new T2w 3D FSE “XETA” sequence was additionally acquired. Using very long echo trains and two-dimensional parallel imaging, 3D FSE XETA can be utilized to acquire volumetric datasets with T2-weighted spin-echo contrast. Low refocusing flip angles at the beginning of the train slow effective T2 decay and store magnetization in longitudinal pathways, which is then gradually retrieved by increasing flip angles throughout the train. Matrices of 224x 224 x 128 produce voxel sizes of 1.2 mm$^3$ (before zero filling to 0.6 mm$^3$) covering the entire head in clinical scan times of ~3 (T2) to ~6.5 (FLAIR) minutes. Once acquired, the 3D T2 data can be arbitrarily reformatted. fMRI data can be superimposed in the typical manner. See Figure 1.

CONCLUSION
Findings in patients low grade tumor and resected AVM demonstrate that the T2w 3D FSE XETA sequence can provide significantly better contrast in situations where traditional T1w contrast is expected to be low, such as mesial temporal lobe epilepsy foci or as demonstrated above. The 3D T2w and FLAIR data sets can be reformatted and processed in with (or without) fMRI results a manner similar to traditional 3D T1w structural datasets, using offline or commercial processing software. The rapid acquisition of a 3D T2w isotropic data set in a manner similar to 3D T1w sequences provides an additional tool to aid in functional MRI analysis and surgical planning/navigation as demonstrated in this initial feasibility study.

REFERENCES
1. OHBM 248:S172, 2006

KEY WORDS: Surgical planning, fMRI, T2 data

Poster 17
Structural Asymmetries of the Normal Human Cingulum Based on DTI Parameters
Maheshwari, M. · Clark, C. · Ulmer, J. · Gaggle, W. · Mark, L.
Medical College of Wisconsin Milwaukee, WI

PURPOSE
To define normal structural asymmetries of the cingulum using diffusion tensor imaging parameters, in order to provide a basis for micro-structural analysis in pathological conditions involving the limbic system.

MATERIALS & METHODS
DTI data were acquired at 1.5T from 19 right handed and 3 left handed healthy human volunteers, ranging from 21-67 years old (10 males and 12 females). DTI EPI imaging parameters included $b=1500$sec/mm$^2$, coronal planes, and gradient encoding in 25 directions. We chose three specific imaging parameters reflecting cingulum micro-structure, fractional anisotropy (FA), mean diffusivity (MD), and volume. Direction-sensitive color-coded maps were generated from FA images, and four ROIs were designated for each subject at right and left anterior (level of anterior commissure) and posterior (level of posterior commissure) cingulum locations. The average of three contiguous ROIs were masked and analyzed at each anterior and posterior location. FA, MD, and volume were derived from each averaged ROI. These parameters were compared across anterior and posterior cingulum, left and right hemisphere, and gender. Paired T-test was used for statistical analysis.

RESULTS
Posterior cingulum volume was significantly ($p \leq 0.05$) greater than anterior cingulum volume bilaterally, but there were no significant volume differences across hemispheres. Mean FA values were significantly ($p \leq 0.05$) greater in left compared to right cingulum, both anteriorly and posteriorly. However, no significant mean FA asymmetries were found between the anterior and posterior cingulum in individual hemispheres. Mean MD values were significantly ($p \leq 0.05$) greater in anterior compared to posterior cingulum bilaterally, but there were no significant left-right hemispheric effects. No significant differences were found in any parameter across gender.

<table>
<thead>
<tr>
<th>Cingulum</th>
<th>FA</th>
<th>MD</th>
<th>Volume</th>
</tr>
</thead>
<tbody>
<tr>
<td>Left vs Right</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anterior</td>
<td>Left→Right*</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Posterior</td>
<td>Left→Right*</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Anterior vs Posterior</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Left</td>
<td>Ant→Post*</td>
<td>Post→Ant*</td>
<td></td>
</tr>
<tr>
<td>Right</td>
<td>Ant→Post*</td>
<td>Post→Ant*</td>
<td></td>
</tr>
</tbody>
</table>

*p<0.05; -p>0.05

CONCLUSION
Significant hemispheric and anterior-posterior structural asymmetries are present in the normal human cingulum. However, imaging asymmetries vary with the specific imaging parameter used. An inverse relationship was observed between volume and MD measures, but not between FA and MD values in the cingulum. Normal DTI and volumetric

Figure 1. fMRI results from visual task superimposed on 3D T2-w FLAIR XETA image. Note clear depiction of post-AVM resection gliosis region (bright) delineated from parenchema.
variations may correlate to functional asymmetries and connectivity, and should provide a basis for assessing abnormal cingulum micro-structure in diseases of the limbic system.

**KEY WORDS:** Diffusion tensor imaging, cingulum, limbic system

**Poster 18**

**MR Perfusion, Diffusion and Spectroscopy Findings in Neuro-Behçet Disease**

Mangla, R. · Malhotra, A. · Westesson, P.
University of Rochester
Rochester, NY

**PURPOSE**

Behçet disease (BD) is a multisystem vasculitis of unknown origin in which neurologic involvement has been reported in the range of 5% to 10% in large series. Although MRI findings in neuro-Behçet syndrome (NBS) are well described in the literature, the roles of newer imaging modalities are sparsely described. We report MR perfusion, diffusion and spectroscopy findings in two cases of NBS who had neural parenchymal involvement.

**MATERIALS & METHODS**

Both the patients were female (age 25 & 49) and were known diagnosed case of Behçet’s Disease presented with CNS symptoms and referred for MRI for evaluation of brain lesions. All images were acquired on 1.5T scanner. Diffusion weighted images (TR/TE/NEX, 10000/125/1; B= 1000) were acquired before injection of intravenous contrast. Dynamic Susceptibility Contrast (DSC) images were obtained during the first pass of a bolus of gadolinium based contrast at a dose of 0.2 mmol per kilogram of body weight. The regional cerebral blood volume (rCBV), regional cerebral blood flow (rCBF), mean transit time (MTT) and time to peak (TTP) maps were calculated using an algorithm for deconvolution. MR spectroscopy was acquired having water saturation with point resolved saturation (PRESS) with TE of 144 or 30 and putting voxel on enhancing lesion on T1 post contrast images.

**RESULTS**

The MR imaging finding in NBS patients was mesodiencephalic junction lesion with edema extending along certain long tracts in the brain stem and diencephalons. The lesions show mildly increased ADC as compared to the normal appearing white matter. Overall, no large perfusion deficits or increase in MTT and TTP was seen in contrast to the patterns seen in the patients with focal arterial infarction. The spectroscopy images showed mild increase in Choline (Cho) /Creatine (Cr) ratio with mildly decrease in N-acetylaspartate (NAA) /Creatine(Cr) ratio.

**CONCLUSION**

Vasculitis is regarded as the key feature in BD with 12% arterial and 88% venous involvement as described in literature. This information, together with our observations on diffusion imaging favor the vasogenic rather than cytotoxic edema being the etiologic factor for the imaging findings.

No increase in MTT or TTP on perfusion in these lesions further support the probable inflammatory-venous pathogenesis for the CNS lesions seen in BD.

**KEY WORDS:** Neuro-Behçet Disease, MR perfusion, diffusion

**Poster 19**

**Longitudinal Studies of Cerebral Vasculitis Using Functional Diffusion Map**

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**PURPOSE**

The functional diffusion mapping (fDM) technique has recently been reported to have value in quantifying and displaying longidiffusional change in apparent diffusion coefficients (ADC) in assessment of brain tumor treatment response¹. We report the extension of the powerful technique to assessment of ongoing ischemic injury from active vasculitis.

**MATERIALS & METHODS**

A 56-year-old man presenting with headache and was found to have a subdural hematoma and multiple ischemic foci of differing ages on initial imaging. Serial MRI with diffusion weighted images (DWI) were performed every 5 to 10 days over one month of rapid clinical progression preceding the patient’s demise. Serial images spatially registered to the earliest DWI using AIR non-linear warping² or spatial normalization option in SPM² (Wellcome Trust Functional Imaging Laboratory, University College London, UK). Serial ADC maps were normalized to the ADC of CSF in the lateral ventricles. Color coded fDM were generated that visually display the longitudinal change in ADC in each scan compared with the previous scan.

**RESULTS**

The result of non-linear image registration was visually confirmed to attain satisfactory registration with exceptions in the sinus region and temporal lobe / basal region where air-tissue interface created strong magnetic susceptibility. A combined registration approach was used since neither AIR nor SPM2 alone independently registered all cases correctly. CSF normalization of serial ADC improved peak-to-peak ADC variation in the apparently uninvolved right thalamus from 0.235x10⁻³mm²/s to 0.120x10⁻³mm²/s, supporting the validity of the CSF normalization technique. Figure 1b showed the fDM map showing the progression in 10 days compared to initial ADC map in Figure 1a. fDM robustly depicted a dynamically fluctuating multifocal ADC increase and decrease throughout all vascular distributions of the brain in a pattern consistent with the known pathophysiology of cerebral vasculitis. Autopsy results demonstrated focal fragmentation of the internal elastic lamina and rare adventitial vessels showed lymphocytic cuffing, consistent with giant cell arteritis.
CONCLUSION

fDM produced from serial CSF normalized and registered ADC maps robustly depict fluctuating changes in diffusivity characteristic with the pathophysiology of active cerebral vasculitis, and suggest that the diagnostic utility of this new image processing technique may extend far beyond brain tumor monitoring to include ischemic disease.

REFERENCES


KEY WORDS: Diffusion weighted, perfusion weighted, arteritis

Poster 20

Diffusion-Weighted Abnormalities in Early Stage Cerebritis

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PURPOSE

In early cerebritis, a non-specific, ill-defined area of high signal intensity (SI) on T2-weighted MR images is seen. In contrast with cerebral abscesses, peripheral gadolinium-enhancement is not observed in these patients. Diffusion-weighted imaging (DWI) however enables early diagnosis of infection by means of a high SI on DWI and a low apparent diffusion coefficient (ADC).

MATERIALS & METHODS

We identified three patients with early cerebritis. MR imaging included fluid-attenuated inversion-recovery (FLAIR), T2-weighted, and T1-weighted sequences before and after gadolinium administration. DWI using a single-shot echo-planar (EPI) pulse sequence was realized. Images were acquired at b-values of 0 and 1000s/mm². ADC maps were created.

RESULTS

T2-weighted imaging showed an ill-defined area of high signal in the frontal lobe in two patients. In the 3rd patient a focal area of high SI was observed in the right middle cerebellar peduncle. After the injection of gadolinium, lesion enhancement was not observed. DWI revealed hyperintensity with low ADC-values, indicating restricted diffusion. Diagnosis of early cerebritis was made and antibiotics were initiated. Follow-up examinations demonstrated the typical evolution towards abscess formation with an enhancing capsule and restricted diffusion in the abscess cavity, indicating the presence of pus.

CONCLUSION

Brain abscesses are life-threatening, and therefore correct diagnosis should be made as soon as possible. Using DWI, diagnosis of early cerebritis is possible, enabling immediate initiation of antibiotics even before abscess formation develops. Imaging findings in our cases indicate diffusion restriction in areas of early cerebritis shown as high signal intensity on DWI with low ADC-values.

KEY WORDS: Early cerebritis, DWI

Poster 21

Correlation of Microvascularity Identified within Human Gliomas Identified on High Resolution 8T Gradient Echo MRI and Directed Biopsy

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PURPOSE

Heterogeneity within human gliomas can result in underestimating tumor grade by only sampling foci of lower grade within the tumor bed. Directing biopsies to regions of higher microvascular density (MVD) may help optimize tumor sampling. This study sought to determine whether microvascularity identified within gliomas using high resolution (HR) GRE MRI at 8 Tesla correlates with directed biopsies on histopathology.
Subjects: Thirty-five subjects bearing biopsy proved gliomas were included: World Health Organization (WHO) grade I - 5 subjects, WHO grade II - 11 subjects, WHO grade III - 9 subjects and WHO grade IV - 10 subjects. Imaging: Cross-sectional UHF 8T HR MR images were acquired on an 8 T/80cm MRI system (Magnex-GE, Abingdon, UK). Two-dimensional T2* weighted GRE sequence was used (TR 600-750 msec, TE 10 msec, flip angle 22.50, matrix 1024×1024, FOV 20 cm, slice thickness/gap 2/3 mm) with an in-plane resolution at 195 µm. Assessment of microvascular density: Regions of interest (ROIs) were identified within the tumor bed of each subject on HR 8T GRE MRI. The MVD within each ROI was assessed on a 3-tier semi-quantitative scale (high, medium and low) based on vessel size and density relative to cortical penetrating veins. ROIs were co-registered to 1.5T MR images acquired for frameless stereotactic guidance. Directed biopsies specimens stained with reticulin, obtained from the ROIs were assessed for MVD and graded as high, medium or low relative to normal white matter and gray matter by an experienced neuropathologist. MVD assessed on HR 8T GRE MRI was compared to MVD assessed on MRIssed on cimens from ROIS directed biopsy specimens and WHO classification grade. Discrepancies between 8T and histopathology assessment of MVD were analyzed in order to help explain the discrepancies.

RESULTS
Haphazardly arranged serpiginous low signal structures within the tumor bed on 8T GRE UHF MRI were presumed to represent microvascularity. Low signal was most likely related to susceptibility effect from deoxyhemoglobin within venous structures. WHO classification tumor grade correlated with: 1) number of foci of microvascularity within the tumor bed on 8T MRI (p<0.0011) and 2) size of abnormal vessels within the tumor bed relative to normal brain on 8T MRI (p<0.01). Concurrence between histopathologic and 8T MRI assessment of microvasculature occurred in 82% of 115 biopsy samples (p<0.001; Pearson). Discrepancies between biopsy samples and 8T GRE assessment of MVD may be explained by: 1) co-existence of radiation induced microvascular change; 2) low signal to noise on the 8T image as a result of artifact; and 3) normal microvascuclarity mimicking tumoral microvasculature at the edge of the tumor. Finally, radiation induced morphological changes, such as necrosis and hemosiderin deposition, were sometimes difficult to distinguish from microvascularity.

CONCLUSION
HR 8T GRE imaging shows promise as a marker for tumoral microvascularity and tumoral microvascularity. It could potentially differentiate from low-grade gliomas and help direct biopsy. Potential pitfalls in analyzing these images include radiation necrosis, normal anatomy mimicking microvascularity and artifact. Further improvements in image quality may help overcome these problems.

KEY WORDS: Glioma, microvascularity, ultrahigh field MR imaging
CONCLUSION
As shown in this initial report also intravascular agents like the protein binding blood-pool-agent Vasovist® are able to pass a disrupted BBB and to allows a sufficient contrast enhancement. Even if there is a smaller amount of contrast media leaking into the extracellular space, the high relaxivity of the complex might compensate for the smaller dosage of Gd which gives a great potential also outside the brain. However, since Vasovist® is very different than conventional contrast agents due to its properties, optimized acquisition patterns, and especially optimized reconstruction strategies, must be developed and verified clinically in a large number of cases.

KEY WORDS: Brain tumors, MR contrast media, vascularization

Poster 23
Evaluation of MR Perfusion and Imaging Changes with Dynamic Susceptibility Contrast MR Imaging in Recurrent Glioblastoma Multiforme in Response to Bevacizumab: Initial Clinical Experience

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PURPOSE
Parameters related to tissue perfusion have been shown to correlate with underlying pathophysiology in a number of neurologic diseases. The purpose of this study is to evaluate this technique in assessing response of high-grade gliomas, such as glioblastoma multiforme (GBM) to Bevacizumab (Genentech, San Francisco, CA), a monoclonal antibody which blocks vascular endothelial growth factor (VEGF). The intra-and extra-tumoral changes in CBV are reported and correlation is also made to imaging findings.

MATERIALS & METHODS
In this ongoing study, a retrospective review of MR exams of eight patients with pathologically proved recurrent high-grade gliomas: GBM (n=7) and anaplastic oligodendroglioma (n=1), was performed. Baseline imaging immediately prior to initiation of Bevacizumab and then follow-up imaging approximately every six weeks was obtained between March and November 2006. Imaging was performed on 1.5T Magnetom Avanto (Siemens Medical systems, Iselin, NJ) according to our departmental tumor protocol which includes both Gradient Recalled Echo (GRE) and Spin Echo (SE) single shot, multiphase scans. The contrast injection required for the GRE perfusion images serves as pre-loading dose to mitigate the transient T1 shortening which affects the SE images. The tumors were evaluated for response to Bevacizumab, with regard to contrast enhancement, FLAIR signal abnormalities, as well as changes in perfusion.

RESULTS
The MRI in four patients demonstrated persistent decreased overall tumor size and enhancement. In two patients, only transient improvement in tumor burden was seen. In one patient there was improvement in tumor burden but there has not been any further follow-up and one patient had no response to Bevacizumab and expired. Detailed perfusion ratios are still to be determined and will be correlated to response and outcome.

CONCLUSION
MRI response of high-grade gliomas to the antioangiogenic agent Bevacizumab was evaluated. Response to therapy will be demonstrated and correlated with dynamic susceptibility contrast MR imaging. Changes in peri-tumoral edema will also be evaluated to determine the effects of Bevacizumab.

KEY WORDS: MR perfusion, Bevacizumab, glioblastoma multiforme

Poster 24
Role of Functional Diffusion Maps in Predicting Progression of Low Grade Gliomas

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PURPOSE
Purpose of our study was a) to measure ADC values in the peritumoral region(PR) of low grade gliomas (LGG) and to evaluate its usefulness in predicting progression to a higher grade (HGG) b) to determine change in ADC values from LGG and its progression to a HGG, and c) to determine ADC of normal appearing white matter(NAWM) before and after treatment.

MATERIALS & METHODS
We retrospectively evaluated MR imaging in 8 patients with histologically proved LGG who progressed to HGG with time to progression (TTP) ranging from 266-1263 day. Regions of interest (ROI) corresponding to abnormal signal on low(LG) and high grade(HG) FLAIR images were delineated by a combination of thresholding and manual tracing using in house software (figure 1). ROIs were also drawn within contralateral NAWM. We co-registered LG and HG FLAIR images on the LG and HG DWI images and then superimposed low and high grade ROIs of tumor and FLAIR images on the LG and HG DWI. This last ROI represented normal appearing white matter(NAWM) respectively. The differences between ADC of PR vs. HGG was not significant. There was a positive correlation between ADC of LGG and HGG was not significant. There was a positive correlation between ADC of LGG and HGG.

RESULTS
The mean ADC values for LGG, HGG, PR and NAWM on LG and HG DWI were 1.40, 1.35, 1.10, 0.76 and 0.91 respectively. The differences between ADC of PR vs. NAWM on LG DWI and ADC NAWM on LG and HG DWI were significant. The difference between ADC of LGG and HGG was not significant. There was a positive correlation

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between PR and NAWM on LG DWI (r=0.64) and also between NAWM on LG and HG DWI (r=0.702). There was a negative correlation between PR and TTP (r = -0.67).

**CONCLUSION**
Using DWI we have demonstrated that there is a difference in the ADC of PR of LGG thus suggesting that DWI may be useful in the preoperative determination of borders of LGGs. This difference in peritumoral ADC also had a negative correlation with TTP to a HGG. ADC of the NAWM also showed statistically significant difference between the LG DWI and HG DWI study suggesting white matter changes related to treatment effects.

**KEY WORDS:** DWI, progression, low grade gliomas

**Poster 25**

**Dynamic Susceptibility-Weighted Contrast-Enhanced Perfusion MR Imaging of Treatment-naïve WHO Grade 2 Glioma Patients: Correlation with MIB-1 Labeling Index**

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**PURPOSE**
The MIB-1 labeling index has been established as a surrogate marker for growth fraction in brain tumors, and has shown a promising role in determining prognosis for tumors where the clinical course is difficult to predict by histologic parameters alone. Recent studies have emphasized the prognostic significance of MIB-1 specifically for WHO Grade 2 glioma patients. However, immunohistochemical staining using MIB-1 demonstrates the same limitations as routine histopathologic evaluation, including sampling errors. Dynamic susceptibility-weighted contrast-enhanced perfusion MR imaging (DSC pMRI) on the other hand may provide physiologic information of the entire brain, and has been used to assess tumor angiogenesis and capillary permeability. The purpose of this study was to assess whether non-invasive hemodynamic parameters derived from DSC pMRI correlate with MIB-1 in WHO Grade 2 glioma patients.

**MATERIALS & METHODS**
Preoperative DSC pMRI was performed in 36 patients with treatment-naïve WHO Grade 2 glioma. Regions of interest were drawn around the contrast-enhancing lesion (CEL) and the peritumoral lesion (PTL), defined by the abnormal T2 signal surrounding the area of contrast-enhancement. Peak height (PH) and percent signal recovery (PSR), derived from DSC pMRI, were calculated for relative CEL and PTL (corrected for overall tumor volume). Pearson correlation was performed comparing the MIB-1 labeling index, obtained using immunohistochemical staining, with DSC pMRI parameters.

**RESULTS**
There was a statistically significant correlation between decreasing average percent signal recovery within the peritumoral lesion and increasing MIB-1 labeling index (p = 0.001).

**CONCLUSION**
Preliminary results of our study suggest that the evaluation of vascular permeability obtained using DSC pMRI may serve as an adjunct to the MIB-1 labeling index in the evaluation of treatment-naïve WHO Grade 2 glioma patients. Future studies with larger sample size, direct correlation with imaging-guided biopsy and clinical outcome analysis may help elucidate the significance of our findings.

**KEY WORDS:** Glioma, perfusion MRI, MIB-1

**Poster 26**

**Role of Perfusion CT in Glioma Grading and Comparison with Conventional MR Imaging Features**

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**PURPOSE**
Perfusion imaging using CT can provide additional information about tumor vascularity and angiogenesis for characterizing gliomas. The purpose of our study was to demonstrate the usefulness of various perfusion CT (PCT) parameters in assessing the grade of treatment naïve gliomas and also to compare it with conventional MR imaging features.

**MATERIALS & METHODS**
PCT was performed in 19 glioma patients (14 high-grade gliomas and five low-grade gliomas). Normalized ratios of the perfusion CT parameters (nCBV, nCBF, nMTT) were used for final analysis. Conventional MR imaging features of these tumors were assessed separately and compared with PCT parameters. Low and high grade gliomas were compared using the nonparametric Wilcoxon two sample tests.

**RESULTS**
Mean nCBV in the high-grade and low-grade gliomas were 3.06±1.35 and 1.44±0.42 respectively with a statistically significant difference between the two groups (p=0.005). Mean nCBF for the low and high grade gliomas were 3.03±2.16 and 1.16±0.36 respectively with a statistically significant difference between the two groups (p=0.045). Thresholds of
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Poster 27

First Pass Perfusion CT: Initial Experience in Differentiating Recurrent Brain Tumors from Radiation Effects/Radiation Necrosis

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Purpose
To differentiate recurrent tumors from radiation effects/necrosis in patients with irradiated brain tumors using perfusion CT imaging.

Materials & Methods
Our institutional review board approved the study and an informed consent was obtained from all the patients. Seventeen patients with previously treated brain tumors, who showed recurrent or progressive enhancing lesions on follow-up MR imaging and had histopathological diagnosis, underwent first-pass perfusion CT (PCT) imaging (21 PCT examinations). Another eight patients with treatment-naïve high-grade tumors (control group) also underwent PCT assessment. Perfusion maps of CBV (cerebral blood volume), CBF (cerebral blood flow), and MTT (mean transit time) were generated at an Advantage Windows workstation using the CT perfusion 3.0 software (General Electric Medical Systems, Milwaukee, WI). Normalized ratios (normalized to normal white matter) of these perfusion parameters (nCBV, nCBF, nMTT) were used for final analysis.

Results
Thirteen patients were diagnosed with recurrent tumor and four patients had radiation necrosis. There was a statistically significant difference between the two groups with the recurrent tumor group showing higher mean nCBV (2.37 vs. 1.06), nCBF (2.77 vs. 0.98) and shorter nMTT (0.88 vs. 1.37) as compared to the radiation necrosis group. nCBV of greater than 1.92 was found to identify the high grade gliomas. nCBV was the single best parameter, however using either nCBV >1.92 or nCBF >1.48 improved the sensitivity and specificity to 92.9% and 100% respectively. The sensitivity and specificity for diagnosing a high-grade glioma with conventional MR imaging were 85.7% and 60% respectively.

Conclusion
PCT can be used for pre-operative grading of gliomas and can provide valuable complimentary information about tumor hemodynamics not available with conventional imaging techniques. nCBV was the single best parameter correlating with glioma grades though using nCBF when nCBV was <1.92 improved the sensitivity. An nCBV threshold of >1.92 was found to identify the high grade gliomas.

Key Words: CT perfusion, tumor, grading

Poster 28

MR Appearance of Oligodendrogliomatosis

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Purpose
To describe the imaging appearance of multifocal oligodendroglioma (oligodendrogliomatosis cerebri), an unusual type of oligodendroglioma which has attracted interest in neuro-oncology and molecular genetics given its potentially favorable response to chemotherapy and improved prognosis in comparison to gliomatosis cerebri.

Materials & Methods
We describe the MR imaging findings in two cases of proved oligodendrogliomatosis cerebri.

Results
MR imaging findings: Case 1: Diffuse, mild expansion and T2 hyperintensity of the bilateral frontal lobe cortex and in the left thalamus. Mild expansion of the splenium of the corpus callosum with signal abnormality throughout the splenium, extending into the periventricular white matter and left occipital cortex. An additional focus of cortical signal abnormality within the left thalamus and basal ganglia with associated mass effect upon the left lateral ventricle. There is extensive signal abnormality throughout the white matter of the frontal lobes and within an expanded genu of the corpus callosum. Enhanced T1-weighted image revealed heterogeneous enhancement in the right frontal lobe, extending into the corpus callosum. Case 2: FLAIR signal abnormality within the midbrain, the bilateral frontal lobes, the left anterior temporal lobe, and the right posterior periventricular white matter, the left thalamus and basal ganglia with associated mass effect upon the left lateral ventricle. There is extensive signal abnormality throughout the white matter of the frontal lobes and within an expanded genu of the corpus callosum. Enhanced T1-weighted images do not demonstrate enhancement. Multifocal areas of T1 hypointensity are seen within the corpus callosum and bilateral frontal cortex and white matter.

Conclusion
Oligodendrogliomatosis cerebri is a distinct neoplastic entity with potentially unique genetic markers and possible favorable response to therapy. The imaging findings are similar to those of gliomatosis cerebri with diffuse involvement.
of more than two lobes, without a focal dominant mass. However, extensive cortical infiltration may suggest this diagnosis, prompting genetic testing for the 1p19q deletion.

**KEY WORDS:** Oligodendrogliomatosis, gliomatosis cerebri

**Poster 29**

Tany-what? A Review of Tumors of the Hypothalamic/Third Ventricle/Suprasellar Region, with an Emphasis on a Rare pilomyxoid Neoplasm

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**PURPOSE**
The purpose of this presentation is to: a) Review the tumors of the third ventricular region; b) Review of mylomyxoid tumors of the third ventricles, alternatively called central neurocytoma, tanycytoma, and chordoid glioma. c) Present the clinical course and imaging features of a tumor that presented at our institution.

**MATERIALS & METHODS**
a) Review of third ventricular anatomy; b) Histopathologic and radiographic review of third ventricular neoplasms, emphasizing characteristic features; c) A 15-year-old female presented with headaches and 2 months of amenorrhea. A CT scan and MRI were obtained, demonstrating a hypothalamic mass. Follow-up study 3 months later demonstrated no change, and the patient remained otherwise asymptomatic. The patient was lost to follow up, but presented at 12 months with increased headaches and diplopia. Physical exam revealed a left sixth nerve palsy. MR imaging at this time revealed interval growth, and hydrocephalus. The mass was surgically resected through a right frontoparietal parasagittal craniotomy and a transcallosal approach. The mass was found to be soft, subtle, and bloody, and subtotal resection was achieved despite a staged procedure. A ventriculostomy catheter was left in place. Radiation therapy was administered to the residual tumor, and the patient is stable and symptom free at 9 months follow up. Hematoxylin and eosin stained sections demonstrated a cellular neoplasm with chaotic growth pattern exhibiting prominent perivascular rosetting. Individual neoplastic cells demonstrated pronounced perinuclear clearing with indistinct processes. Glomeruloid vascular proliferation also was noted. Mitotic figures were not appreciated. Ultrastructural studies from tumor extracted from the paraffin block demonstrated poorly preserved tumor cells with numerous small cellular processes. Most cell membranes had been extracted during processing; however, some processes showed scattered dense cores.

**RESULTS**
On CT scan, the lesion was hypodense to brain, with intense peripheral enhancement. On MRI, the lesion was hypointense to brain, with a slightly more intense rim on T1 WI, and enhanced intensely and heterogeneously. On T2 WI, the lesion was slightly hypointense to CSF with internal architecture. It was hyperintense on PDWI, and heterogeneously hyperintense on FLAIR.

**CONCLUSION**
There are few tumors that arise in the third ventricle/hypothalamic/suprasellar region, and MRI and CT are useful in distinguishing between them. Tanycytomas rarely occur in this region, and have characteristics that separate them from similar tumors of this region.

**KEY WORDS:** Tanycytoma, third ventricle, tumor

**Poster 30**

Myo-Inositol - A Marker for Reactive Astrogliaosis in Glial Tumors?

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**PURPOSE**
Myo-Inositol (MI) is one of the most abundant metabolites visible in 1H-MRS of the human brain at short TE (∼30ms). Its concentration is significantly increased in various diseases (1,2) including brain tumor with a potential role to serve as a diagnostic marker (3). In this study we have investigated the biochemical background of increased MI in order to elucidate the impact of increased MI on differentiation of tumor grade and type.

**MATERIALS & METHODS**
2D 1H MRSI with TE of 30 ms was performed before surgery in 56 patients with glial brain tumors. The spectroscopic data were processed and quantified offline using LCModel (4). Concentrations of Myo-Inositol (MI), Trimethylamines (TMA), Creatine/Phosphocreatine (tCr), and N-acetylaspartate/N-acetylaspartateglutamate (tNAA) were evaluated for the whole tumor and normalized to normal appearing contralateral brain tissue. Necrotic areas were excluded. The normalized peak and mean concentrations of MI were correlated with the types of glial tumors, with the tumor grade and with the concentrations of tCr and TMA. The tumor diagnoses were based on the histopathologic grading according to the WHO criteria in conjunction with MR imaging.

**RESULTS**
The mean concentration of MI was significantly higher for all tumor tissues compared to the normal appearing white matter. Gliomas and oligo-astrocytomas WHO grade II showed significantly higher concentrations of MI and tCr than the other tumor entities. Significant differences between astrocytomas grade II and III were found for mean and maximum tumor values of TMA; however for MI, comparison of maximum tumor signal was required to obtain significance, emphasizing the advantage of CSI for tumor diagnosis. In all glial tumors, the mean concentrations of MI and tCr were positively correlated, while no correlation was found for MI and TMA concentrations ($r = 0.70$ for tCr and $r = 0.12$ for TMA). A similar behavior also was found for maximum peak concentrations.

**CONCLUSION**
Myo-Inositol is increased significantly in glial tumor tissue, especially in gliomas. Significant differences between low- and high-grade astrocytomas were found for normal-
ized concentrations of TMA and for maximum tumor concentrations of MI which to some extend confirms previously reported results from Castillo (3). In all glial tumors the increase of MI is positive related to increase of tCr. Such a correlation was found in gliomatoses (6) and in other cerebral diseases like MS (7,1) and HIV (8) which are known for high reactive astrogliosis. A similar process also may be responsible for the observed changes in the other tumor entities.

REFERENCES

KEY WORDS: Myo-inositol, MRS, glioma

Poster 31

Comparison of Perfusion MR Imaging and FDG-PET in Preoperative Glioma Grading

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PURPOSE
Advanced tumor imaging techniques such as perfusion MR or positron emission tomography (PET) have been used for predicting preoperative glioma grade. However, there have been few comparative studies between the two modalities. Our purpose is to compare the diagnostic performance of the two modalities in glioma grading.

MATERIALS & METHODS
We retrospectively reviewed pathologically proved gliomas of 23 patients. All the patients underwent the perfusion MR imaging and PET in addition to conventional MRI, preoperatively. Relative regional cerebral blood volume (rCBV) value of 1.55 was applied as a threshold value for discriminating high and low grade based on receiver operating characteristic curve analysis. On PET, tumor activity similar to or above that of gray matter was categorized as high grade. Their sensitivity, specificity, and accuracy were compared. The kappa statistics were applied to compare the performance of the two modalities.

RESULTS
The sensitivity, specificity, and accuracy were 0.91, 0.67, 0.78 in perfusion MRI and 0.9, 0.5, 0.7 in PET, respectively. Kappa statistics demonstrated a moderate correlation between the two modalities. Both techniques showed tendency to mislead oligodenogliomas to high grade. All of the perfusion MR misleading cases were oligodenogliomas. PET had a tendency to mislead low grade gliomas to high grade.

CONCLUSION
The sensitivity of perfusion MRI and PET were similar but perfusion MRI showed higher specificity and accuracy. The two modalities showed a moderate correlation. Clinical relevance: Further studies are necessary for evaluation of clinical usefulness of PET in predicting glioma grade.

KEY WORDS: Glioma, perfusion MR, preoperative grading

Poster 32

Intracranial Extraskeletal Mesenchymal Chondrosarcoma: Case Report

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PURPOSE
We present a patient with dural-based intracranial extraskeletal mesenchymal chondrosarcoma. Intracranial chondrosarcomas are rare tumors, with the mesenchymal variety being the rarest subtype. Most reported cases of mesenchymal chondrosarcomas are in patients in their 2nd or 3rd decade of life. We report a case of mesenchymal chondrosarcoma in a 68-year old gentleman.

MATERIALS & METHODS
A 68-year old male presented with a several month history of headaches and a two week history of confusion and mental status changes. He had past medical history of hypertension, diabetes and atrial fibrillation, but no history of cancer. CT and MRI showed a large mass in the right temporal lobe. The provisional diagnosis on imaging was an atypical meningioma or metastasis. The patient underwent advanced total resection of the temporal lobe mass followed by adjuvant radiotherapy. The tumor was signed out by pathology as a dedifferentiated chondrosarcoma, mesenchymal variety. The patient developed local recurrence within 4 months of surgery.

RESULTS
CT and MRI revealed a large right temporal lobe mass, appearing predominantly intraaxial with broad dural enhancement in the periphery. The overlying bone appeared unremarkable with no sign of destruction. No calcification was seen within the lesion. The mass showed peripheral, thick rind of enhancement. Significant perilesional edema and mass effect with midline shift were noted. At surgery, the lesion seemed intraaxial but was invading the middle cranial fossa dural floor. There was no calvarial or skull base destruction or erosion. Microscopic sections revealed a mesenchymal tumor with areas of chondroid, dedifferentiated spindle cells and hypercellular areas with small, round cells. Histopathology and immunochemistry were consistent with mesenchymal, dedifferentiated chondrosarcoma.

CONCLUSION
Mesenchymal intracranial chondrosarcomas are very rare. Most of the reported cases are in young adults and typically dural based. Extraskeletal mesenchymal variety is the most malignant subtype. This rare tumor should be considered in the differential diagnosis of aggressive-appearing dural
based lesions. We present a case of this tumor in a 68-year old male, an older age group than previously described for these rare tumors in the literature.

**KEY WORDS:** Chondrosarcoma, mesenchymal, imaging

**Poster 33**

**MR Perfusion: Grading of Anaplastic Astrocytomas**

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**PURPOSE**
Dynamic susceptibility contrast (DSC) MR imaging is one of many available techniques for perfusion imaging. It is a robust and widely used technique for differentiation and grading of brain tumors in MR. DSC MR imaging of suspected brain tumors has become an integral part of the tumor imaging protocol at our institution. Various studies have described how to differentiate between low and high grade lesions with MR perfusion imaging. The aim of this study was to demonstrate value of MR perfusion, with regard to WHO grade III anaplastic astrocytomas, since they do not seem to follow the general rules as described in perfusion imaging of other gliomas.

**MATERIALS & METHODS**
During the last year we have so far analyzed 11 consecutive patients who were histopathologically diagnosed as WHO grade III anaplastic tumors and who had a pre-operative MR perfusion scan at our institution. The patients in which pre-operative perfusion imaging was sub-optimal or not performed were excluded from the study. All imaging was performed on a 1.5-T GE Signa MR system. A series of 60 T2*-weighted gradient-echo echo-planar images were obtained during the first pass of a bolus of gadolinium based contrast at a dose of 0.2 mmol per kilogram of body weight. Twelve axial section levels were chosen for imaging, based on lesion extent as determined by the pre-operative FLAIR images. Raw perfusion-weighted MR data were processed offline on LUPE: the Lund perfusion program. For arterial input function (AIF) calculation one branch of the ipsilateral MCA artery was chosen among the vessels suggested by the software. Implementation of a correction algorithm for T1 effects from blood brain barrier leakage, as described in Haselhorst et al., was applied in all cases. The rCBV measurements were obtained from the perfusion-weighted MR data. Maximal rCBV (region of interest placement) measurements were obtained by identifying regions of maximal perfusion from color maps. The measurements were related to the rCBV of normal appearing white matter and tumor/white matter ratios were calculated.

**RESULTS**
The maximal rCBV ratios in these anaplastic astrocytomas varied markedly, measuring from 0.58 to 5.7 with an average of 2.6 +/- 1.61 SD. Based on the use of a cut-off value of rCBV ratios of 1.5, which is the lowest value suggested in different studies to differentiate between the low and high grade gliomas, the perfusion imaging was able to diagnose 7 cases out of 11 as malignant. We are in the process of analyzing MR perfusion and histopathologic findings in more cases of anaplastic astrocytomas and would like to present the final results during the meeting.

**CONCLUSION**
There was a large variation in rCBV ratios, varying from quite low to high within this group of WHO grade III astrocytomas, raising the need for further investigations. It is important to determine whether tumors of this histopathological category, which seem to differ with regard to rCBV also differ in terms of prognosis and treatment response.

**KEY WORDS:** MR perfusion, anaplastic astrocytoma, rCBV

**Poster 34**

**MR Cisternographic Evaluation of Lower Cranial Nerve Complex**

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**PURPOSE**
Cranial nerves IX (glossopharyngeal), X (vagus), XI (spinal accessory) are intimately located. Therefore, it is usually impossible to differentiate one from the other with routine magnetic resonance imaging sequences. They are regarded as a unit and called lower cranial nerve complex. The purpose of this study was to evaluate the visibility of each of these nerves with MR cisternography.

**MATERIALS & METHODS**
Thirty patients (M/F, 14/16; mean age: 52.46) with complaints of vertigo, tinnitus and hearing loss were examined with routine temporal MRI study. All examinations were performed on a 1.5 T whole body MRI system (Excite, General Electrics, Milwaukee, Wisconsin) with a 33 mT/ m maximum gradient capacity. The imaging protocol consisted of 3D fast imaging employing steady-state acquisition (FIESTA) in addition to routine sequences. The images were scanned by sagittal section. These images were transferred to an Advantage Workstation 4.0 (GE Medical Systems), and reformatteD in the voluntary section. This sequence provided excellent cerebrospinal fluid -nerve contrast and high spatial resolution. Therefore it was possible to identify the cisternal segments of cranial nerves. Visibility of 168 nerves of 56 sides was evaluated by consensus of two radiologists using an evaluation scale from 2 (excellently visible), 1 (partially visible) to 0 (not visible).

**RESULTS**
A total of 168 nerves were investigated. They were best evaluated in the sagittal oblique view. The rates for successful visualization for each nerve were as follows: glossopharyngeal nerve (100%, 0%, 0%); vagus nerve (100%, 0%, 0%); spinal accessory nerve (80.3%, %3.55, %16,15).

**CONCLUSION**
Glossopharyngeal, vagus and spinal accessory nerves can be reliably evaluated with MR cisternography obtained by 3D FIESTA in the sagittal plane.

**KEY WORDS:** MR cisternography, lower cranial nerve complex, 3D FIESTA
Poster 35

Subsecond 3D Time Resolved CE MRA Using Radial k-Space Trajectories and Highly Constrained Back Projection Reconstruction (HYPR PR TRICKS): Analysis of Spatio-temporal Characteristics and SNR for Six Reconstruction Conditions

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PURPOSE
The purpose of this study was to characterize the temporal behavior, spatial resolution, arterial to venous signal intensity ratio and SNR for a completely new approach to time-resolved CE MRA that uses hybrid radial k-space coverage (1) combined with highly constrained back projection reconstruction (2) called HYPR PR TRICKS.

MATERIALS & METHODS
HYPR PR TRICKS exams were obtained in 14 subjects using the following parameters: TE/TR = 0.8/6.6ms, matrix = 512x512, FOV = 24cm, slices = 28, thickness = 1-2mm, injection rate = 2 mL/sec, dose = 0.1 mM/kg. Ten radial projections were acquired at each time frame, giving a frame update time of 0.26 s. To form a HYPR time frame, a composite image (formed using data from multiple time frames of data) was multiplied by a weighting image (formed from the 10 projections acquired in each time frame). A key element of HYPR reconstruction is that the the weighting image contains all the temporal information and the composite image is used to map the temporal information to the proper spatial location and to achieve high SNR and minimize the streak artifacts typically associated with undersampled radial acquisitions. In order to assess arterial (A) and venous (V) separation, the maximum A/V ratio was calculated using signal intensity measurements from the internal carotid artery and the sagittal sinus. SNR was also calculated.

RESULTS
With all of the composite methods, arterial and venous phases were well separated with good SNR and image quality. HYPR images produced using sliding window composites of duration 5.5s and 8s had the highest A/V ratio, whereas the fixed composite gave the lowest A/V ratio. The differences were statistically significant (P<0.05). The SNR values achieved with the intermediate length (8s, 11s) sliding window methods were significantly higher (P<0.05) than those achieved with the shorter length (2.8s, 5.5s) window and the cummulative composite methods. The temporal resolution of HYPR PR TRICKS was ten times better than for 3D Cartesian TRICKS and the spatial resolution was four times higher.

CONCLUSION
HYPR reconstruction permits subsecond frame update times with minimal streak artifacts and well-preserved SNR, and provides time-resolved 3D CE MRA data sets with sub-cubic-millimeter voxels. Composite windows of 5.5s and 8s provided good A/V separation and SNR for CE MRA.

REFERENCES

KEY WORDS: MRA, contrast, time-resolved

Poster 36

Three-dimensional Bone-free CT Angiography of the Aneurysms Near the Skull Base Using a New Application

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PURPOSE
To examine the utility of “AutoBone”, a new application in CT angiography (CTA) based on tracking that allows removal of bones from images. The application was used to images of cerebral aneurysms near the skull base.

MATERIALS & METHODS
Twenty-two patients with 26 angiographically confirmed aneurysms near the skull base were investigated using three-dimensional CTA (3D-CTA). There were 11 aneurysms at the junction of the internal carotid artery (ICA) and the posterior communicating artery (IC-PC an), 4 aneurysms at the paraclinoid part of the ICA (paraclinoid an), 4 at the junction of the ICA and the anterior choroid artery (Acho an), 3 aneurysms of the intracavernous ICA (cavernous an), 2 aneurysms at the junction of the ICA and the ophthalmic artery (IC-oph an), 1 aneurysm at the terminal portion of the ICA, and 1 aneurysm of the basilar tip (basilar tip an). CT examinations were performed using a 32-row spiral CT scanner with 32 x 0.625 mm detector collimation. Contrast
medium was injected at a rate of 4 mL/s. The size of these aneurysms ranged from 2.0 to 33.1 mm with a mean of 7.1 mm. The 3D maximum intensity projection (MIP) images were initially obtained using the AutoBone application. Further post-processing was performed to obtain the MIP and volume rendering (VR) images. The quality of the initial images (MIP) through the AutoBone was analyzed for removal of bone and depiction of arteries. Visualization of aneurysms in the images after further processing was also reviewed. DSA was the standard of reference, and reviewers were aware of the DSA results. Final interpretation was based on reviewer consensus.

**RESULTS**
The initial images through the AutoBone showed almost bone-free images in 19 of the 22 patients. In the other 3 patients, the initial images contained remnants of the clivus or petrous bones. Further processing almost completely removed these remnants in these 3 patients. In 6 of the 22 patients, part of the ICA near the skull base was removed in the initial images obtained using AutoBone. Three of these 6 patients had intensely calcified ICAs, which were removed together with the bones. One of these 6 patients had a giant aneurysm at the cavernous portion of the ICA which disturbed filling of part of the ICA. Post-processing was able to recover all loss of the ICA image in these 6 patients. All 26 aneurysms were visualized in both MIP and VR images. The necks of all aneurysms were identifiable.

**CONCLUSION**
The AutoBone application allows fast selective elimination of bony structures, which can improve the interpretation of aneurysms near the skull base.

**KEY WORDS:** Aneurysm, CTA

**Poster 38**

**Neuropsychological Relevance of Postinterventional Cerebral Microembolism**

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**PURPOSE**

Incidence of periprocedural cerebral microembolism in neuroradiological interventional procedures is quoted between 11.2% and 69%, depending on author and procedure. Clinical relevance of cerebral microembolism is still topic of discussion. Many articles deal with this subject matter and report of neuropsychologic deficits provoked by microembolism.

**MATERIALS & METHODS**

Incidence of periprocedural cerebral microembolism in neuroradiological interventional procedures is quoted between 11.2% and 69%, depending on author and procedure. Clinical relevance of cerebral microembolism is still topic of discussion. Many articles deal with this subject matter and report of neuropsychologic deficits provoked by microembolism.
consisted of a MRI scan (T1, FLAIR and diffusion weighted images) and a standardized neuropsychological test battery including 14 subtests. Results of pre- and the postoperative tests were compared using SPSS 12 software.

RESULTS
After surgery 47 % of the patients showed small lesions in diffusion weighted images. Focal neuropsychological deficits were recorded in some patients but no correlation was apparent between neuropsychological results and occurrence of cerebral microembolism (p>0.05).

CONCLUSION
Cerebral microembolism does not seem to have any neuropsychologic measurable influence to the patients.

KEY WORDS: Interventional, microembolism, neuropsychology

Poster 39
Long-term Follow Up of Hemorrhagic Injuries Identified by Susceptibility-weighted Imaging in Adults with Traumatic Brain Injury
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PURPOSE
Small hemorrhagic lesions associated with cerebral contusions or shearing injuries are visualized increasingly with more sensitive imaging techniques, but the temporal evolution of these hemorrhages is not known. The purpose of this study was to compare acute traumatic hemorrhagic parenchymal lesions detected by a susceptibility-weighted imaging (SWI) sequence, with the same lesions on follow-up studies.

MATERIALS & METHODS
Fourteen patients with age range of 16-80 years (mean = 32) were imaged within 2-23 days (mean = 6) of injury. Admission Glasgow Coma Scale (GCS) ranged from 3-13, with motor vehicle accidents as the most common mechanism of trauma (10 of 14). In addition to a standard MR protocol, an SWI sequence was added (modified 3D GRE sequence with special postprocessing). Follow-up SWI was done within the first year after trauma. Six patients were followed in the first 6 months and eight patients were followed in the second 6 months after trauma. A software program, Image Pro Plus (Media Cybernetics Silver Spring, MD), was used to semiautomatically trace lesions using selected minimum intensity threshold levels. After predefined observer-dependent adjustments, the program computed the pixel area of lesions in each image, which then was converted to lesion volumes. Hemorrhagic lesions were categorized in nine brain regions: frontal gray matter (FG), frontal white matter (FW), parietotemporal-occipital white matter (PTOW), parietotemporal-occipital gray matter (PTOG), corpus callosum (CC), basal ganglia (BG), thalamus (THAL), brain stem (BS), and cerebellum (CBL). This population data set satisfied nonparametric assumptions and was analyzed with Mann-Whitney and Kruskal-Wallis tests. Statistical analyses were performed using SPSS version 12.0 (Chicago, IL).

RESULTS
We observed a total of 2,311 hemorrhagic lesions with a total volume of 900,722 mm3 in our 14 patients. Most patients had involvement of PTOG (12 of 14 patients), FW (11 of 14), and PTOW (10 of 14). Three regions were involved less commonly; BG and THAL (6 of 14) and CBL (only 1 of 14). There was 46% decrease in the lesion volume and 49% decrease in lesion number, over all patients. Improvement in lesion volume and number, respectively, were as follows: BG (26%,14%), BS (26%,34%), CC (75%,65%), FG (48%,40%), FW (37%,49%), PTOG (80%,77%), PTOW (53%,53%), THAL (45%,20%). There was a significant difference (p < 0.05) between lesion volume in the first and second scan, in FW (P = 0.03), PTOG (P = 0.016) and PTOW (P = 0.004). Overall improvement in lesion volume and number, respectively, among patients who were followed in the first 6 months (45%, 48%) and those followed in the second 6 months (48%, 49%) were not significantly different.

CONCLUSION
Interval decrease in volume of traumatic hemorrhagic lesions, within 1 year, is most significant in PTOG, PTOW and FW. There was no significant difference in other brain regions, although this may be due to small sample size. Most of the improvement occurs in the first 6 months after trauma, and not the second 6 months.

KEY WORDS: MRI, trauma, hemorrhage

Poster 40
64-Slice Multi-Detector CT Angiography Screening for Blunt Cerebrovascular Injury
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PURPOSE
Although digital subtraction angiography (DSA) has been accepted as the gold standard for evaluation of the cranial and cervical vessels, there continues to be a search for a less invasive and less costly imaging technique that can be used to screen for blunt cerebrovascular injury (BCVI). Preliminary evidence showed that 16-slice Multi detector CT angiography (MDCTA) was relatively accurate in screening for BCVI (1). Significant progress has been made regarding the temporal and spatial resolution of MDCTA because of an increasing number of detectors. Our purpose was to preliminarily determine the accuracy of 64-slice MDCTA in detecting BCVI.

MATERIALS & METHODS
Internal review board approval was obtained. We retrospectively reviewed 64-slice MDCTA of 27 patients considered at risk for BCVI, where the study was performed under 24 hours after presentation into the emergency department . Each MDCTA was denoted as good, fair or poor. Examinations were reviewed by two neuroradiologists independently, using a 3D workstation. One patient was excluded from the study as MDCTA data was poor in quality. Patients with positive or equivocal MDCT results underwent
DSA, except two patients with low grade injury, which were followed clinically. None of the patients underwent DSA if they had a negative MDCTA result. The MDCTA results and clinical course were collected, and compared to the DSA results and the clinical course.

RESULTS
Twenty-six of patients screened as BCVI and underwent MDCT angiography. Six patients were diagnosed with BCVI. There were cervical spine fractures in 9 and skull base fractures in 3 of the patients. There were 5 vertebral artery dissections (4 stenotic, 1 occlusive) and 1 carotid artery dissection. Three of the vertebral artery injuries and the carotid artery injury were confirmed with DSA (Figure), while two of the vertebral artery injuries were followed clinically. Twenty patients with normal CTA did not undergo DSA. They showed no evidence of BCVI at their clinical follow up. The sensitivity, specificity of MDCT were 100%, 100% respectively.

CONCLUSION
Preliminary data shows that MDCT is accurate when acutely screening for BCVI. 64-slice MDCT improves the quality of the images, has decreased scan time related to earlier generation scanners, and is less costly than catheter DSA, which are important, practical factors in the emergent evaluation of trauma patients.

References

KEY WORDS: Blunt cerebrovascular injury, CT angiography, 64 multidetector CT
# Poster 42
**Evaluation of Carotid Stenosis with Phase Contrast with Vastly Undersampled Isotropic Projection Reconstruction (PC-VIPR): Initial Clinical Results**

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**PURPOSE**
PC-VIPR method (Phase Contrast with Vastly undersampled Isotropic Projection Reconstruction) is a novel MR sequence that is able to generate anatomical images as well as physiologic information including arterial velocities, blood flow and pressure gradients across areas of stenosis. Preliminary animal and phantom work has shown high correlations between invasively measured stenoses, using digital subtraction angiography, and that provided by PC-VIPR. We hypothesize that there is a similar correlation between velocity measurements obtained using PC-VIPR and carotid duplex ultrasound in patients undergoing preoperative evaluation for carotid stenosis.

**MATERIALS & METHODS**
The study was approved by the IRB and conforms to HIPAA regulations. Patients referred for imaging evaluation prior to surgical intervention for carotid stenosis were selected for the study and submitted informed consent. Each patient selected underwent MRI/MRA, including PC-VIPR, and carotid duplex ultrasound according to clinical protocols. MR imaging was performed using an eight or sixteen channel neurovascular array coil on either a 1.5 T or 3 T GE Signa Scanner (v 14.0 TwinSpeed, Waukesha, WI). The PC-VIPR sequence was performed with imaging parameters providing 0.7 mm³ isotropic voxel resolution and the peak velocity in the region of stenosis was measured. All patients underwent standard carotid duplex ultrasound examinations with peak systolic velocities recorded. The velocities measured in PC-VIPR were plotted against the velocities of US.

**RESULTS**
Four patients have been enrolled to date. The studies demonstrated similar maximum velocity measurements using the PC-VIPR method and ultrasound (Figure 1). The stenoses varied from 50 to 85 percent in these patients and velocities ranged from 92 to 256 cm/sec.

**CONCLUSION**
Preliminary data demonstrates good correlation between maximum velocities obtained with PC-VIPR sequences and with traditional duplex ultrasound. Further work in this area is currently underway to recruit more patients. Ultimately our goal is to also correlate the anatomical images obtained with PC-VIPR with traditional MR angiography methods with the hope of eventually providing both anatomical and physiologic data from one study.

**KEY WORDS:** Carotid stenosis, MRA

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# Poster 43
**Unsuspected Cerebrovascular Pathology in Spontaneous Dissection of the Carotid and Vertebral Arteries**

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**PURPOSE**
Spontaneous CAD is becoming an important cause of ischemic stroke. Patients are thought to have an underlying structural defect of blood vessels. We therefore hypothesized that patients with first ever presentation of CAD might have additional cerebrovascular pathology and examined unsuspected cerebrovascular pathology in patients with cervical artery dissection (CAD).

**MATERIALS & METHODS**
Records of all patients hospitalized within 2001-2005 with stroke were examined for CAD and were analyzed for presentation, neuroimaging findings, therapy, course and outcome. In all, cerebral blood vessels were visualized by CTA, MRA and/or four vessel angiography.

**RESULTS**
Twenty-two patients, 15 males, with CAD were identified. Presenting symptomology was related to the vertebrobasilar system in 8, to the right carotid artery in 7, the left carotid in 6 and both carotids in 1. Fourteen presented with severe headache and in one, headache was the sole abnormality at presentation. 14/22 patients (64%) had radiological evidence
of additional cerebrovascular pathology related to the dissection. This included 10 with carotid artery and 4 with vertebral artery dissection. Only one patient presented with two clinical episodes of CVD and 2 had spontaneous dissection involving more than one vessel at the same time. In the other 11 patients the visualized associated abnormality was old and without a history of previous CVA. In 8/10 with carotid artery dissection the additional pathology was localized to the other carotid artery; in all 4 with vertebral artery dissection the previous dissection involved the other vertebral artery. Four had radiological evidence of fibromuscular dysplasia. Nine of 14 sustained complete recovery.

CONCLUSION
Occult cerebrovascular pathology is present in a significant number of CAD patients, supporting the hypothesis that this condition is due to an underlying structural pathology. The additional vascular pathology tends to involve the same vascular supply, namely either the carotid or the vertebral system. Despite radiological evidence for previous, subclinical dissection, recurrent CAD has a good prognosis.

KEY WORDS: Dissection, carotid, vertebral

Poster 44

Improved Background Suppression for Neurovascular Imaging with 3D Time of Flight MRA Using Robust Fat Suppression with IDEAL at 3T

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PURPOSE
3D-TOFMRA is a routine tool for neurovascular imaging, but high signals from subcutaneous short T1 tissues compete with arterial blood signal and can interfere with visualization of the carotid bifurcations, retrobulbar vasculature, or deep penetrating vessels particularly on maximum intensity projection images. The IDEAL method (Iterative Decomposition of water and fat with Echo Asymmetry and Least-squares Estimation) provides robust fat/water separation with greater signal-to-noise (SNR) efficiency and less sensitivity to field inhomogeneities than chemical fat saturation. The purpose of this work was to adapt IDEAL fat suppression for improved neurovascular visualization with 3DTOFMRA.

MATERIALS & METHODS
Volunteers were imaged under an IRB approved protocol on a 3.0T MRI scanner (v12.0 TwinSpeed, GE Healthcare, Waukesha, WI) and 8-channel head coil. 3DTOFMR of the Circle of Willis (COW) was performed with TE/TR 2.7/20ms, 22cm FOV, 1.0mm slice thickness, 40 slices/excitation slab, a superior saturation-band, flip angle 30°, bandwidth ±41.67 kHz, 512 x 224 pixel resolution with 0.45 x 0.98 x 1.00mm voxel resolution. 3DTOF of the carotid bifurcations used TE/TR 6.9/32, flip angle 30°, FOV 32, slice 1.6 mm, 42 slices/excitation slab, 256x192 pixel resolution, 1 Nex. Imaging parameters were identical for IDEAL-3DCOW and 3DCOW, except three optimized TE values (2.2, 3.0 and 3.8ms) were used to achieve the best possible SNR performance. Both 3DCOW and IDEAL-3DCOW used flow compensation with the readout gradient 1° moment nulled and a SENSE based parallel acceleration method (ASSET) and acceleration factor of 1.75. Scan time for IDEAL-3DCOW was 5:16 minutes compared with 1:48 for 3DCOW. For IDEAL-3DCOW and IDEAL-3DTOF separate fat, water, and recombined in-phase (water+fat) and out of phase (water-fat) images were reconstructed using an online reconstruction algorithm. IDEAL-3DTOF took 3:20 minutes.

RESULTS
The IDEAL-3DCOW (right) has tremendously improved suppression of background signal compared to conventional 3DCOW (left). Enhanced visualization of the ophthalmic arteries (large arrow) and extra-axial vessels (small arrow) is clearly demonstrated. The combined background suppression and signal averaging improves visualization of the distal and perforating intracranial vessels. IDEAL-3DTOF improved background suppression and visualization of the carotid bifurcations.

CONCLUSION
IDEAL-3DTOF improves background suppression by optimization of echo-shifts to produce the best possible SNR performance of the water-fat decomposition. Superior visualization of extra-axial and intracranial vessels is obtained. The improved vascular signal-to-background demonstrates the potential of this technique for imaging subcutaneous vascular lesions (e.g. hemangiopericytomas, temporal arteritis). The single disadvantage, at this time, is the increased acquisition time of IDEAL-3DTOF over 3DTOF.

KEY WORDS: MRA, 3DTOF, IDEAL

Poster 45

Transverse Sinus Venus Thrombosis: The Importance of the Nonaffected Sinus

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PURPOSE
The goal of the present work was to find association between the unaffected sinus and the clinical presentation of patients with cerebral sinus thrombosis (CST).
Materials & Methods
The medical database at Soroka Medical Center was used to identify patients with transverse or sigmoid CST who were hospitalized between January 1995 and June 2006. The venograms were evaluated to confirm the diagnosis of CST, its location and the dominant side of the transverse sinuses. A measurement of the distal superior sagittal sinus (SSS) and of each right and left transverse-sigmoid conduit (TSC) was done separately. The measurement of the right and left TSC was performed in the highest degree of stenosis encountered from the torcula to the distal sigmoid sinus. Patients were classified into two groups. Patients who had papilledema or underwent LP with an opening pressure of more than 250mmH\textsubscript{2}O were classified as having intracranial hypertension (IH). Patients without papilledema or who underwent LP with an opening pressure less than 250mmH\textsubscript{2}O were classified as having normal intracranial pressure (ICP).

Results
Thirty-nine patients were included in the study. There were 19 males and 20 females with a median age of 24 years. Twenty-four patients were included in the IH group and 15 patients were included in the normal ICP group. In 25(64%) patients the affected TSC was the dominant side, while in 10 (26%) patients it was the nondominant side. Of 25 patients with the dominant side affected 21 (84%) had IH compared only to one (9%) patient out of 10 who had IH in the non-dominant side affected group (p < 0.001). Patients with IH had significantly narrower TSC in the unaffected side than those with normal ICP (p < 0.0001). In the IH group the mean percentage of patency in the unaffected side was 40% (of the distal SSS) while in the normal ICP group it was 86%.

Conclusion
The nondominant transverse sinus is identified less commonly with thrombosis, suggesting silent event due to sufficient drainage of the brain by the dominant sinus. In patients with CST in transverse sinus, the most important factor that predicts the development of IH is the size of the contralateral sinus.

Key Words: Cerebral venous thrombosis, intracranial pressure

Poster 46
Imaging and Clinical Features of Reversible Segmental Cerebral Vasoconstriction or Call-Fleming Syndrome

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Purpose
In 1988, neurologists Gregory Call and Marie Fleming described clinical and angiographic findings in four patients with reversible vasospasm of the cerebral vasculature in the setting of thunderclap headache and normal or near normal cerebrospinal fluid analysis. Some authors have referred to this constellation as Call-Fleming syndrome. Classically, Call-Fleming syndrome has been described as occurring in the absence of subarachnoid hemorrhage. We report a case series of 6 female patients presenting with clinical and imaging features typical of Call-Fleming syndrome, but some of which have cerebrospinal fluid analysis or imaging diagnostic of a small amount of subarachnoid hemorrhage.

Materials & Methods
A retrospective search of the Radiology Information Systems from January 2000 to November 2006 was performed to generate a list of all adult patients who presented to the department of radiology with a history of headache and whose workup included a cerebral angiogram, CT angiogram, MR angiogram or a combination of these studies. This data base then was limited to subjects whose radiology reports included one of the following terms: subarachnoid hemorrhage, vasospasm, vasoconstriction, vasculitis, vasculopathy, angiopathy or Call-Fleming syndrome. Patients with definitive clinical, laboratory or imaging data supportive of a diagnosis of vasculitis, ruptured aneurysm or underlying vascular malformation were excluded. Nine subjects were identified and three were excluded on the basis of confounding variables.

Results
Six subjects were identified, all of whom were female and ranged in age from 35 to 59 years old with a mean age of 50. All patients presented with acute, severe headache. Three patients had focal neurologic deficits or mental status changes at presentation. Initial imaging included: 6 head CTs, 4 MRIs, 4 MRAs, 1 CTA and 6 angiograms. Five patients had CT, MRI or lumbar puncture consistent with subarachnoid hemorrhage. One patient had an MRI equivocal for subarachnoid hemorrhage. Cerebral angiograms failed to demonstrate aneurysm as a cause for subarachnoid hemorrhage and instead revealed diffuse segmental vasospasm. Extensive rheumatologic workup in the patients excluded central nervous system (CNS) vasculitis as a cause for segmental areas of arterial constriction. Repeat vascular imaging (cerebral angiogram, n = 4; CTA, n = 1) in five patients demonstrated reversal of vasospasm.

Conclusion
Call-Fleming syndrome is a well described entity in the neurology literature, classically described as occurring in the absence of subarachnoid hemorrhage. As demonstrated by our series, subarachnoid hemorrhage can be a feature of Call-Fleming syndrome. The neuroimaging features are quite typical and can confidently help establish the diagnosis in the correct clinical setting. The presence of a small amount of blood over the convexities, extensive vasospasm out of proportion to the amount of blood and the acute presentation with severe headache are quite typical of this entity. All of these features are rarely encountered in CNS vasculitis with which this syndrome is often confused.

Key Words: Call-Fleming, vasospasm, vasculitis
Poster 47
Advanced Imaging of Arterial Anatomy of Pterygopalatine and Middle Cranial Fossa Using Angiographic Computed Tomography (DynaCT) and Dual-Volume Technique

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PURPOSE
Arterial anatomy of the pterygopalatine and middle cranial fossa including the cavernous sinus region is complex and difficult to understand even when imaged using the modern 2D DSA systems. We report on our experience in studying a difficult to understand anatomy even when imaged using the modern angiographic technique. The purpose of this study is to determine whether or not statistically significant seasonal or monthly variations in the rate of aneurysmal SAH could be detected in patients admitted to our institution.

MATERIALS & METHODS
In five patients with arteriovenous shunting lesions of the CS and three patients with skull base tumors an arterial 3D DSA was performed using a dedicated dual volume technique for small vessels. Dual volumes were obtained by separate reconstructions of mask and filling run and subsequent fusion using a dedicated commercially available workstation (Leonardo Siemens). Additional ACTs (DynaCT) were performed using the following parameters: 10 sec, 2.5 cc/sec, total of 28 ml (300 mg Iodine) Dual volume images were obtained by separate reconstructions of mask and filling run and subsequent fusion using a dedicated commercially available workstation (Leonardo Siemens). Additional ACTs (DynaCT) were performed using the following parameters: 20 sec. rotations, 0.4 increment, 220° total angle, 1024 matrix, 538 projections, “bone, sharp”, 512 x 512 reconstruction mode. Image postprocessing was performed using maximum intensity projections (MIPs). Contrast enhancement was achieved using 20% or 50% dilution (300 mg Iodine), 2 cc/sec and total of 40 ml.

RESULTS
Visualization of small arteries in the pterygopalatine and middle cranial fossa using -enhanced ACT was excellent and superior to 2D DSA. It provided opacification of small branches of the internal maxillary and pterygopalatine artery such as the accessory meningeal artery, artery of the foramen rotundum and the vidian artery, as well as their course through the bony skull base. Dual volume technique demonstrated in addition the precise relationship between arteries and bony foramina and canals such as the foramen spinosum, ovale and rotundum, used to enter the intracranium.

CONCLUSION
Dual volume technique in combination with DynaCT is capable of providing a new level of anatomical information in vascular imaging. It improves knowledge and understanding of regions with complex vascular anatomy such as the pterygopalatine fossa and the cavernous sinus region. This knowledge is of high value for interventional neuroradiologists when performing endovascular treatment of arteriovenous shunting lesions supplied by arteries in this territory. The quality of image information obtained is comparable to plastic casts obtained from cadaver studies, currently the reference method when studying complex vascular anatomy.

KEY WORDS: Vascular imaging

Poster 48
Seasonal Variation and Cerebral Aneurysm Rupture: Analysis of 886 Consecutive Cases of Subarachnoid Hemorrhage at a Single Institution

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PURPOSE
The literature has yielded conflicting results regarding the existence of seasonal variations in the rate of aneurysmal subarachnoid hemorrhage (SAH). The purpose of this study was to determine whether or not statistically significant seasonal or monthly variations in the rate of aneurysmal SAH could be detected in patients admitted to our institution.

MATERIALS & METHODS
A series of 886 consecutive patients admitted for aneurysmal SAH between January 1991 and December 2004 was entered into a prospective database. Poisson regression was used to determine the significance of variation in SAH counts by month and season, using age and gender as covariates.

RESULTS
A total of 886 patients with aneurysmal SAH were analyzed. The mean age was 51.6 years (SD 14.4 years), with 540 (60.9%) patients under age 55, and 346 (39.1%) patients age 55 or older. There were 638 (72.1%) females and 248 (27.9%) males. The number of total SAH for a given month ranged from a high in October (n = 90) to a low in April (n = 55). By season, the highest SAH counts were found in fall (n = 243) and the lowest in spring (n = 197). Poisson regression analysis of the entire sample, adjusted for gender and age, detected a significantly higher rate of SAH for the months of December (RR 1.5, CI 1.1-2.2), January (RR 1.4, CI 1.0-2.0), July (RR 1.6, CI 1.1-2.2), and October (RR 1.7, CI 1.2-2.3) when compared to the month of April. By season, there was a significantly higher rate of SAH for fall compared to spring (RR 1.2, CI 1.0-1.5). A stratified analysis showed that these seasonal and monthly variations persisted in women, but were not significant in men; women as a group had a significantly higher rate of SAH in the fall (RR 1.3, CI 1.0-1.6) compared to the spring. Further stratified analysis of women by age group found that this increase persisted for women under age 55 (RR 1.8, CI 1.3-2.4), while it was not significant for women over age 55 (RR .86, CI .62-1.2).

CONCLUSION
Significant seasonal and monthly variations in the rate of aneurysmal SAH were detected for women under age 55, with an increased risk in the fall compared to the spring. These variations were not significant in men. Further research is needed to identify risk factors for SAH that would be specific to premenopausal women and would exhibit a similar pattern of variation, such as seasonal hormonal changes.

KEY WORDS: Subarachnoid hemorrhage, epidemiology, seasonal variation
**Poster 49**  
**Cerebral CT Angiography Using a Reduced Dose of Contrast Material at a High Iodine Concentration in Combination with a Saline Flush**  

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**PURPOSE**  
We assessed the feasibility of reduced dose (50 or 75 mL) and higher concentration (350 mgI/mL) of contrast material in combination with a saline flush in cerebral CT angiography (CTA) using a 16-detector row system.

**MATERIALS & METHODS**  
Our study group comprised 28 consecutive patients. They were assigned to one of four protocols: group A: 50 mL of 350 mgI/mL with a saline flush (40 mL); group B: 75 mL of 350 mgI/mL with a saline flush; group C: 75 mL of 350 mgI/mL without a saline flush; and group D: 100 mL of 300 mgI/mL without a saline flush. CTA was performed with the following parameters: pitch, 15; collimation, 0.5 mm; and reconstruction interval, 0.3 mm. On source images, we measured the attenuation of regions of interest placed bilaterally on the ICA, proximal MCA, and proximal ACA. Additionally, on final images, two readers visually evaluated the demonstration of arteries and veins using a three-point grading scale.

**RESULTS**  
There were no statistically significant differences in attenuation of the ICA, MCA or ACA among the four groups, the only exception being a significantly higher attenuation of the ACA in group A than in group D (p = 0.02). Neither were any significant differences noted among the four groups on the visual assessment.

**CONCLUSION**  
By using a reduced dose (50 mL) and a higher iodine concentration (350 mgI/mL) with a saline flush, it is possible to obtain cerebral CT angiograms comparable to those obtained with a standard dose and concentration.

**KEY WORDS:** CT angiography, contrast material

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**Poster 50**  
**Correlation between X-Ray Angiography and Radial Sliding Window MRA of Arteriovenous Malformations**  

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**PURPOSE**  
The intracranial vasculature remains a challenge for MRA due to the increased importance of flow dynamics for diagnosis of arteriovenous malformations (AVM). The purpose of the study was to develop an MRA technique that will accurately depict the flow dynamics and anatomy of the intracranial vasculature.

**MATERIALS & METHODS**  
We have developed a high frame rate MRA pulse sequence that is capable of mapping the vascular architecture of intracranial AVMs. This pulse sequence uses a radial k-space trajectory (in plane) and Cartesian sampling through plane in a “stack of stars” sampling scheme. We have coupled this acquisition with a sliding window reconstruction to allow for frame rates at 3 frames/second. Sliding mask subtraction was used for better separation of arterial and venous phases. We varied subtraction intervals to determine what lag time results in the image with optimal contrast-to-noise ratio (CNR) and artery-vein separation. A series of patients who were scheduled for pre-treatment endovascular embolization of intracranial AVMs were recruited for this IRB approved study. Patients were imaged on a 3.0T MRI scanner (Trió, Siemens) equipped with multi-channel capabilities. The parameters of our MRA protocol were: FOV=220x220, frame rate = 0.35 sec/frame, spatial resolution = 1.14x1.14mm, N_s=16, thickness=2.0mm). A multi-injection protocol was used to acquire right lateral, left lateral and coronal scans with stepped contrast dosage, not exceeding 0.3 mmol/kg*(body weight). The CNR and venous conspicuity were evaluated of this novel pulse sequence were evaluated.

**RESULTS**  
The figure shows a representative example of an MRA/X-ray comparison in a confirmed Spetzler-Martin grade II AVM. The MRA was able to identify the smallest feeding artery in this patient which measured 1.8 mm based on X-ray. The CNR during venous phase was 217 for initial mask and 203 for sliding mask, with a better separation between arterial and venous phases for the sliding mask (Artery-to-vein contrast of 103 for initial mask and 175 for sliding mask). Although CNR is reduced from sliding subtraction, we have determined that for an interval of about 30 frames (10 seconds), the CNR loss associated with dynamic mask-mode subtraction is recovered, with the added benefit of improved venous images free of arterial overlap.
CONCLUSION
We have developed an MRI pulse sequence with sub-milimeter spatial resolution capable of acquiring images at 3 frames/sec. Correlative studies of this sequence and X-ray DSA in neurosurgical patients were done. Optimal sliding subtraction mask interval was determined for best contrast.

KEY WORDS: Angiography, MRA, radial

Poster 51

4D Dynamic High-resolution Parallel Imaging Accelerated Contrast-enhanced MR Angiography of the Cerebral Vasculature

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PURPOSE
To evaluate a fast contrast-enhanced MR angiography sequence in comparison to a conventional time-of-flight MRA with regard to image quality and potential fields of use.

MATERIALS & METHODS
All examinations were performed under institutional review board approval. Fourteen consecutive patients, undergoing contrast-enhanced MRI of the head for exclusion or follow up of brain lesions, were included into this prospective study. Patients were examined at a 1.5 T Magnetom Espree (Siemens, Erlangen, Germany) equipped with a standard 12-channel head coil. In addition to a standard head examination patients consented to the acquisition of a non-CE time-of-flight MRA (TR/TE = 41 ms/7 ms; matrix 320 x 240; flip angle 20°; GRAPPA acceleration factor = 2; TA 5:28 min) and a four-fold GRAPPA accelerated dynamic contrast enhanced TWIST-MRA1 (TR/TE= 3.28 ms/1.51 ms; matrix 256 x 176; flip angle 25°; TA 0:40 min). Contrast enhancement was achieved using a single bolus injection of 0.2 mmol/kg body weight gadoversetamide (Optimark, Mallinckrodt Inc., St.Louis, MO) with no need for a test bolus acquisition.

RESULTS
All patients tolerated the examination well. On a single best image TOF MRA in 12/14 patients provided superior image quality and vessel visualization of the vasculature proximal to the major MCA, ACA and PCA branches. In 2/14 patients TWIST MRA allowed better image analysis. In a patient with a vessel clip TOF MRA did not allow visualization of a 3.7 x 2.4 x 3.5 cm³ volume, whereas TWIST MRA provided excellent vessel visualization. Also, patient motion had a strong negative impact on TOF MRA image quality preventing image analysis in one patient. In spite of motion TWIST MRA delivered high quality dynamic MRA with superior vessel differentiation in this patient. TWIST MRA was superior over TOF MRA in temporal resolution. TWIST MRA provided high-resolution images allowing the differentiation of multiple arterial, parenchymal and venous phases. Particularly in the late arterial phase vessel depiction was superior in all 14 patients to the nondynamic TOF MRA. Also, TWIST MRA enabled to analyze the venous drainage, which cannot be expected from an arterial TOF MRA.

CONCLUSION
High-resolution dynamic MR angiography with an acquisition time of 40 s provides a valuable tool examining brain vasculature, particularly in patients with difficulties to control head movement and patients with metal artifacts. A great advantage for image interpretation over TOF MRA derives from the dynamic information collected. The simplicity of data acquisition, making bolus timing unnecessary and speed of the technique may have a strong impact on patient handling in day to day practice.

REFERENCES

KEY WORDS: MRA, TWIST MRA, parallel imaging

Poster 52

Large Arachnoid Granulations Involving the Posterior Superior Sagittal Sinus: Findings on MRI, Time-of-Flight and Contrast-enhanced MR Venography

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PURPOSE
Large arachnoid granulations (AG) within the posterior superior sagittal sinus (SSS) are less frequently encountered than those in the transverse sinus, have been incompletely characterized, and can be confused with thrombosis and neoplasm.

MATERIALS & METHODS
Nine cases of large AG in the posterior SSS are presented, identified by MR imaging. Four cases were imaged at 3T and 5 cases at 1.5T. 3 patients had MRV, 2 utilizing high resolution elliptic centric ordered contrast enhanced MRV. Signal characteristics, size, location, venographic appearance and association with adjacent venous and osseous structures were documented.

RESULTS
Intra-sinus tissue consistent with AG were identified in nine patients projecting into the posterior SSS (Figure 1.). A clear defect in the dura of the SSS was seen in all cases communicating with the subjacent subarachnoid space; seven on the right and two on the left. The average size of the AG was 7.2 x 8.7 x 11.3 mm (range: 4 - 19mm). The average vertical distance of the AG superior to the torcular herophili was 48.5 mm (range 30 - 62mm). 7 AG produced calvarial remodeling and 8 AG were in the direct vicinity of the lambda, with one AG occurring 12 mm above the lambda. On T2-weighted images all AG were hyperintense to brain. On FLAIR 7 were isointense, and 2 were hypointense. On T1-weighted images, 5 were hypointense and 4 were hypointense with mixed areas of isointense signal. All AG were associated with cortical venous structures entering into the sinus. Six cases
demonstrated internal venous channels within the AG. Average diameter stenosis of the SSS secondary to the AG was 56% (range: 20 - 86%). On MRV, AG appeared as protrusions into the sinus, focal in nature, displacing or projecting into the lumen of the sinus. In 4 cases, the AG was associated with septation of the SSS. Five patients had headache without other visible cause on MR imaging, and two were initially interpreted at outside institutions as thrombosis.

**Conclusions**

Large AG can occur in the posterior SSS. They are well defined projections of the subarachnoid space into the sinus, can cause luminal narrowing and calvarial remodeling, and have typical signal characteristics, position, and morphology differentiating them from thrombosis. Association with patient symptoms is uncertain, although when large, can result in significant venous stenosis.

**Key Words:** Arachnoid granulation, venous anatomy

**Poster 53**

Advanced Imaging of Venous Skull Base Anatomy Using Angiographic Computed Tomography (*DynaCT*) and Dual Volume Technique

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**Purpose**

Venous anatomy of the skull base is complex and remains difficult to understand even when imaged using modern 3D MRI or CTA. We report on our experience in studying a new software mode dual volume technique (DVT) for 3D DSA, combined with contrast-enhanced angiographic computed tomography (ACT) (*DynaCT*) and its value for the visualization of venous structures at the skull base.

**Materials & Methods**

In four patients with arteriovenous shunting lesions of the CS and in three patients undergoing petrosal sinus sampling, an arterial and/or venous 3D DSA was performed using a C-arm mounted flat detector system (AXIOM Artis dBA, Siemens Medical Solution) and the following parameters: 10 sec, 2.5 cc/sec, total of 28 ml (300 mg Iodine). Dual volumes were obtained by separate reconstructions of mask and filling run and subsequent fusion using a dedicated commercially available workstation (Leonardo Siemens). Additional ACTs (*DynaCT*) were performed using the following parameter: 20 sec. rotations, 0.4 increment, 220° total angle, 1024 matrix, 538 projections, “bone, sharp”, 512 x 512’ reconstruction mode. Image postprocessing was performed using maximum intensity projections (MIPs). Contrast enhancement was achieved using 20% or 50% dilution (300 mg Iodine), 2 cc/sec and total of 40 ml.

**Results**

Visualization of major and minor venous structures using both, DVT and ACT was excellent and superior to 2D DSA. ACT (*DynaCT*) visualized in high-detail small venous structures such as the anterior condylar confluens, petro-occipital sinus and the internal carotid artery plexus (Rektorzik), often times obscured on standard 2D DSA. Dual volume technique provided in addition the precise relationship between venous and osseous structures, not obtainable with other, currently available imaging tools.

**Conclusion**

Dual volume technique in combination with *DynaCT* is capable of providing new level of anatomical vascular information that is of high value for improving knowledge and understanding of regions with complex vascular anatomy such as the skull base. This knowledge is crucial for interventional neuroradiologists when performing endovascular treatment and for neurosurgeons when performing open surgery in this area. The quality of image information obtained is comparable to plastic casts obtained from cadaver studies, currently the reference method when studying vascular anatomy in this area.

**Key Words:** Vascular imaging

**Poster 54**

Dynamic Perfusion CT Assessment of Blood-Brain Barrier Permeability Distinguishes between Infarct and Penumbra in Acute Stroke Patients

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**Purpose**

To quantitatively measure blood-brain barrier permeability (BBBP) in acute ischemic brain tissue using dynamic perfusion CT (PCT), and to assess for permeability differences in the infarct and the penumbra.

**Materials & Methods**

Thirteen acute hemispheric stroke patients who underwent a specific PCT protocol using a prolonged acquisition over 3 minutes were identified retrospectively. Patlak modeling was used to analyze the PCT data and assess BBBP based on the degree of contrast extravasation from the intra to the extravascular compartment. Permeability coefficients (K)
were measured in regions of interest (ROIs), both in terms of absolute (mL/100g/min) and relative (% of CBF) leakage flow. Infarct and penumbra were defined from PCT data using reported mean transit time and cerebral blood volume thresholds; their respective volumes were recorded. Conventional admission and follow-up imaging datasets were reviewed. Patients’ charts were reviewed for demographic and clinical data. Blood-brain barrier permeability values were compared using t-tests, and linear regression analysis with respect to clinical data was performed.

**RESULTS**

Measured BBBP values are reported in the Table below.

<table>
<thead>
<tr>
<th>Region</th>
<th>Absolute Permeability (mL/100g/min)</th>
<th>Relative Permeability (% of CBF)</th>
<th>CBF (mL/100g/sec)</th>
<th>CBV (mL/100g)</th>
<th>MTT (sec)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Infarct Center</td>
<td>0.78 ± 0.40</td>
<td>19.30 ± 13.71</td>
<td>5.05 ± 2.61</td>
<td>1.21 ± 1.38</td>
<td>39.64 ± 31.20</td>
</tr>
<tr>
<td>Infarct Periphery</td>
<td>0.75 ± 0.45</td>
<td>12.76 ± 10.01</td>
<td>7.55 ± 3.18</td>
<td>1.30 ± 2.27</td>
<td>27.06 ± 16.15</td>
</tr>
<tr>
<td>Penumbra Center</td>
<td>0.74 ± 0.40</td>
<td>4.25 ± 2.61</td>
<td>21.75 ± 5.18</td>
<td>4.30 ± 0.83</td>
<td>13.78 ± 0.05</td>
</tr>
<tr>
<td>Penumbra Periphery</td>
<td>0.61 ± 0.27</td>
<td>3.24 ± 2.23</td>
<td>32.61 ± 9.44</td>
<td>4.00 ± 0.81</td>
<td>11.88 ± 5.27</td>
</tr>
<tr>
<td>Surrounding Penumbra</td>
<td>0.47 ± 0.37</td>
<td>2.09 ± 2.56</td>
<td>32.61 ± 9.44</td>
<td>3.71 ± 0.48</td>
<td>7.49 ± 2.94</td>
</tr>
<tr>
<td>Nonischemic Hemisphere</td>
<td>0.49 ± 0.25</td>
<td>1.41 ± 0.98</td>
<td>38.10 ± 9.65</td>
<td>3.44 ± 0.50</td>
<td>5.72 ± 1.50</td>
</tr>
</tbody>
</table>

Absolute BBBP measurements were significantly higher in the infarct and in the penumbra center compared to the region surrounding the penumbra and the contralateral nonischemic hemisphere (p = 0.05 and p = 0.04, respectively). Relative BBBP measurements were significantly higher in the infarct compared to the penumbra, region surrounding penumbra, and contralateral nonischemic hemisphere (p = 0.002, p = 0.0007, and p = 0.0005, respectively). Both absolute and relative BBBP values for the infarct tended to increase with the time from symptom onset to CT scan (hours) (r^2 = 0.32 with slope = .20 and r^2 = 0.19 with slope = .056, respectively) and with the admission infarct volume (cm^3) (r^2 = 0.12 with slope = .0067 and r^2 = 0.25 with slope = .0031, respectively). Both absolute and relative BBBP values for the penumbra tended to increase with the time from symptom onset to CT scan (r^2 = 0.21 with slope = .063 and r^2 = 0.52 and slope = .010, respectively).

**CONCLUSION**

Perfusion CT offers quantitative measurements of BBBP and identifies different BBBP values in the infarct, penumbra and nonischemic brain tissue. Future studies with a larger sample size are required to better understand these differences, to compare the utility of absolute and relative measurements of permeability, and to determine if BBBP assessment can help predict which stroke patients are going to develop hemorrhagic transformation or malignant edema.

**KEY WORDS:** Stroke, perfusion-CT, permeability
CONCLUSION
Within 3 hours of stroke onset, infarct volume, as measured on follow-up CT, is best predicted by the cerebral blood volume map data.

KEY WORDS: CT perfusion maps, acute stroke

Poster 56
Neural Substrates Involved in Cognition for Stroke Patients and Control Subjects

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PURPOSE
Localization of cognitive functions on the basis of deficits associated with chronic strokes has focused on infarcted brain regions. This study examines the influence of hypoperfused brain regions, in addition to the area of the infarct itself, on reorganization of the cognitive processes underlying word generation in stroke patients.

MATERIALS & METHODS
Six chronic stroke patients (ages 28-58 years) and six control subjects (ages 24-57 years) with no known neurologic disease underwent a stroke protocol MR imaging including perfusion imaging (PWI or CASL) as well as functional MR imaging (fMRI) on a 1.5T whole-body MR scanner. Functional MR imaging study consisted of a word generation paradigm (60 seconds) where subjects were asked to generate words subvocally beginning with a letter that was presented to them alternating with rest (30 seconds) for 11 epochs. The fMRI data were analyzed within SPM99 as an epoch design of the fixed response/box car form. Statistical parametric maps were created according to the general linear model and subsequently appropriately thresholded to generate fMRI maps.

RESULTS
All six stroke patients had major subcortical focus of infarcts in centrum semiovale and basal ganglia with no cortical infarcts (Fig). Perfusion imaging in patients with left and right subcortical infarcts showed large areas of hypoperfusion, including frontal, parietal, and temporal cortices in the left and right MCA vascular distribution respectively. Functional MR imaging activation in the six chronic stroke patients was dependent on the location of the subcortical infarct and the area of hypoperfusion. In patients with hypoperfusion involving left MCA territory, greater recruitment of right-hemisphere regions and less BOLD signal in the left fronto-temporo-parietal network compared to normals was observed. Similarly, TG, who showed hypoperfusion of right fronto-temporo-parietal regions, showed less BOLD signal than normal subjects in these areas. JH, who showed only right parietal hypoperfusion, showed the normal pattern, since the normal activation pattern does not encompass hypoperfused regions (right BA 40 and 37).

CONCLUSION
While normal subjects displayed a left-lateralized fronto-temporo-parietal and bilateral cingulo-striatal-thalamic-cerebellar network, the activation pattern of stroke patients was determined both by the hypoperfused regions and infarcted areas of the brain. Specifically, patients showed diminished BOLD effect in the cortical regions that were hypoperfused, even though their infarcts were subcortical, and showed increased BOLD effect in the homologous regions of the normal hemisphere. This finding raises the possibility that cortical hypoperfusion in the absence of infarct can cause shift of language functions to the opposite, intact hemisphere.

KEY WORDS: Stroke, functional MR imaging, memory

Poster 57
MR Perfusion of the Basilar Artery Stenosis before and after Stenting

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PURPOSE
MR perfusion study has been used for analysis of brain perfusion abnormality in the supratentorial arterial abnormalities. We report the application of MR perfusion in basilar arterial stenosis and evaluated with independent component (IC) analysis method.
**Materials & Methods**

We used the Fast IC analysis algorithm to analyze perfusion images. It first applied principle component analysis to input perfusion images to reduce the data dimension. Then Fast IC analysis technique employed an estimate of entropy as the cost function and a fix-point optimization algorithm to sequentially find output IC images. Thresholding and manual drawing techniques were applied to the output IC images to select regions of interest (ROIs) of different tissues for quantitative measurements. For the parametric image calculation, rCBV, rCBF, MTT, and TTP were calculated. We calculated values in the thalamus, lentiform nucleus, occipital lobes, and the brain stem in these parametric images for analysis. Two cases of basilar artery stenosis before and after stenting will be demonstrated and analyzed.

**Results**

We found there was marked hypoperfusion in the bilateral occipital lobes, thalamus, and midbrain before stenting in these two patients. After stenting, the clinical complaints and neurologic deficits disappeared completely in both patients. Hypoperfusion in one of these patients returned to a normal status. Temporary hyperperfusion was found in the occipital lobes in the other patients and a new complaint - the patient saw wavy movements of distant objects - was noted next day after stenting, and this complaint disappeared at 17 days after stenting, and the brain perfusion returned to normal 18 days after stent procedure.

**Conclusion**

MR perfusion can show the hypoperfusion in thalamus, occipital lobes, and brainstem in patients with basilar arterial stenosis. Analysis of the MR perfusion data with IC analysis method may help the understanding of MR perfusion. Hyperperfusion after stenting can be shown by MR perfusion.

**Key Words:** MR perfusion, basilar arterial stenosis

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**Poster 58**

**Lesion Patterns of Ischemia in Spontaneous Extracranial Acute Internal Carotid Artery Dissection**

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**Purpose**

Spontaneous internal carotid artery dissection (ICAD) is recognized as one of the most frequent causes of ischemic stroke in patients less than 50 years. The clinical syndromes from this type of ICAD result from two basic mechanisms: embolism and hemodynamic. Although the mechanism of infarction cannot be explained accurately based on its distribution on radiologic studies, it has been suggested that infarcts involving the superficial and/or the subcortical middle carotid artery (MCA) territories are probably secondary to artery-to-artery embolism, while watershed infarcts are probably secondary to hemodynamic compromise. The aim of this study is to investigate the ischemic lesion patterns resulting from spontaneous extracranial ICAD using diffusion-weighted imaging (DWI) and to discuss their mechanism.

**Materials & Methods**

Consecutive acute spontaneous extracranial ICAD referred to our department for MR imaging evaluation within 10 days after symptoms onset. Inclusion criteria for this study were: (a) Diagnosis of spontaneous extracranial ICAD confirmed by MR imaging or by cerebral angiography; and (b) Performance of the MR exam within the first 10 days after symptoms onset including DWI. Infarct patterns were analyzed based on DWI according to the following classification: cortical territorial, subcortical, lacunar, and watershed.

**Results**

Forty-eight patients were included in this study (33 male and 15 female; mean age 45.2; range from 18-65). Diagnosis of ICAD was obtained by MR imaging in all patients. Catheter angiography was obtained only in four patients. Three patients had bilateral ICAD (6.25%), resulting in a total of 51 dissected arteries (left side 29; right side 22). Internal carotid artery dissection resulted in complete occlusion of the involved vessels in 18 cases, in severe to moderate stenosis in 23 cases and in mild stenosis in 10 cases. Middle carotid artery territorial infarctions were observed in 29 cases (56.8%) (cortical, subcortical, fragmented), while watershed infarctions were observed only in 8 cases (15.7%) (internal, and/or cortical). Fourteen ICAD (27.4%) were not associated with acute infarction on DWI. No association was observed between degree of ICA stenosis and pattern of infarction.

**Conclusion**

Territorial MCA infarctions are the most common pattern observed in our patients with spontaneous extracranial ICAD patients. This finding supports the embolic mechanism as a major cause of cerebral ischemia in ICAD, a fact that should encourage the use of thrombolytic therapy in these patients.

**Key Words:** Stroke, carotid artery dissection, diffusion-weighted imaging

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**Poster 59**

**Stroke Subtype Predicts Ultimate Volume of Infarct on MR Diffusion-weighted Imaging**

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**Purpose**

To determine whether stroke subtype correlates to infarct volume on diffusion-weighted MR imaging.

**Materials & Methods**

This consecutive cohort comprised 100 women and 116 men who presented to our emergency department (ED) within 24 hours of stroke onset and had brain MR imaging done during hospitalization. Stroke subtype was classified according
to the Trial of ORG 10172 (TOAST) criteria. General Electric Medical Systems Advantage Windows workstation with version 4.2 software was used to measure the areas of interest on the MR scans, acquired on a 1.5T GE scanner. Echo-planar whole-brain, multislice, diffusion-weighted MR images were obtained. Acquisition parameters were as follows: 10.050/94.8 TR/TE, 40 cm FOV, 128 x 256 matrix size, 5 mm section thickness, 1 mm section gap, and number of signals acquired 1. Consecutive slices revealing the infarcted area were identified and marked. Area of the infarct on each individual slice was mapped out, and then was subsequently multiplied by the sum of section thickness and section gap to estimate the infarct volume on the particular slice. The same process was carried out in all slices except the last where the mapped-out area was multiplied by the section thickness only. Ultimately, the total infarct volume was calculated by summing up the volumes of infarct on individual slices. Statistical analyses were performed using SAS version 8.0 and JMP version 6.0. Nonparametric methods (Wilcoxon Rank sum tests) were used to determine the association between TOAST and MR imaging volumes.

**RESULTS**

The median age was 73 years, with an interquartile range of 62-81. The most frequent subtypes were cardioembolic (28%) and large vessel disease (27%) followed by small vessel (14%) disease.

### Infarct volume vs stroke subtype:

- **Patients with large vessel or cardioembolic cause had significantly larger infarct volume than patients with small vessel (p<0.001), or no cause identified (p=0.029).**
- **Patients with large vessel disease had a significantly larger MRI volume than patients with small vessel (p<0.001), multiple causes (p=0.10), no cause identified (p=0.029).**
- **Patients with cardioembolic strokes had a significantly larger MRI volume than patients with small vessel (p<0.001), multiple causes (p=0.12), no cause identified (p=0.064).**
- **Patients with small vessel disease had a significantly smaller MRI volume than patients with other causes (p=0.002), multiple causes (p=0.063), no cause identified (p=0.002), insuff info (p=0.002), and likewise significantly smaller than large vessel and cardioembolic.**
- **Patients with other causes of strokes had a significantly larger MRI volume than patients with no cause identified (p=0.12).**
- **Patients with no cause identified had a significantly smaller MRI volume than patients with insufficient info (p=0.070).**
- **Patients with no cause identified had a significantly smaller MRI volume than patients with insufficient info (p=0.070).**

### CONCLUSION

Stroke subtype predicts ultimate volume of infarct on diffusion-weighted MR imaging.

**Key Words:** Stroke, volume of infarct, MR imaging

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**Poster 60**

**MR Imaging Patterns in Cocaine-related Strokes**

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**PURPOSE**

Cocaine use has been associated with ischemic and hemorrhagic strokes. The purpose of this study is to review the MR imaging of patients with cocaine-related ischemic strokes with the objective of identifying specific patterns of involvement in an effort to direct clinical and therapeutic interventions.

**MATERIALS & METHODS**

We reviewed the neuroimaging data of all patients discharged from the Miami VA Healthcare System from January 2002 to July 2006 with ICD9.CM codes of 433-437 and 305.6. Documentation of cocaine use, type, route and time of last use, and the results of urine or toxicology studies were recorded. The results of brain MR imaging and MR angiography were recorded. Strokes subtypes were determined using the TOAST criteria.

**RESULTS**

We identified a total of 30 patients with cocaine-related ischemic strokes. All patients were men except three. The mean age was 55 years. Sixty-seven percent (20/30) of all patients had acute strokes in the anterior circulation. Fifty-seven percent (17/30) had strokes of the large vessels. In the group of patients younger than 55 years, 50% (6/12) were HIV positive, and the HIV status was unknown in 33%. There was an increased incidence of chronic small vessel ischemic disease and previous strokes in the older age group (> 55 years) of approximately 72% (13/18), compared to 25% (3/12) incidence in the younger age group (< 55 years). The young age group had strokes of the large vessels in 67% (8/12) of the cases, while the older age group had equal amount of involvement of the large and small vessels (9/18 in each group). Cigarette smoking (24/30) and hypertension (20/30) were the most common risk factors identified with no significant difference among both groups. Elevated levels of erythrocyte sedimentation rate (ESR) were identified in one patient over 55 years; while most (4/7) of the available ESR levels were elevated in the younger age group.

**CONCLUSION**

Our data indicates that almost half of the patient with cocaine-related ischemic strokes had radiologic evidence of prior strokes. The anterior circulation was the most frequent acute stroke location. Young patients were characterized by acute strokes of the large vessels in the anterior circulation, with no significant evidence of previous strokes, chronic small vessel ischemic disease and vaso-occlusive disease; while the majority of older patients had evidence of chronic small vessel ischemic disease and prior strokes with involvement of large and small vessels. Cocaine-related ischemic strokes have a different presentation as compared to the general population. Increase incidence of ischemic strokes of the large vessels and anterior circulation is noted. Findings described in our study might substantiate the need for larger clinical trials and further direct future clinical and therapeutic interventions.

**Key Words:** Stroke, cocaine
Comparison of MRA Source Image and IVUS for Evaluating Fibrous Cap of Carotid Plaque

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PURPOSE
In the patients with asymptomatic carotidstenosis, arteries with thinned or ruptured fibrous caps were associated with the occurrence of subsequent cerebrovascular events. It is reported that dense fibrous cap shows hypointense band near the bright arterial lumen on time-of-flight (TOF) MR angiography (MRA). The purpose of this study is to evaluate the usefulness of TOF MRA source image for investigating fibrous cap of carotid plaque in comparison with intravascular US (IVUS).

MATERIALS & METHODS
The subjects were 16 carotid stenotic lesions of 14 cases (average age: 68.5 years old), who were performed MRA and IVUS simultaneously since April 2002 to September 2006. MRA images were obtained using 3D TOF MRA sequence (TR: 26msec, TE: 7.1msec, FA: 25, slice thickness: 1.2-1.5mm) on a 1.5T MR scanner (Sonata, Siemens AG, Erlangen, Germany). IVUS images were obtained using InVision System (Volcano, CA, USA). On TOF MRA images, the hypointense areas around the arterial flow signal were interpreted as fibrous cap. While, on IVUS images, hyperechoic areas around the arterial lumen were interpreted as fibrous cap. The percentage of the fibrous cap area within arterial wall at stenotic lesion was calculated on both TOF MRA and IVUS images, and the agreement was evaluated. The comparison between the percentage of the fibrous cap area on TOF MRA and that of IVUS images was conducted using the Pearson’s correlation coefficient.

RESULTS
The percentage of fibrous cap area agreed with 10% error range in 5 of 16 lesions. While, there were lesions with slight disagreement (10-20%; figure) in 9 of 16 lesions and moderate disagreement (30-40%) in 2 of 16 lesions between TOF MRA and IVUS images. On the figure, the hyperechoic area around the arterial lumen was intact for almost whole circumference on IVUS image (A). However, there was a defect of hypointense band (white arrow) on TOF MRA (B). In the statistical analysis, there was significant correlation (P<0.01, r=0.718) between TOF MRA and IVUS images.

CONCLUSION
Fibrous cap of carotid plaque can be investigated by TOF MRA source image, which has statistically significant agreement with IVUS images. However, each case should be evaluated carefully in that there were some cases which showed disagreement with IVUS findings.

KEY WORDS: Carotid plaque, MRA, IVUS

Preliminary Qualitative Visual Assessment of Perfusion Patterns on CASL in AD and MCI Patients: Possible Vascular Etiology in Pathogenesis of AD and MCI

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PURPOSE
Although current classification systems separate Alzheimer disease (AD) as distinct from vascular dementia (VaD), the similarity between these two including risk factors such as atherosclerosis and hypertension, the presence of capillary degeneration in both, pharmacologic therapies for AD that improve perfusion, neuroimaging showing hypometabolism and hypoperfusion in AD and MCI, and the fact that amyloid angiopathy does exist make vascular disorder a likely causative factor in AD and MCI. With the improvement in continuous arterial spin labeling (CASL), it is possible to quantify rCBV and rCBF paralleling the accuracy of xenon CT, SPECT, and PET. But more importantly adds a noninvasive, more cost-efficient means of assessing cerebral perfusion. It is the purpose of this exhibit to present our experience with CASL in the qualitative visualization of perfusion patterns in AD and MCI. (Quantitative will be presented later.)

MATERIALS & METHODS
Eleven controls, 10 AD, and 10 MCI were recruited from the Pittsburgh Cardiovascular Health Study Cognition Study. All underwent UPDRS, HRS, CES-D, NPI, and extensive neuropsychiatric testing. Patients were studied on a 1.5T GE Signa by multislice CASL with ASD adiabatic inversion pulse sequence (50 repetitions, 3.7s pulse train at 92%) with ramped EPI for 19 contiguous slices (64 x 64, 5 mm). Segmented spgr images were voxel warped to colin 27 brain to which the perfusion images were applied. Perfusion images were viewed in color mode (hot) on SPM2 software. Quantitative assessment of rCBV and rCBF was facilitated by partial least squares method on the fused perfusion and spgr images.

RESULTS
Normal brains showed robust (red), symmetrical cortical mantle with no gaps, and normal size/perfused thalam, lentiform, and cingulate displayed as red. Hot spots (yellow/white) appeared in prefrontal (11/12 Brodmann area), dorsal anterior cingulate (32BA), entire cingulate (23/24/31BA), and Rolandic sulcus. Alzheimer disease showed thinned mantle with focal gaps, and total lobar signal dropout, and decreased size/perfused thalam, lentiform, and cingulate. There was striking absence of hot spots in
11/12BA and 23/24/31BA. There were scattered focal areas of hot spots elsewhere. MCI showed thinned mantle but not as severe as AD, but sometimes appeared normal. Focal gaps and lobar loss occurred but not as often. Hot spots also were absent in inferior frontal and cingulate. Decreased size/perfused thalami and lentiform occurred less often, but thinning of cingulate occurred as often as AD. Hot spots were preserved in Rolandic in AD and MCI. Abnormalities in perfusion overlapped in AD and MCI. Quantitative data of these regions will not be presented at this time.

CONCLUSION
Visual assessment of perfusion with CASL is enhanced by color. Preliminary results confirm abnormalities in perfusion at sites well known by other imaging modalities. The potential for CASL in evaluating perfusion abnormality in AD and MCI is significant even in this small population. Quantitative data back up these preliminary observations. Vascular pathology in the pathogenesis of AD and MCI is strongly supported by CASL imaging. This exhibit will focus on the visual assessment of perfusion abnormalities.

KEY WORDS: Continuous arterial spin labeling, Alzheimer and MCI, perfusion imaging

Poster 63

Assessment of Alzheimer Disease with MP-RAGE Signal Intensity Normalization

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PURPOSE
The purpose of this study was to assess the signal intensities of MP-RAGE head datasets quantitatively and comparatively in the context of the Alzheimer’s Disease Neuroimaging Initiative (ADNI) to distinguish Alzheimer disease-related changes in brain matter. We use several histogramic parameters, including mean peak values and volume, among others, to study the quantified pixel intensities. This study also attempts to investigate the reliability of the technique in 1.5T and 3.0T magnetic fields by using volumetric analyses and comparing mean peak values.

MATERIALS & METHODS
Thirty-two MP-RAGE brain datasets (sixteen 1.5T and sixteen 3.0T datasets) ranging in age from 74-84 years were processed successfully. The data acquired for this study were from two ADNI sites - Boston University and Johns Hopkins University. Normalization and segmentation (Fig 1) using Mathcad 2000i (PTC, Needham, MA) was performed to obtain pixel values histograms. Statistical analyses were performed for each dataset using t-test across various parameters mentioned above at different magnetic fields.

RESULTS
For the 1.5T datasets, the histograms of WM and GM showed no significant decrease in mean peak values of WM and GM in Alzheimer patients (WM: 521.79 +/- 37.75 RU to 496.25 +/- 21.25 RU; GM: 360.491 +/- 29.159 RU to 348.753 +/- 23.126 RU). For the 3.0T datasets, the histograms showed no significant decrease in mean peak values of WM and GM in Alzheimer patients compared to the normal cohort (WM: 514.481 +/- 41.362 RU to 489.471 +/- 41.797 RU; GM: 340.597 +/- 23.752 RU to 330.185 +/- 19.714 RU). All other parameters yielded no significant findings. Significantly better segmentations (volume) were achieved in datasets taken in 1.5T than 3.0T image sequences raising questions about the reliability of technique in 3.0T images and possible adjusting measures.

CONCLUSION
The evidence reported here indicated that the declining shift of the peaks towards shorter T1 values may be statistically significant with a larger cohort. It has been shown previously using magnetization transfer imaging that there was a significant decrease in WM and GM volumes in Alzheimer patients (1). The reasons for this decline may lie in the loss of myelin sheaths and atrophy of brain cells with the onset of Alzheimer disease.

REFERENCES

KEY WORDS: Signal intensity, Alzheimer disease, MP-RAGE
**Poster 64**

**Neuroimaging Follow Up of Amyotrophic Lateral Sclerosis Patients by Diffusion Tensor Imaging and MR Spectroscopy**

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**PURPOSE**

Nonconventional MR techniques, such as diffusion tensor imaging (DTI) and MR spectroscopy (H-MRS), have been used recently in searching for a marker of upper motor neuron (UMN) involvement in amyotrophic lateral sclerosis (ALS)/motor neuron disease patients. The aim of this work is to find neuroimaging markers for ALS patients’ progressive clinical impairment.

**MATERIALS & METHODS**

Thirty-two ALS patients were studied: 13 with definite/probable (D/P), and 19 with possible (P) ALS, according to the El Escorial criteria. All subjects underwent brain MR scans every 4 months by 1.5 T device (GE Signa ExciteTM HD, Milwaukee, IL, USA) during a 16-month period. Diffusion fractional anisotropy (FA) and average apparent diffusion coefficient (ADC) were analyzed along the cortico-spinal tracts from prerolandic gray and white matter down to bulbar pyramids. H-MRS has been carried out by sampling Rolandic regions with single-voxel technique. Patients’ data were compared among each other according to progressive clinical impairment.

**RESULTS**

We found a significantly (p < 0.05) negative correlation between clinical disability and FA values (in the posterior limbs of internal capsules and in the cerebral peduncles of D/P ALS patients, but only in the pons on both sides and in the left cerebral peduncle of P ALS patients). Moreover, a significantly (p < 0.05) positive correlation was observed between clinical impairment and average ADC values (in almost all the cortico-spinal tracts of D/P ALS patients and only in the posterior limb of internal capsule and cerebral peduncle on the left side and right hemipons of P ALS patients). According to the disability progression, an increased mI/Cr ratio in D/P ALS patients was found only on the right side, and a decreased NAA/Cr ratio in P ALS patients was found.

**CONCLUSION**

Our findings support the idea that DTI markers may discriminate between D/P ALS and P ALS patients, as we and other authors already reported in basal assessments. Moreover, in D/P ALS patients, average ADC seems to be a more global index of progressive UMN damage. Single-voxel H-MRS, which is useful in comparing ALS patients and healthy controls as groups, resulted on the contrary weaker in patients’ follow up, probably due to its low sensitivity in detecting small variations. Although our data need further confirmation in wider patients’ groups, we think that DTI might bring useful contributions to study ALS natural history, and for clinical trials.

**KEY WORDS:** ALS, diffusion tensor imaging, MR spectroscopy

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**Poster 65**

**Measurement of the Blood-Brain Barrier Permeability in Multiple Sclerosis: A Dynamic Susceptibility Contrast Perfusion MR Imaging Study**

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**PURPOSE**

Increased permeability of the blood-brain barrier (BBB) is an early phenomenon in plaque development in multiple sclerosis (MS) and might precede monocyte infiltration into the CNS. Although Gd-DTPA-enhanced MR imaging is a powerful diagnostic tool to detect areas of BBB breakdown, it is not quantitative and may underestimate the overall extent of BBB disruption. A recently published method for quantifying microvascular permeability uses T2*-weighted gradient-echo echo-planar imaging during the first pass of Gd-DTPA. The purpose of this study was to quantify regional BBB permeability in MS patients by using dynamic susceptibility contrast (DSC) perfusion MR imaging.

**MATERIALS & METHODS**

Ten patients, six with clinically isolated syndrome (CIS) suggestive of MS and four with relapsing-remitting MS and 10 healthy controls underwent the following MR protocol on a 3.0T imaging unit (Trio, Siemens, Erlangen Germany): axial pre and postcontrast T1-weighted, T2-weighted images and dynamic susceptibility contrast (DSC) enhanced T2*-weighted sequences. DSC images were acquired with a gradient-echo EPI sequence during the first pass of a standard dose (0.1 mmol/kg) bolus of Gd-DTPA. The transfer coefficient, Ktrans, represented by the endothelial permeability surface area product, was measured in 20 hypointense, 21 isointense, 4 Gd-enhancing lesions, 20 areas of controlateral NAWM (cNAWM) in patients and in corresponding 20 areas of WM in controls.

**RESULTS**

The average Ktrans was 0.02 ± 0.01 min⁻¹ for Gd-enhancing lesions, 0.007 ± 0.02 min⁻¹ for hypointense lesions, 0.001 ± 0.004 min⁻¹ for isointense lesions, 0.002 ± 0.007 min⁻¹ for areas of cNAWM and 2 x 10⁻⁷ ± 1 x 10⁻⁷ min⁻¹ for areas of WM. As expected, the Gd-enhancing lesions showed the highest Ktrans value. Compared to controls’ WM, Ktrans was higher in hypointense, isointense lesions and in cNAWM suggesting that the impairment of the BBB permeability can be more extensive than shown by Gd-enhancing MR imaging.

**CONCLUSION**

In MS, BBB permeability is increased not only in Gd-enhancing lesions but also in nonenhancing lesions and NAWM. Future studies will have to assess the relationship between the extent of impaired microvascular permeability and the clinical manifestations of the disease.

**KEY WORDS:** Multiple sclerosis, perfusion MR imaging, microvascular permeability
Leukoaraiosis: FLAIR and T2-Weighted Sequences Comparison and Correlation with Neurocognitive Status

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**PURPOSE**
Previous reports on the frequency, extent and clinical correlates of white matter hyperintensities (WMH) have been contradictory. They often are based on the T2 sequences. FLAIR sequence often is used in clinical routine. The goals of this work are to compare FLAIR and T2-weighted sequences for leukoaraiosis evaluation and to correlate MR images with neuropsychological status.

**MATERIALS & METHODS**
Three hundred seventy-one hypertensive patients aged over 60 years, without dementia (MMS > 23), depression and stroke history were studied on a Signa 1.5T MR (GEMS) with T2-weighted, FLAIR and diffusion-weighted sequences. White matter hyperintensities (WMHs) were separated from periventricular (PVHs): frontal and occipital horns (graded 0 to 3), wall of lateral ventricles (graded 0 to 3), fornix (0-1) and deep white matter (DWMHs) (graded 0 to 4). Neuropsychological status was established with a combination of psychometric tests: Montgomery, Folstein, Benton, Isaacs, Wechsler, Grober and Büschke.

**RESULTS**
1) FLAIR sequence is slightly better to demonstrate periventricular white matter hyperintensities (83 vs 80% for frontal and occipital horns and 70 vs 66%) with a higher difference for fornix abnormalities (27.3% on FLAIR versus 11.6% on T2-weighted images). But we did not find any difference for the deep white matter. 2) Periventricular hyperintensities are correlated with the neurocognitive status and especially with the Grober and Büschke test (p = 0.0009). There is a relationship between the hyperintensities degree and the neurocognitive status. On the other hand, DWMHs are poorly correlated with the neurocognitive status.

**CONCLUSION**
Periventricular white matter hyperintensities degree is correlated with neurocognitive status. FLAIR sequence seems to be sensitive particularly for periventricular white matter evaluation and may be integrated in leukoaraiosis scales.

**KEY WORDS:** Leukoaraiosis

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On the Pixel Intensity Information Contents of MP-RAGE Brain Data Sets: 1.5T versus 3.0T

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**PURPOSE**
To study quantitatively and comparatively, the pixel information contents of MP-RAGE head datasets in the context of the Alzheimer disease. Neuroimaging initiative (ADNI), using a multiphase image processing protocol including: a) pixel intensity normalization, b) three-dimensional intracranial segmentations, and c) histogram generation of whole-brain segments and sub-segments (WM and GM).

**MATERIALS & METHODS**
MP-RAGE brain datasets (sixteen 1.5T and sixteen 3.0T datasets) acquired for ADNI at Boston University and Johns Hopkins University were analyzed. Images were transferred to our image processing laboratory and analyzed with Mathcad 2000i (PTC, Needham, MA). For each volumetric data set, the maximum pixel intensity of buccal fat was ROI-measured and used for normalization.

**RESULTS**
For the 1.5T datasets, all generated whole brain histograms were unambiguously bimodal (Fig1) consisting of a narrower peak at high pixel (WM) juxtaposed to a partially overlapping and broader peak at lower pixel (GM). It is further noted that the MP-RAGE histogram shapes at 1.5T are very similar to the whole brain T1 histograms generated with quantitative MR imaging (1). As shown in Figure 2, the 3.0T histograms are comparatively featureless and unimodal in shape. Also visually apparent is the reduced intersubject histogram shape and pixel normalization reliability of the 3.0T histograms relative to 1.5T.
CONCLUSION

The findings reported here indicate that the tissue information contained in MP-RAGE pixel intensities might be compromised at 3.0T relative to 1.5T. Likely causes are the increased B0 and B1 homogeneity deteriorations associated with the use of higher B0 field platforms raising possible implications in future design of multicenter studies and of high field (3.0T and greater) MR technologies.

REFERENCES


KEY WORDS: Signal intensity, pixel intensity, MP-RAGE

Poster 68

Cerebral Perfusion in Alzheimer Disease Using Dynamic Susceptibility Contrast MR Imaging

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PURPOSE

A decrease in cerebral perfusion has been observed with SPECT and more recently with perfusion MR imaging in Alzheimer disease (AD). Although arterial spin labeling techniques are being applied to AD, the application of DSC perfusion with intravenous gadolinium contrast injection to investigate perfusion changes in AD has received only limited attention. It may be clinically advantageous to develop DSC further because the technique can be performed rapidly, provides cerebral blood flow (CBF), cerebral blood volume (CBV), mean transit time (MTT) maps, and is less sensitive to normal age-dependent reductions in blood flow. Moreover, recent approaches using a constant contrast infusion have made DSC MR imaging more quantitative by providing estimates of blood volume in the steady-state. The purpose of this study is to determine the feasibility of DSC perfusion MR imaging for the detection of qualitative CBV and CBF changes in subjects with AD with an overall goal of quantifying these changes with novel DSC MR techniques.

MATERIALS & METHODS

Seven subjects with AD (mean age 76.9 years) and six normal control subjects (mean age 71.5 years) were scanned on a GE Signa 1.5T MR unit. The imaging protocol included one relatively rapid gadodiamide bolus injection (65 µmol/kg at 3 mL/s) followed by a slow infusion (35 µmol/kg at 1 mL/s). These perfusion maps were normalized to standard MNI space and smoothed with a 10 mm FWHM Gaussian kernel using SPM5 [http://www.fil.ion.ucl.ac.uk/spm/]. A two-sample t-test was implemented voxel-by-voxel and thresholded at p < 0.0005 comparing the normal control group to the AD group for differences in CBV and CBF.

RESULTS

For the CBV comparison, the AD group showed hypoperfusion (relative to controls) in the posterior cingulate, lateral parietal cortex, and the left posterior para-hippocampal gyrus. The CBF comparison also showed hypoperfusion in the posterior cingulate (Table 1).

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<th>Table 1</th>
<th>A comparison of Cluster Level Statistics using SPM5 for AD vs CN Groups</th>
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<td>Perfusion Map</td>
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Conclusions

The data support DSC MR imaging as a viable means for measuring relative perfusion changes in AD. Future processing will include quantitative CBF maps obtained by scaling the calculated flow values using the steady-state infusion measurement.

KEY WORDS: Alzheimer disease, perfusion, DSC

Poster 69

Differences between Acute and Chronic Demyelinating Plaques in Patients with Multiple Sclerosis: A Diffusion Tensor MR Imaging Study

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PURPOSE

To investigate the apparent diffusion coefficient (ADC) and the fractional anisotropy (FA) values on the acute and chronic demyelinating plaques and surrounding normal-appearing white matter (NAWM) of patients with multiple sclerosis, using diffusion tensor imaging (DTI).

MATERIALS & METHODS

Fifty-nine patients (43 females and 16 males; mean age 42 years) with relapsing-remising MS and 21 healthy controls sex- and age-matched were study with conventional MR.
imaging and DTI (12 directions) at 1.5T scanner. The diffusion tensor images were postprocessed and similar regions of interest (ROI) were defined on the ADC and FA maps on the acute (n = 14) and chronic (n = 52) plaques, as well as on the surrounding NAWM. In addition, ROIs were placed on the NAWM symmetrical and contralateral to the plaques, as well as on the NAWM of the frontal, parietal, temporal and occipital lobes of the patients with MS and controls. The ADC and FA values were compared and the statistical treatment was done with student’s t-test.

**RESULTS**

There were no differences between the ADC and FA values on the acute and chronic plaques (p = 0.8155 and p = 0.2313, respectively) or between the surrounding NAWM of both plaques (p = 0.6898 and p = 0.1724). The FA values were significantly lower than surrounding NAWM, contralateral NAWM and NAWM of the four studied brain lobes in both chronic (p < 0.00001) and acute plaques (p < 0.00001). The ADC values were significantly higher on the acute (p < 0.00001) and chronic (p < 0.00001) plaques compared to all the NAWM areas measured.

**CONCLUSION**

The DTI does not show differences between the ADC and FA values on acute and chronic demyelinating plaques in patients with MS. Although the pathologic findings in these lesions are diverse, the DTI characterizes both of them as lesions presenting higher ADC and lower FA values than NAWM.

**KEY WORDS:** Diffusion tensor imaging, MR imaging, multiple sclerosis

**Poster 70**

**Normal-appearing White Matter in Patients with Multiple Sclerosis: Could the Diffusion Tensor Imaging Demonstrate Differences of the Fractional Anisotropy Values between the Brain Lobes?**

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**PURPOSE**

To investigate the fractional anisotropy values on the normal-appearing white matter (NAWM) of the different brain lobes in patients with multiple sclerosis (MS), using diffusion tensor imaging (DTI).

**MATERIALS & METHODS**

Fifty-nine patients (43 females and 16 males; mean age 42 years) with relapsing-remitting MS and 21 healthy controls sex- and age-matched were study with conventional MR imaging and DTI (12 directions) at 1.5T scanner. The diffusion tensor images were post-processed and similar regions of interest were defined on the fractional anisotropy (FA) maps in NAWM of the following brain lobes: frontal, parietal, temporal and occipital. The FA values were compared between the patients with MS and controls, and the statistical treatment was performed with student’s t-test.

**RESULTS**

The FA values of the NAWM in patients with MS were significantly lower than in controls in the frontal (mean FA 0.525 vs 0.571; p = 0.0025) and occipital lobes (mean FA 0.532 vs 0.589; p = 0.0002). No significant differences were seen on the temporal (mean FA 0.500 vs 0.521; p = 0.1898) and parietal lobes (mean FA 0.561 vs 0.583; p = 0.0870).

**CONCLUSION**

Patients with MS may show reduced FA values in the NAWM of the frontal and occipital lobes. This finding suggests that the extension of the disease could be better studied with DTI in comparison to conventional MR imaging.

**KEY WORDS:** Diffusion tensor imaging, MR imaging, multiple sclerosis
and cingulate gyrus. Significant differences in FA values in the insular cortex, thalamus, and corpus callosum and significant differences in ADC values in frontal white matter also were noted when comparing the SLE group with the fibromyalgia and normal groups.

**Conclusion**
The results of this study indicate significant differences in ADC and FA values in multiple regions of the brain in individuals with SLE compared to normal controls and patients with fibromyalgia. These alterations may be based on loss of tissue integrity as seen with processes such as demyelination. Diffusion tensor imaging may be of clinical utility in monitoring disease progress and in further understanding the pathogenesis of these disease processes.

**Key Words:** Lupus, fibromyalgia, diffusion tensor imaging

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**Poster 72**

**Longitudinal MR Imaging Findings in the Brain and Spinal Cord in Adult Polyglucosan Body Disease**

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**Purpose**
Adult polyglucosan body disease (APBD) is a rare progressive neurologic condition manifested by upper and lower motor neuron, urinary, and cognitive dysfunction. Disease onset is typically in the fifth or sixth decade, and significant time can elapse before accurate diagnosis. Pathologically, characteristic inclusions are seen in nerve and skin. Radiologic manifestations of APBD have not been extensively described, with only a few reports mostly limited to description of end stage disease. The purpose of this work is to further elucidate APBD imaging findings by presenting the longitudinal imaging findings over 13 years in a biopsy-proved case of APBD.

**Materials & Methods**
Serial MR imaging was evaluated in a female patient who first presented in 1993 (at 50 years old) with gait abnormalities. She had abnormal visual, sensory and brainstem evoked potentials. From 1996 to 1999 she was treated with steroids for presumed diagnosis of MS. Her spastic paraparesis and sensory level continued to worsen, with the presumed diagnosis of MS being entertained along with others, including adrenoleukodystrophy. The patient presented at our institution in 2006. Repeat MR imaging of the brain and entire spine was interpreted as suggestive of APBD. Nerve biopsy demonstrated the presence of polyglucosan bodies, and low glycogen branching enzyme was evident on fibroblast culture, establishing definitive diagnosis of APBD.

**Results**
The most recent MR findings revealed mild generalized cerebral and more pronounced brainstem and cerebellar atrophy. There was striking bilaterally symmetric T2 signal abnormality at the periphery of the medulla. Similar signal abnormality was present extending rostrally along the corticospinal tracts to the posterior limbs of the internal capsule. Additional symmetric signal abnormality was present at the dorsal pons, superior cerebellar peduncles and periventricular fourth ventricular region, including the dentate nuclei. Supratentorially, there was bilaterally symmetric periventricular T2 signal abnormality, including adjacent to the temporal horns, with more patchy signal at the deep and subcortical white matter. There was no restricted diffusion or abnormal enhancement. This constellation of findings is similar to other reported cases of APBD. Original brain scanning 13 years previously demonstrated only subtle periventricular signal abnormality. Subsequent exams showed progressive development of brainstem signal changes including corticospinal tract signal abnormality. Seven years previously, there was increase in signal abnormality at the margins of the lower brainstem and 4th ventricle, including the dentate nuclei. Accompanying this was progressive increased signal abnormality at the cerebellar peduncles, and hemispheric white matter bilaterally, including adjacent to the temporal horns. This appearance essentially defined the developed stage of the disease, with subsequent imaging demonstrating no significant changes. No abnormal contrast enhancement or restricted diffusion was present on the later exams that included these sequences. At the spinal cord, recent imaging revealed pronounced cord atrophy throughout. There was questionable subtle cord signal at cervical levels. Longitudinal analysis demonstrated progression of atrophy over the 13 year imaging interval.

**Conclusion**
The diagnosis of APBD remains elusive. However, with improved recognition of associated imaging findings, and better understanding of the longitudinal temporal evolution of these imaging changes, earlier diagnosis is likely.

**Key Words:** Polyglucosan, APBD

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**Poster 73**

**White Matter Lesions Involving the Cerebrocerebellum in Acquired Hepatocerebral Degeneration**

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**Purpose**
Acquired (non-Wilsonian) hepatocerebral degeneration (AHD) is a progressive, largely irreversible neurodegenerative syndrome which can occur in the setting of chronic liver disease and repeated episodes of hepatic encephalopathy. The most commonly described imaging findings on MR imaging are T1-weighted hyperintensities in the globus pallidus. White matter lesions in AHD are less often reported in the literature. We will illustrate several cases of AHD which specifically involve the white matter tracts of the cerebrocerebellum and discuss possible underlying pathophysiologic mechanisms based on the current understanding of this disease.

**Materials & Methods**
Serial MR imaging was evaluated in a female patient who first presented in 1993 (at 50 years old) with gait abnormalities. She had abnormal visual, sensory and brainstem evoked potentials. From 1996 to 1999 she was treated with steroids for presumed diagnosis of MS. Her spastic paraparesis and sensory level continued to worsen, with the presumed diagnosis of MS being entertained along with others, including adrenoleukodystrophy. The patient presented at our institution in 2006. Repeat MR imaging of the brain and entire spine was interpreted as suggestive of APBD. Nerve biopsy demonstrated the presence of polyglucosan bodies, and low glycogen branching enzyme was evident on fibroblast culture, establishing definitive diagnosis of APBD.

**Results**
The most recent MR findings revealed mild generalized cerebral and more pronounced brainstem and cerebellar atrophy. There was striking bilaterally symmetric T2 signal abnormality at the periphery of the medulla. Similar signal abnormality was present extending rostrally along the corticospinal tracts to the posterior limbs of the internal capsule. Additional symmetric signal abnormality was present at the dorsal pons, superior cerebellar peduncles and periventricular fourth ventricular region, including the dentate nuclei. Supratentorially, there was bilaterally symmetric periventricular T2 signal abnormality, including adjacent to the temporal horns, with more patchy signal at the deep and subcortical white matter. There was no restricted diffusion or abnormal enhancement. This constellation of findings is similar to other reported cases of APBD. Original brain scanning 13 years previously demonstrated only subtle periventricular signal abnormality. Subsequent exams showed progressive development of brainstem signal changes including corticospinal tract signal abnormality. Seven years previously, there was increase in signal abnormality at the margins of the lower brainstem and 4th ventricle, including the dentate nuclei. Accompanying this was progressive increased signal abnormality at the cerebellar peduncles, and hemispheric white matter bilaterally, including adjacent to the temporal horns. This appearance essentially defined the developed stage of the disease, with subsequent imaging demonstrating no significant changes. No abnormal contrast enhancement or restricted diffusion was present on the later exams that included these sequences. At the spinal cord, recent imaging revealed pronounced cord atrophy throughout. There was questionable subtle cord signal at cervical levels. Longitudinal analysis demonstrated progression of atrophy over the 13 year imaging interval.

**Conclusion**
The diagnosis of APBD remains elusive. However, with improved recognition of associated imaging findings, and better understanding of the longitudinal temporal evolution of these imaging changes, earlier diagnosis is likely.

**Key Words:** Polyglucosan, APBD
CONCLUSION
The pathophysiology of the white matter lesions involving the cerebrocerebellar tracts is uncertain. Possible mechanisms include myelinolysis from osmotic imbalance in liver disease, and gliosis or neuronal death from chronic exposure to toxic substances such as ammonia in portosystemic shunting. Although the reason for cerebrocerebellar involvement in AHD has yet to be fully understood, it may explain the eventual cerebellar atrophy seen in patients with severe liver disease.

KEY WORDS: Hepatocerebral, acquired, cerebrocerebellum

Poster 74
Intraventricular Lactate as a Marker of Idiopathic Normal Pressure Hydrocephalus: A Magnetic Resonance Proton Spectroscopy Study

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PURPOSE
Previous studies have suggested that the presence of intraventricular (iv) lactate demonstrated by magnetic resonance proton spectroscopy (MRPS) could be a marker of idiopathic normal pressure hydrocephalus (iNPH). This study aims to investigate if the presence of iv lactate could differentiate iNPH from other causes of dementia, as well as if it could be seen in patients with hydrocephalus caused by other etiologies.

MATERIALS & METHODS
We studied 22 patients with iNPH (15 females and 7 males; mean age 75.3 years), 26 patients with vascular or Alzheimer dementia (16 female and 10 male; mean age 75.3 years), 14 patients with obstructive hydrocephalus (nine female and five males; mean age 47.5 years) and 25 healthy controls age and sex matched (15 female and 10 males; mean age 77.2 years). All the patients were studied in a 1.5T scanner with conventional protocol and with multivoxel MRPS (PRESS technique; TE=135 ms). The integral values of the iv lactate and creatine (periventricular region) peaks were obtained. The integral iv lactate peak and the lactate/creatine ratio were compared between the groups and the statistical treatment underwent considering p>0.05 statistically significant.

RESULTS
IV peaks of lactate were seen in 95% of the cases of iNPH, 65% of the patients with vascular or Alzheimer dementia, 57% of the cases of obstructive hydrocephalus and 76% of the control patients (p>0.05). There was no significant difference between the integral values of iv lactate peak or the lactate/creatine ratios in the different groups of patients (p>0.05).

CONCLUSION
The presence of iv lactate demonstrated by MRPS is not a marker of iNPH. In addition, the integral values of iv lactate peak and the lactate/creatine ratios of patients with iNPH are similar to those seen in patients with dementia from other causes, obstructive hydrocephalus and healthy controls.

KEY WORDS: Idiopathic normal pressure hydrocephalus, magnetic resonance imaging, spectroscopy
Poster 75

Examination of Location Shift of Subdural Electrodes by Using Fusion CT during Extraoperative Invasive Video Encephaloelectrographic Monitoring

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PURPOSE
For extraoperative invasive Video EEG monitoring (IVEEG), it is important to recognize the accurate relationship between the subdural electrode position and the brain anatomy. Some patients who underwent implantation of subdural electrodes may show a shift in the electrode location by effusion and hematoma sometimes encountered in secondary surgeries. The purpose of this study was to examine whether fusion CT would provide accurate information on the relationship between electrode location and brain surface anatomy.

MATERIALS & METHODS
Three patients with a history of extratemporal lobe epilepsy underwent implantation of subdural electrodes. Plain CT was performed before and after the electrode placement. Two sets of 3-dimensional (3D) brain surface imaging with and without electrode images were constructed with 3D image analyses software (Virtual Place, Ver. 2.02, AZE, Japan). Electrode images on the brain surface were fused with preoperative 3D CT images in order to reduce artifacts due to the electrodes. We compared the electrode locations on these 3D CT (Fusion CT) images to the actual electrode positions in secondary surgeries.

RESULTS
Three-dimensional brain surface images with electrodes were successfully constructed. The difference in the electrode locations between actual findings and fusion CT images was within one-gyrus displacement. There was a case where the shift in electrode location was revealed by subdural hematoma before secondary surgeries.

CONCLUSION
Original Fusion CT imaging with IVEEG furnished accurate simulation for epileptic zone delineation on 3D brain surfaces prior to secondary resective surgeries.

KEY WORDS: Fusion CT, subdural electrode, IVEEG

Poster 76

Epileptic Syndromes with Complex Partial Seizures: Evaluation of Not Lesioned Corpus Callosum by Means of Diffusion Tensor Imaging and MR Spectroscopy

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PURPOSE
Transient hyperintensity on T2- and diffusion-weighted images in the splenium of the corpus callosum (CC) not associated with clinical symptoms, has been reported mostly in epileptic patients treated with antiepileptic drugs, up to now without any explanation. The aim of this study is to investigate the CC lacking in lesions on T2-weighted images of epileptic patients by mean of diffusion tensor imaging (DTI) (FA and avADC) and H-MRS and to correlate the data with clinical and therapeutic parameters.

MATERIALS & METHODS
Sixteen patients (4 males, 12 females, mean age 44.37 years, s.d. ± 10.58 years) affected by partial epileptic seizures were studied with: standard MR imaging, DTI (axial, coronal and sagittal plane; 25 different diffusion gradient directions) and H-MRS (single voxel located on both the amygdal-hippocampal regions and the splenium of the CC). The patients were grouped on the basis of: MR imaging structural abnormalities (lesioned or not lesioned), seizures frequency (high or low number of monthly seizures) and the treatment with carbamazepine (CBZ or not CBZ). FA and avADC maps were elaborated measuring with a ROI the values of: Genu,
body and splenium of the CC; amygdala and hippocampus (head, body, and tail) on both the sides. The values were compared with 10 normal subjects and within each subgroups.

RESULTS
Reduction of FA and increase of avADC were revealed in the affected amygdala and hippocampus of the lesioned patients compared with the control subjects. At hippocampal MRS sampling a statistically significative reduction of the NAA was found in lesioned group with respect to not lesioned one. In the CC there was a statistically significant reduction of the FA in the splenium (p = 0.044), and a not statistically significant trend in the body (p = 0.051) comparing the patients whole group with controls. In CBZ group with respect to the not CBZ there was a statistically significant reduction of FA values in the body (p = 0.001) an in the genu (p = 0.049). No statistical differences were found analyzing the avADC values. The MR spectroscopy sampling of the splenium of the CC showed a significant reduction of NAA in patients with high number of monthly seizures compared with controls (p = 0.021).

CONCLUSION
In our patients the lack of structural lesions associated with statistical variations of some DTI and MRS values indicates a functional effect of the epileptic status on the CC, confirmed by the presence of MRS alterations in patients with number of monthly seizures; doubts persist regarding the role of the CBZ. Even if other studies need to confirm our data, for a prognostic balance of the pharmacologic treatment of the epileptic patients it is recommended to add the sampling of the corpus callosum to standard MR sequences and to DTI and MRS studies of the critical regions.

KEY WORDS: Corpus callosum, epilepsy, diffusion tensor imaging-MR spectroscopy

Poster 77
Presurgical and Postsurgical Findings in Refractory Epilepsy Patients with Anterior Temporal Lobe Resection: Predictive Factors of Surgical Outcome

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PURPOSE
To determine if the presurgical and postsurgical findings after anterior temporal lobe resection (ATLR) in refractory epilepsy patients are predictive factors of surgical outcome.

MATERIALS & METHODS
Thirty-five refractory epilepsy patients with ATLR were reviewed retrospectively. All patients had temporal lobe seizures and were previously EEG-video monitored. MR exams were performed before and after surgery using specific epilepsy protocol that includes 1.5 mm slice coronal SPGR, 3 mm slice coronal FLAIR and T2-weighted centered in temporal lobe. Presurgical findings, the extent of resection, and postsurgical changes such as hemosiderin and malacia were evaluated. Annual clinical follow up was performed using International League Against Epilepsy criteria.

RESULTS
Twenty-three patients had mesial sclerosis, five patients had dual lesions, three patients had tumor lesions and in four patients MR images were normal. All patients with tumor lesions had good outcome while three of the four patients with normal MR imaging had seizures after surgery. Patients with mesial sclerosis showed good outcome in 67% of the cases. In 22 patients the anterior temporal lobe resection was complete though seven patients had seizures after surgery. In 12 patients, hyperintense hippocampus tail and/or body was present in the postsurgical studies although 58% of these patients were free of seizures after surgery.

CONCLUSION
Presurgical findings in refractory epilepsy are predictive factors of good outcome; however incomplete hippocampus resection was not a indicator of seizure recurrence after surgery.

KEY WORDS: Refractory epilepsy, anterior temporal lobe resection

Poster 78
Dynamic Thresholding: A Standardized Approach to Analyzing Functional MR Imaging Data in Individuals

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PURPOSE
Finding the appropriate statistical threshold for analyzing functional MR imaging (fMRI) data in individuals is difficult especially when it comes to clinical applications that require reliable functional diagnoses. As the level of activation varies considerably between different patients, measurements and scanning sessions established data evaluation strategies using fixed thresholds are inappropriate to precisely identify and localize the centers of activation as well as to reliably determine hemispheric dominance. Here a standard approach is presented to overcome these problems by adapting the evaluation to individual fMRI data sets by using a “dynamic statistical threshold.”

MATERIALS & METHODS
Examples are presented for dynamic thresholding of motor, somatosensory and language fMRI at 1.5T and 3T. Data analysis: BrainVoyager®. To achieve precise determination of the anatomical correlates of different functional activations the empirically proved cluster size of 36 mm 3 is applied. A very high statistical threshold for the correlation (r=1.0) between the measured BOLD signals and the hemodynamic reference function is selected first, no functional activation is displayed (EM). This threshold is continually reduced, the activation with the highest correlation to the hemodynamic reference function is displayed first (1). By further reduction of the threshold, activations in other functional areas with lower correlations between measured BOLD-signals and hemodynamic reference function are dis-
played in a hierarchical order (2-4). This procedure is con-
tinued until activations are detectable in all ROIs (e.g., pri-
mary motor cortex, Broca’s and Wernicke’s area). A threshold
of r=0.4 with p<0.05 was established as lower limit to
ensure that BOLD-signals are clearly distinguishable from
background noise. Language dominance is determined
according to the established equation: LI = (n Vx left - n Vx
right)/(n Vx left + n Vx right), where n Vx is the number of
activated voxels at a particular threshold (3, 4) (Fig 1).

RESULTS
By providing well defined clusters of 36 mm³ in volume
dynamic thresholding enables to precisely localize the cen-
ters of BOLD-activation, to determine the anatomical corre-
lates and to measure the corresponding BOLD-signals in
individual fMRI data. The method also enables to reliably
determine hemispheric dominance. Differences in the level
of activation between patients or measurements are not rele-
sant as long as the BOLD-activation is within the lower limit
(r=0.4; p<0.05).

CONCLUSION
During clinical routine fMRI dynamic thresholding proved
to be highly practical and has been applied in more than
3000 individual fMRI measurements conducted in approxi-
mately 500 neurosurgical, neurologic and psychiatric
patients and 150 volunteers.

KEY WORDS: Functional MR imaging, individual data, eval-
uation

Poster 79

Can Functional MR Imaging Select Patients with
Parkinson’s Disease for Deep Brain Stimulation
Treatment?

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PURPOSE
Parkinson’s disease (PD) can be treated with deep brain
stimulation (DBS), an expensive and invasive procedure. The
success rate is variable, and there are no definitive criteria
for its indication. Functional MR imaging is a noninvasive
method that can access the brain activity during motor tasks.
There is consistent data in the literature reporting the differ-
ces in PD patient’s brain activation pattern relative to nor-
mal controls. Our aim was to test if the surgical response is
related to activity in motor circuitry.

MATERIALS & METHODS
Seven right-handed severe PD patients, with previous right
pallidotomy waiting for DBS, were compared to controls
matched for sex and age. An expert neurologist examined
patients a week before surgery and after 6 months, with
UPDRS (parts II, III, IV, total, and all of them with selected
items), after oral medication (ON), and without it (OFF). We
used 1.5T MR scanner, EPI-GRE, 3.15 mm 2 voxels, 15 7
mm ACPC slices. The motor task consisted of right-hand fi
nger tapping, in event-related design. Each subject performed
the task in three independent sessions for test-retest purpos-
es. Data analysis included motion correction (XBAM), and
statistical inference based on GLM considering Volterra
expansion to model HRF (p=0.00001). Regions of interest
ROI) analysis was carried out in 9 regions, based in
Talairach atlas (SPM). The sum of chi-values (Wald test)
inside each ROI was extracted and correlated with clinical
outcome (UPDRS) using Pearson and Spearman tests. The
pre and posttreatment UPDRS status was compared using
Wilcoxon test. We considered significant p<0.05 and ten-
dency if p<0.1.

RESULTS
Six months after surgery patients improved motor part (III)
of UPDRS (p=0.018), and had a tendency to improve total
UPDRS OFF (p=0.090), and drug complications part (IV) of
UPDRS, for ON and OFF conditions (p=0.078). The activa-
tion in PD patients was similar, but tends to be larger than
controls. There was significant correlation for left primary
motor somatosensory cortex (SM1) with total UPDRS ON
(R=0.81); left SM1 and right globus pallidus (GP) with part
II (daily activities) ON (R=0.92 e R=0.76). There was also a
tendency for correlation of left SM1 with total UPDRS OFF
and part II OFF; right cerebellum with part III ON. With
selected items, there was correlation for left SM1 with total
UPDRS ON (R=0.83) and OFF (R=0.77), part III ON
(R=0.95), and OFF(R= 0.76), and part IV OFF (R=0.86); for
right GP with total UPDRS ON, and supplementary motor
area (SMA) with part III ON (R=0.78). There was also a ten-
dency for correlation for right GP with part III ON, and part
IV ON, and SMA with part IV OFF.

CONCLUSION
The correlation of functional MR imaging motor activation
pattern of contralateral SM1 and clinical outcome for DBS
implants, raises a chance for prediction of clinical outcome.
With a larger sample of patients, it may be possible to
improve specificity of this test, using secondary motor areas,
and refine the selection for candidates to DBS implants.

KEY WORDS: Functional MR imaging, Parkinson’s disease,
deep brain stimulation
**Poster 80**

**Presurgical Localization of Language-related Areas Using Functional MR Imaging**

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**PURPOSE**

Functional MR imaging (fMRI) using language tasks was performed in patients with potentially resectable brain tumors to avoid neurologic impairment during surgery near language-related eloquent brain areas.

**MATERIALS & METHODS**

Thirty-two patients (11 males, 21 females) with brain tumor underwent fMRI in the past 4 years for the present study. The patients’ ages ranged from 7 to 74 (mean, 44.8) years. Written informed consent was obtained from all patients. Verbal generation was performed as follows: patients listened to several words and repeated them to themselves without speaking. Patients were instructed on the procedure and rehearsed the task design. MR imaging was performed using a 1.5T scanner. A single-shot T2-weighted gradient echo-planar imaging (EPI) sequence was used for the fMRI scans, with a section thickness of 4 mm; TR/TE/flip angle, 6000/60 ms/60 degree; field of view, 22 cm; acquisition matrix, 128 x 128. To cover the whole brain, 24 contiguous axial sections, paralleling the bicomissural line, were acquired. Anatomical MR imaging was acquired using a spin-echo T1-weighted sequence. The task protocol followed an ON-OFF block design, in which the task was performed during the ON condition and stopped during the OFF condition. An “ON” condition and an “OFF” condition was defined as one set; four sets were defined as one series. All patients performed two series sequentially. “Functool and “Brain Wave,” which are capable of dealing with real-time fMRI, were used to analyze the data. Activation maps were calculated by comparing images acquired during each ON state with those acquired during each OFF state. Maps were thresholded to a correlation coefficient, which varied from 0.350 to 0.499 depending on the threshold for the optimal localization of the activation foci. Statistical data were overlaid in color on a registered set of coplanar anatomical MR images.

**RESULTS**

In 17 patients, the main activation was noted in the inferior frontal gyrus and the superior temporal gyrus. In 16 patients, the activation areas were on the left side; in one patient the activation area was on the right. No significantly activated areas were found in 15 patients. Activation occurred only during the first series in two patients, only during the second series in five patients, and during both series in 10 patients. The results of the present study were useful at surgery in the 17 patients that showed activated areas, because the activated areas could be preserved; in fact, none of these patients had postoperative language deterioration. The identification of activated areas using our approach could be done quickly and easily, but the positive rate of identification was not high. Therefore, the approach requires modification in order to increase the identification rate of activated areas.

**CONCLUSION**

This study demonstrates that the approach adopted was useful for the identification of language-related eloquent areas before surgery in patients with brain tumors. The method can be done quickly and easily. The fMRI results allowed safe resections to be performed.

**KEY WORDS:** Language-related areas, functional MR imaging, brain tumor

**Poster 81**

**Diffusion Tensor Imaging and Functional MR Imaging Studies in 3,4 Methylenedioxymethamphetamine Abusers**

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**PURPOSE**

3,4 methylenedioxymethamphetamine (MDMA) is known to cause toxic effects on serotonin pathway, resulting in memory and mood impairment in long-term user. Functional MR imaging studies allow for assessing cognitive abnormality that may not be identified on conventional anatomical imaging. The purpose of this study is to evaluate the working memory and possible white matter abnormalities in young MDMA users using functional MR and diffusion tensor imaging (DTI).

**MATERIALS & METHODS**

The study was approved by institute ethic committee. Fifteen MDMA (12 male, 3 female, aged 18-34 years) abusers with positive hair and urine tests were enrolled for MR study. Seven normal healthy nonabusers (6 male, 1 female, aged 24-30 years) also were included as controls. All subjects signed informed consent before participating in this study. MR imagings were acquired at a 3.0T MR system (Philips, Achieva, Best, Netherlands). The working memory was evaluated by immediate and delayed memory task. Functional activation maps were calculated by using Statistical Parameteric Mapping, version 5 (SPM5). As for DTI, 3D fractional anisotropy (FA) volume data sets of all subjects were normalized to a predetermined brain template by utilizing normalization function of SPM5. FA volume data sets of the MDMA abusers and normal controls were subsequently compared voxel-wise using one-tail t-test.

**RESULTS**

Significant increased activation was seen in the bilateral frontal, fronto-parietal lobes and hippocampus in MDMA users. Voxel-based comparison, with p-value set < 0.05, of FA maps between MDMA abusers and normal subjects showed clusters of decreased FA in the left superior-frontal lobe, left corona radiata, left inferior parietal deep white matter, the posterior sensory tract of the right internal capsule and the right cerebral peduncle. The largest cluster is located in the right internal capsule.
**Conclusion**

Our preliminary results suggest that MDMA abuser is associated with increased hippocampal and superior fronto-parietal activation during working memory task. This activation pattern might suggest working memory deficit with increased supplemental cortical activation which may appear before changes in cognitive performance, thus suggesting an early stage of neuronal injury following the use of MDMA. In DTI study, the results showed significant decrease of FA at different specific regions, suggesting that use of MDMA may cause multifocal white matter alterations. Whether it is related to certain neural circuitry remains to be investigated. The limitation of the study is that all the MDMA abusers were also multidevice users (such as ketamine, cannabis, etc.) users. Therefore, the functional change and white matter alterations found in this study cannot be attributed fully to the effect of MDMA.

**Key Words:** MDMA, diffusion tensor imaging, functional MR imaging

**Poster 82**

Quantification of Cerebral Blood Flow in Cognitively Unimpaired and Impaired HIV+ Patients by Pulsed Arterial Spin Labelling MR Imaging

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**Purpose**

HIV dementia is associated with early involvement of deep white and subcortical gray matter and later involvement of cortical gray matter. Although mechanisms leading to neuronal injury have not been fully identified, both viral and host factors are likely involved in the neurotoxic cascade that triggers neuronal injury and death. In this regard, it would be expected that perfusion abnormalities would be associated with or even precede brain structural changes. Nuclear medicine techniques and dynamic susceptibility contrast (DSC) MRI have demonstrated varying, sometimes inconsistent focal and global perfusion abnormalities in HIV+ patients. The only existing study using arterial spin labelling MRI (CASL), reported only measurements of cerebral blood flow in the caudate nucleus. The aim of this study was to employ pulsed arterial spin labelling MRI (PASL) to quantify cerebral blood flow (CBF) abnormalities of the whole brain in two subgroups of HIV+ patients.

**Materials & Methods**

A PASL method described by Wang et al. was implemented on a Siemens 3T Trio scanner, with the pulse sequence and postprocessing codes provided by Wang from University of Pennsylvania. Measurements were performed on 12 HIV+ patients on stable antiretroviral regimen and on 26 seronegative controls. HIV+ patients were classified as either cognitively unimpaired (n=5) or impaired (n=7). All subjects underwent a standard neuropsychological evaluation as previously reported by Marder et al. Cerebral blood flow (CBF) images were calculated off-line by a Matlab program incorporating SPM2 functions for image registration and perfusion calculations. Cerebral blood flow was compared among groups by ROI analysis of 10 different gray matter and white matter regions of the brain using student’s t-test.

**Results**

CBF values of gray and white matter observed in seronegative control subjects were in the reported range for normal humans (mean CBF range of white matter was 18-24 ml/min 100 g, and of gray matter 60-67 ml/min 100 g). CBF of cognitively unimpaired HIV+ patients, as compared to control subjects, was significantly reduced in frontal gray matter (p=0.018) and in the precuneus (p=0.003). Compared with seronegative controls, cognitively impaired HIV+ patients showed significantly reduced CBF bilaterally in the frontal (p=0.003 dx, p=0.006 sin)) and parietal white matter (p=0.011 dx, p=0.028 sin) as well as in the precuneus (p=0.002). The only significant difference between the two HIV+ subgroups was observed in the putamen, with lower CBF in the impaired group (p=0.025 dx, p=0.044 sin).

**Conclusion**

The normal range of CBF values in our control subjects suggests that the PASL sequence used is a reliable method for quantification of perfusion. Significant hypoperfusion, compared to controls, was found in multiple brain regions in both HIV cognitively impaired and unimpaired subjects. These findings extend our knowledge based on a previous DSC study that reported contrasting results for white matter; however, CBF values within the prior study were relative and thus difficult to interpret. Furthermore, the significantly reduced CBF values in the putamen of impaired HIV+ patients as compared to unimpaired patients suggest that putamen perfusion might serve as surrogate biomarker of HIV-associated cognitive disease progression.

**Key Words:** HIV, cerebral perfusion, arterial spin labelling MR imaging

**Poster 83**

Comparison of Metabolite Ratios Obtained on 1.5 and 3T MR Units in a Group of Healthy Volunteers

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**Purpose**

High field (≥ 3T) MR spectroscopy (MRS) is becoming more prevalent, both in clinical practice as well as within the research setting. MR spectroscopy is an accepted method for the evaluation and follow up of focal brain lesions. In clinical practice, metabolite ratios often are used as they are far less time-consuming to obtain compared to absolute metabolite concentrations. Previous experimental and in vivo studies have demonstrated differential T1-relaxation effects on brain metabolites; only a few studies have compared metabolic ratios obtained on MR units of different field strength. The purpose of this study was to evaluate for differences in measured metabolite ratios using spectra obtained on both 1.5T and 3T MR units in a group of healthy volunteers.

**Materials & Methods**

A comparison of metabolite ratios obtained on 1.5 and 3T MR units in a group of healthy volunteers was undertaken at University of Michigan, Ann Arbor. In vivo MR spectroscopy was performed using a 3.0 T Siemens Allegra MR scanner (Siemens, Erlangen, Germany) and a 1.5 T Siemens Symphony (Siemens, Erlangen, Germany) MR scanner. The purpose of this study was to evaluate for differences in measured metabolite ratios using spectra obtained on both 1.5T and 3T MR units in a group of healthy volunteers.
Materials & Methods

Eleven healthy volunteers (9 women, 2 men, aged 28-59 years, mean = 47.7 years) were examined on both a 1.5T scanner (LX EchoSpeed, GE Medical Systems) and a 3T scanner (Philips Achieva MRI system). The subjects were considered healthy after a clinical workup and all had a conventional pre and postcontrast-enhanced MR exam in addition to our routine MRS protocol. Two dimensional CSI MR spectroscopy was performed with the following parameters on the 1.5T scanner: 2D-CSI, PRESS, TR/TE 1000/144 ms, FOV 23, thickness 6 mm, interspacing 1.5 mm, matrix 16 x 16, scan time 4:20 minutes. Parameters on 3T included: 2D-CSI, PRESS, 8CH coil, SENSE, TR/TE 2000/144ms, FOV 240, matrix 16 x 16, scan time 5:20 minutes. Manually selected ROI (100 mm²) placed in the basal ganglia, frontal and parietal white matter were evaluated. The metabolic ratios NAA/Cr, Cho/Cr, Cho/NAA and NAA/Cho were calculated. Paired t tests were used for statistical analysis with a p value of < 0.05 deemed as statistically significant. Metabolic spectra were analyzed using scanner-compatible postprocessing software for the 1.5T and 3T datasets respectively.

Results

There were no significant differences in the obtained Cho/Cr ratios between 1.5T and 3T. NAA/Cr and NAA/Cho ratios were significantly higher (p > 0.05), and the Cho/NAA ratios were significantly lower (p > 0.05) on the 3T compared to 1.5T in all three anatomical areas.

Conclusion

Ideally, metabolite ratios should not have field strength dependence in clinical practice. Nevertheless, there are known differential T1 and T2 relaxation effects on the metabolic compounds, N-acetyl aspartate (NAA), choline (Cho) and creatine (Cr). Therefore the predicted relaxation factor for single metabolites and for metabolic ratios were calculated and considered to explain the observed discrepancy between 1.5 and 3T. While the predicted relaxation effects are consistent with a larger NAA/Cho and lower Cho/NAA at 3T, the degree of discrepancy cannot be solely attributable to relaxation. The present study demonstrates that other factors beside relaxation play a role. The spectral resolution of metabolites is better on 3T due to greater chemical shift dispersion thereby reducing inappropriate assignment of metabolite areas.

Key Words: MR spectroscopy, metabolite ratios, field strength

Poster 84

Differences of Peritumoral Edema of Meningiomas and Metastatic Brain Tumors on Diffusion Tensor MR Imaging

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Purpose

To prospectively compare the fractional anisotropy (FA) and mean diffusivity (MD) in peritumoral edema of meningiomas and metastatic brain tumors with diffusion tensor MR imaging.

Materials & Methods

The study protocol was approved by the local ethics committee, and written informed consent was obtained. Preoperative diffusion tensor MR imaging was performed in 15 patients with meningiomas and 15 patients with metastatic brain tumors. Regions of interest (ROIs) were placed in the peritumoral edema and normal-appearing white matter (NAWM) of the contralateral hemisphere to measure the FA and MD. Ratios of FA and MD were calculated for ROIs in relation to the NAWM of the contralateral hemisphere. Changes in peritumoral MD and FA, in primary values and ratios, were compared by using a two-sample t test. P < 0.05 indicated statistical significance.

Results

Mean MD values (×10⁻³ mm²/sec) in peritumoral edema were 0.896 ± 0.057 for metastases and 0.820 ± 0.094 for meningiomas. Mean MD ratios in peritumoral edema were 212.1 ± 23.5 for metastases, and were 193.1 ± 23.4 for meningiomas. Mean FA values in peritumoral edema were 0.148 ± 0.031 for metastases and 0.199 ± 0.052 for meningiomas. Mean FA ratios in peritumoral edema were 33.0 ± 6.0 for metastases and 46.0 ± 12.1 for meningiomas. Significant differences were found in MD values (P = 0.012), MD ratios (P = 0.035), FA values (P = 0.003) and FA ratios (P = 0.001) between metastases and meningiomas in peritumoral edema.

Conclusion

The peritumoral edema of metastatic brain tumors and meningiomas are different in MD and FA measurements on diffusion tensor MR imaging.

Key Words: Diffusion tensor MR imaging, meningioma, metastatic brain tumor

Poster 85

Evaluation of Coregistration Methods for Diffusion Tensor Imaging Data: Comparison of BCP Index in Tractography

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Purpose

Correcting echo-planar DWI is a critical procedure for reconstruction of white matter fiber pathways. Although various coregistration approaches have been proposed, they have not been evaluated based on the similarity of white matter fiber pathways. In the study, we proposed a quantitative index for comparisons of bundle-shape formalism.

Materials & Methods

A volunteer was scanned on a 1.5T Sonata system to acquire 13-direction transaxial DTI images. Isotropic spatial resolution was 2.2x2.2x2.2 mm³, b= 000s/mm² and TR/TE was 8900/95 ms. In this study, four correction methods [i.e., entropy correlation coefficient (ECC), normalized correlation coefficient (NCC), mutual information (MI) and normalized mutual information (NMI)], were conducted on raw DTI data to obtain four corrected DTI data sets. Fiber tracking was performed by using tensor deflection tractography with a fixed step size. To characterize the bundle-shape for-
nalism of the traced fiber tracts, a new morphology index, Bundle Curvature Profile (BCP), was proposed to capture the mean curvatures to represent the 3D fiber bundle shape. For each bundle, the BCP was computed by using a Loess regression method with a quadratic function on the curvature profile of fiber tracts. Wilcoxon Rank Sum test then was used to assess their similarity differences.

RESULTS
The upper-left panel of Fig. 1 showed the fiber tracts of corpus callosum by NMI method. Artifacts caused by geometric distortion were not corrected well in NCC method as indicated in colored vector-encoded FA maps in lower-left panel (white arrow), causing erroneous tracts in upper-right panel (blue arrow). The curvatures along all fiber tracts (purple dots) and BCPs (red curves) were given in lower-right panel. The mean (standard deviation) of BCP values in ECC, NCC, MI and NMI were 0.176 (0.033), 0.170 (0.034), 0.175 (0.035) and 0.176 (0.034), respectively. Among four BCP values, six pairs Wilcoxon Rank Sum tests were performed with family-wise and individual significance levels of 0.05 and 0.008. No significant differences were found among the other three ($p<0.008$), suggesting that ECC, MI and NMI are superior to NCC in correcting DTI data.

CONCLUSION
A novel index, BCP, was proposed as the basis to quantify the similarity between two fiber bundles. In this study, four coregistration methods provided by SPM2 were evaluated based on BCP index, and the results suggested that ECC, MI and NMI methods are more suitable for DTI data correction.

KEY WORDS: BCP, diffusion tensor imaging

Poster 86
Magnetoencephalography Reveals Somatosensory Deficit in Schizophrenia: A Selective-Attention Network Approach
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PURPOSE
We use magnetoencephalography (MEG) to identify networks that support somatosensory processing in healthy adults and to determine if these networks are dysfunctional in schizophrenia. In addition, we determine if neuronal responses in source-space during MEG somatosensory testing are related to the severity of symptoms in schizophrenia.

MATERIALS & METHODS
Human Subjects: Schizophrenia patients: Ten right-handed patients (8 males, 2 females) with chronic schizophrenia were studied. Average age 41.0 ± 12.5 years. Age-matched healthy control subjects: Nine right-handed subjects (7 males, 2 females). Average age 39.3 ± 13.9 years. Somatosensory Oddball Test for Selective Attention: Strong but painless electrical stimuli were presented to right and left median nerves. The entire oddball paradigm contains four blocks in which blocks one and three are the same, as are blocks two and four. In blocks one and three, 15% of the stimuli are delivered to right wrist and 85% to left wrist. Subjects count silently the rare stimuli to the right wrist and ignore the frequent stimuli to the left wrist. In blocks two and four, 85% of the stimuli go to the right wrist and 15% to the left wrist. After each block, the number of rare stimuli counted by the subject are recorded. Then, the MEG trials recorded by whole-head MEG system from blocks one and three are concatenated, as are the trials from blocks two and four. Eventually, on each wrist, 150 trials of rare MEG responses, and about 850 trials of frequent responses, are obtained and averaged to create two averaged files, one for rare and one for frequent responses. Then for each side, the rare and frequent MEG conditions are compared. Data Analysis: The rare-minus-frequent MEG responses were analyzed using multistart spatio-temporal multiple dipole modeling algorithm: downhill simplex searches are performed (a few thousands), for a given model order (i.e., the number of dipoles to fit).

RESULTS
Multiple sources were activated in both normals and schizophrenic patients during median-nerve oddball stimulation (rare minus frequent), including: left (contralateral) primary somatosensory (SI), secondary somatosensory (SII), supramarginal gyrus (SMG), dorsal premotor area (dPMA), dorsal lateral prefrontal cortex (DLPFC), ventral premotor area (vPMA), thalamus, midline supplementary motor area (SMA), anterior cingulate cortex (ACC), and right (ipsilateral) SII. The SMG, DLPFC, and ACC are a crucial part of the attentional network recently shown to be modality-independent by our group. Averaged dipole time-courses for healthy controls and schizophrenia patients for 5 key cortical sources were plotted. The key group findings: 1) MEG median-nerve oddball test evoked the same parietal-frontal attention network that was observed previously using auditory or visual stimuli. 2) MEG median-nerve oddball test reveals somatosensory specific deficits in schizophrenia patients: (a) hyperactivation in dPMA/M1, (b) hypo-activation in SII. 3) Deficits of the parietal-frontal network in schizophrenia patients by somatosensory stimuli (SMG, DLPFC, ACC).

CONCLUSION
1) As listed above, MEG demonstrates several significant differences between schizophrenic patients and normals, in cortical activations evoked by the median-nerve oddball test. 2) MEG deficits correlate with symptom scores in schizophrenia patients.

KEY WORDS: Magnetoencephalography, schizophrenia, somatosensory
**Poster 87**

**Diffusion Tensor MR Imaging in Temporal Lobe Epilepsy at 3T**

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**Purpose**

We have previously demonstrated the usefulness of diffusion tensor imaging (DTI) performed at 1.5T in localizing the seizure focus in temporal lobe epilepsy (TLE). In this study, we investigated the relative value of DTI in mapping the hippocampal formation (HF) in TLE patients at 3T resolution.

**Materials & Methods**

Seven subjects were recruited for the study (one bilateral independent TLE, one left TLE, two right TLE, and three control subjects with no TLE). The epileptic focus was defined by clinical history, interictal and ictal EEG recording. A 3T GE scanner was used to acquire seventeen 3 mm axial and/or coronal slices covering the temporal lobes. To determine the diffusion tensor fully, we collected DTI images along 25 different directions with b = 1000 sec/mm² as well as an image acquired without diffusion weighting (b = 0). The imaging parameters included: TR = 6000 ms, TE = 82 ms, FOV = 200 mm, 256 x 256, slice thickness 3 mm, and 2 acquisitions. We obtained the diffusivity (trace D) and anisotropy values from symmetrical voxels sampling the head of the HF bilaterally at 3 slice locations. Three different anisotropy maps also were evaluated: fractional anisotropy (FA), relative anisotropy (RA), and volume ratio (VR). The DTI measures were calculated using DTI-Studio (John Hopkins University). High-resolution structural T2-weighted images also were acquired at the same slice locations. We determined abnormal DTI values by comparing the above indices in the HF and temporal lobe white matter of the epileptogenic temporal lobes in the patient subjects vs HF and temporal lobe white matter in the control subjects.

**Results**

Group statistics revealed increase in the diffusivity values (D) in the HF of the TLE patient group compared to controls (0.0023 vs 0.0019; p < 0.05). The D values were not statistically different in the temporal lobe white matter between the two groups. FA, RA, and VR indices did not demonstrate statistically significant differences between the two groups in either the HF or the temporal lobe white matter.

**Conclusion**

Mean diffusivity values obtained with DTI at 3T are altered in the abnormal HF, and may play a role in presurgical evaluation of TLE patients and hence warrant further clinical investigation.

**Key Words:** Epilepsy, diffusion tensor MR imaging, functional MR imaging

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**Poster 88**

**Diffusion Tensor Imaging in Schizophrenic Patients: Preliminary Results**

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**Purpose**

The aim of this study is to investigate and localize the fractional anisotropy differences between schizophrenic subjects and control group.

**Materials & Methods**

Fifteen schizophrenic subjects and a control group of five subjects underwent diffusion tensor magnetic resonance imaging. Data was processed on a statistical parametric mapping program, using voxel based morphometry. Analysis were made both between groups and for each schizophrenic patient.

**Results**

In bilateral globus pallidus, caudate nucleus, posterior limb of internal capsule and in the genu of right corpus callosum, FA values were significantly reduced in the schizophrenic group. When each patient was analyzed seperately, three had widespread reduction of FA values. One patient showed decreased FA values in the right cerebral peduncle, and another patient in the parahippocampal gyri. Six patients showed no significant differences when compared with the control group.

**Conclusion**

Diffusion tensor MR imaging can provide information about the pathology of neural circuitry. Voxel based morphometry is a fast and reliable method to compare the DTI data and localize the pathology.

**Key Words:** Diffusion tensor imaging, schizophrenia

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**Poster 89**

**Anti-VEGF (Avastin) Therapy Monitoring in Recurrent Glioblastoma Multiforme Using Dynamic Contrast-enhanced (DCE) Imaging**

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**Purpose**

Dynamic contrast-enhanced MR imaging (DCEMRI) is a noninvasive tool used to estimate the degree of alteration in vascular permeability, and is approximated by Ktrans when the blood-brain barrier (BBB) is reasonably intact. It is unclear, however, what the most optimal metric derived from DCEMRI variables is to assess the therapeutic effect in brain tumor patients undergoing anti-angiogenic therapy. The purpose of this study was to determine the optimal quantitative variable that represents the alterations in vascular permeability and hence serve as a surrogate marker of antiangiogenic activity.
**RESULTS**

Five patients were categorized as PR and 3 were PD. The descriptive statistics had limited ability to characterize the change in the patients’ examinations, as they did not consistently represent with biological change. However, the histogram analysis demonstrating $K_{trans}$ pixel frequency, value, and distribution, showed to represent biological change in all eight of our patients (Fig.1).

**CONCLUSION**

Our study shows that a static measure of $K_{trans}$ alone is not sufficient to assess the dynamic changes in tumor vasculature that occur during and after therapy and to determine treatment response. Our preliminary result suggests that a histogram analysis of $K_{trans}$ on a pixel-by-pixel basis before and after therapy more accurately determines changes in tumor vasculature due to anti-angiogenic therapy.

**KEY WORDS:** DCEMRI, $K_{trans}$, therapy

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**Correlating Perfusion/Diffusion to Anatomy: A Clinical Study Assessing Automated Image Registration**

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**PURPOSE**

Diffusion-weighted imaging (DWI) and perfusion-weighted imaging (pMRI) are rapidly becoming part of routine imaging of brain tumors to provide functional information on tumor biology and complement anatomical MRI. However, both imaging techniques require correlation with anatomical images for accurate lesion localization and interpretation. The purpose of our study was to determine the accuracy of registration between DWI/pMRI and anatomical MRI by using an automated image registration algorithm.

**MATERIALS & METHODS**

For 65 patients, anatomical scan parameters from a GE Signa 1.5T MR scanner were: 3DSPGR, DWI, pMRI, Apparent Diffusion Coefficient (ADC) and the Negative Enhancement Index (NEI) images were computed from the diffusion- and perfusion- series, respectively. While qualitative evaluation was done with all results, 20 pairs were chosen for quantitative evaluation. Two clinical experts identified a set of anatomical and pathologic landmarks (Table 1). They independently denoted registered pairs [10 cases, each with SPGR-ADC and SPGR-NEI co-registered pairs]. Correspondences were recorded in a sequential manner alternating between co-registered anatomical and functional images. The misregistration between the recorded points was calculated on the basis of a mean squared measure and categorized based on reader 2. The pairs were registered using the multi-resolution registration framework. The algorithm was enhanced to first register the relevant functional scans with SPGR and use the result to transform the computed maps (ADC and NEI). The selection of an appropriate optimizer, leveraging DICOM patient reference information, and custom filtering by dynamic image thresholding led to a stable solution (Fig.1a). Registration accuracy was evaluated using an image comparison tool (Fig.1b), offering visualization capabilities and allowing selection of correspondences in orthogonal views.

**RESULTS**

The readers picked point correspondences (Table 1) to provide a total of 117 {SPGR-ADC} and 78 {SPGR-NEI} data points. The mean errors for SPGR-ADC registration were 1.58 mm and 2.43 mm for reader1 and reader2 respectively, inter-observer variability being 0.89 mm. Mean errors for SPGR-NEI registration were 1.2 mm and 1.46 mm with 0.59 mm inter-observer variability.
**CONCLUSION**
The results of our study show that a qualitative analysis of all 65 cases reported 85% success, and concluded that such co-registration provided much more information and would be of great help in surgical planning.

**KEY WORDS:** Registration, perfusion, diffusion

**Poster 91**

**Posterior Reversible Encephalopathy Syndrome in Solid Organ Transplantation**

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**PURPOSE**
To assess the clinical and imaging characteristics as well as frequency of posterior reversible encephalopathy syndrome (PRES) after solid organ transplantation (SOTx).

**MATERIALS & METHODS**
Patients who developed PRES after SOTx were identified retrospectively from the radiology MR imaging report data base assessed over an 8 year 8 month period and confirmed by image inspection. The type of transplant was noted and clinical timing and events surrounding the development of PRES were identified and tabulated. Clinical and imaging features were evaluated including blood pressure at toxicity and extent of brain edema graded on imaging studies at toxicity (1).

**RESULTS**
Overall, 26 patients were identified with PRES developing after SOT. PRES developed in 21 of 4061 SOTxs (0.52%) performed within the study period to include: Liver- 9 of 1423 (0.63%), Kidney- 5 of 1465 (0.34%), Heart- 2 of 306 (0.65%), Lung- 3 of 438 (0.68%), Kidney-Pancreas- 1 of 184 (0.54%) and Small Bowel- 1 of 56 (1.79%). These differences were not statistically significant. Five cases of PRES were identified in patients that were transplanted prior to the study period. Liver Txs typically developed PRES in the first 2 months after Tx and were associated with CMV antigenemia or systemic bacterial infection. Kidney Txs typically developed PRES 12 months or more after Tx and were commonly associated with bacterial infection or transplant rejection. The other Txs were more variable in timing and demonstrated a mixture of CMV expression, bacterial infection and/or rejection in association with PRES. Blood pressure at toxicity in liver transplants was usually near normal (average mean arterial pressure: 103 mmHg) with average brain edema grade 2.87. Blood pressure at toxicity in kidney transplants was typically markedly elevated (average mean arterial pressure: 143 mmHg) with average brain edema grade 1.44.

**CONCLUSION**
SOTs have a similar incidence of developing PRES but the time point of toxicity and clinical associations differ with the type of transplant. Infectious/immune-related sequella including CMV reactivation, infection and rejection appear to be common associations during the development of PRES after SOT. Early presentation of PRES in liver transplant may be related to disease severity and clinical debilitation at transplantation, innate immune suppressed state, increased risk of infection and immunogenic character of the liver. Late presentation of PRES in renal transplants may follow issues related to chronic organ rejection and nonspecific infection. Extent of brain edema in kidney transplants with PRES was half as great as in liver transplants with markedly elevated blood pressure at toxicity in the renal transplant patients. This observation parallels findings in patients with infection, sepsis and shock where less edema also was recognized in the severely hypertensive group (1). Elevated blood pressure may be a protective response in PRES.

**REFERENCES**

**KEY WORDS:** FK506 toxicity, cyclosporine toxicity, transplant
Neuroborreliosis: MR Imaging Findings in 12 Patients

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Purpose
Central and/or peripheral nervous system involvement (neuroborreliosis) is frequent in Lyme disease, and often the first presentation. White matter lesions on T2-weighted images have been well documented in patients with neuroborreliosis within the United States. We reviewed the MR imaging findings in our patients, and we focused our attention towards the presence of white matter abnormalities on T2-weighted imaging and FLAIR sequence.

Materials & Methods
In the period 2002-2006, 12 patients with proved neuroborreliosis underwent an MR examination. Thirteen MR examinations were performed, nine brain studies are included in this retrospective study. All examinations were performed on a 1.5T MR scanner, with following sequences: sagittal FFE T1-weighted imaging, axial TSE T2-weighted imaging, axial FLAIR and axial, sagittal and coronal SE T1-weighted imaging with gadolinium. A correlation was made with the clinical findings of the neurologist, serology and Western-blotting.

Results
The study contains 1 normal brain study. The presence of white matter lesions was evaluated on FLAIR and T2 images. Five examinations showed specific white matter lesions. On the T1 images after gadolinium administration, four examinations had cranial nerve enhancement; one left trigeminal nerve and facial nerve, one glossopharyngeal nerve, three patients with vestibulo-cochlear nerve and two patients with oculomotor nerve involvement. In our study one patient had a right hemispheric cerebellitis with leptomeningeal enhancement.

Conclusion
In our series of patients with proved neuroborreliosis, cranial nerve enhancement was a frequent observation. White matter lesions also were observed, but were in general more discrete and certainly not disease specific. Probably they represent age-related changes. Possibly this cranial nerve pathology we observed, which differs from the findings (white matter lesions) reported in the United States, could be caused by a different species of Borrelia in the endemic region; our hospital is situated in Belgium, Europe.

Key Words: Neuroborreliosis, MR imaging

Computed Tomography Perfusion Study in Differentiating Brain Abscess from Necrotic Tumor

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Purpose
To evaluate the usefulness of computed tomography perfusion (CTP) in differentiating between brain abscess and necrotic tumor.

Materials & Methods
Prospective study was performed in patients suspected of space-taking lesion in brain. CT perfusion was done at the suspected levels and postprocessing measurement of CBV, CBF, MTT, and PS were evaluated at ring-enhanced area, central nonenhanced area, edema, and contralateral normal brain.

Results
Seventeen patients with 21 lesions were studied. Of total 21 lesions, 12 were abscesses and nine were tumors. By comparing means, only MTT at the ring-enhanced area showed statistically significant difference between brain abscess and tumor (p = 0.009, 95% CI = 1.403 to 4.900). When ratio of CBF, CBV, and MTT of the ring-enhanced area and contralateral normal brain were analyzed (CBVr, CBFr, MTT), there were significant differences of CBVr and CBFr between the two groups (p = 0.003, 95%CI = -4.266 to -1.051 and p = 0.006, 95% CI = -9.934 to -1.969 respectively). With the threshold of CBVr more than or equal to 1.5 and CBFr more than or equal to 1, the sensitivity, specificity, positive predictive value, negative predictive value, and accuracy for diagnosis of tumor were 100%, 75%, 75%, 100%, and 85.7% respectively.

Conclusion
The CTP was shown to be useful in differentiating brain abscess from tumor. With CBVr less than 1.5, tumor can be excluded.

Key Words: Brain abscess, CT perfusion, necrotic tumor

Diffusion-weighted Imaging and Apparent Diffusion Coefficient of Intracranial Abscesses at MR Imaging

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Purpose
Although the differential diagnosis between intracranial malignant tumors and brain abscesses is frequently difficult with conventional MR images, brain abscesses showed markedly high signal intensity on diffusion-weighted images (DWI). It has been believed that the markedly high signal on
DWI resulted from the strongly reduced apparent diffusion coefficient (ADC). However, DWI contain mixed contributions from changes in T2, proton density, and ADC. In this study, we analyzed the ADC of intracranial abscesses to solve the reason for the high intensity of brain abscesses on DWI. Second, we compared the ADC for the inside of ring-enhanced abscess with normal brain, while some abscesses were higher than normal brain, and some abscesses were lower than normal brain. The ADCs of some abscesses were lower than that of normal brain, while some abscesses were higher than normal brain. The ADCs at nonenhanced cystic/necrotic lesion of glioblastoma were ranging from 0.631 to 1.221 X 10-3 mm2/sec (mean 0.907; median 0.952). The ADCs of some abscesses were lower than that of normal brain, while some abscesses were higher than normal brain. The ADCs at nonenhanced cystic/necrotic lesion of glioblastoma were ranging from 1.491 to 3.143 X 10-3 mm2/sec (mean 2.498; median 2.508). The ADCs at the nonenhanced cystic/necrotic lesion of metastatic tumors were ranging from 1.062 to 3.161 X 10-3 mm2/sec (mean 2.583; median 2.816). The distributions with ADC in brain abscesses were statistically lower than nonenhanced cystic/necrotic lesion of glioblastoma (p < 0.0001) and of metastatic tumor (p < 0.0001). The ADC values of edema with brain abscess were not statistically different from tumors.

**RESULTS**

All intracranial brain abscesses including three epidual abscesses and one subdural abscess showed high intensity on DWI. All nonenhanced cystic/necrotic lesion in glioblastomas and metastatic tumors except one patient showed low intensity on DWI. The ADCs of intracranial abscesses were ranging from 0.631 to 1.221 X 10-3 mm2/sec (mean 0.907; median 0.952). The ADCs of some abscesses were lower than that of normal brain, while some abscesses were higher than normal brain. The ADCs at nonenhanced cystic/necrotic lesion of glioblastoma were ranging from 1.491 to 3.143 X 10-3 mm2/sec (mean 2.498; median 2.508). The ADCs at the nonenhanced cystic/necrotic lesion of metastatic tumors were ranging from 1.062 to 3.161 X 10-3 mm2/sec (mean 2.583; median 2.816). The distributions with ADC in brain abscesses were statistically lower than nonenhanced cystic/necrotic lesion of glioblastoma (p < 0.0001) and of metastatic tumor (p < 0.0001). The ADC values of edema with brain abscess were not statistically different from tumors.

**CONCLUSION**

DWI was useful for diagnosis of all intracranial abscesses. The high intensity of abscess on DWI is not only caused by the restriction of diffusion but also caused by the T2 shine-through effect. Although the ability of DWI and the ADC to distinguish brain abscesses from ring-enhanced malignant tumors has been statistically confirmed, malignant tumors potentially showed high intensity on DWI and low ADC.

**KEY WORDS:** Abscess, diffusion-weighted imaging, apparent diffusion coefficient

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**Poster 95**

**Rare Sites of Intracranial TB in Immunocompetent Adult Patients**

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**PURPOSE**

To illustrate rare sites of intracranial T.B. in an immunocompetent adult patient.

**MATERIALS & METHODS**

Retrospective review of 3 immunocompetent patients, 2 males and one female, confirmed to have neuro-tuberculosis. The first patient 33 years old male presented with blurring of vision, seizure and confusion. The second patient 60 years old female presented with bilateral eyelid ptosis, fever, nystagmus with extra pyramidal signs on the right upper and lower limb. The third patient 42 years old male presented with intractable partial complex seizure. Clinical signs of meningitis were encountered in 2 patients and absent in one patient, CSF analysis was consistent with T.B. meningitis in 2 patients and negative in one patient. Tuberculin test was positive in 2 patients, negative in one. No history of contact to T.B. patient. All had MR Study of the brain 1.5T (GE Hi speed Milwaukee, SIGNA) system utilizing AxT1 (TR TR 566, TE11, 5mm thickness, 2mm gap, 256X192 matrix, FOV 21), Axial T2 (TR2350, TE 90, 5mm thickness, 2mm gap, 256X192 matrix, FOV 21), Axial FLAIR (TR 9000, TE 161, IT 2000, 5mm thickness, 2mm gap, 256X192 matrix, FOV 22), Cor T2 (5mm thickness, 2mm gap, 256X192 matrix, FOV 21), Sagittal T1 (TR 500 TE 11, 3mm thickness, 256X192 matrix, FOV 22 ), post contrast Coronal T1 (TR 500, TE 11, 5mm thickness, 2mm gap, 256X192 matrix, FOV 22), Coronal 3D SPGR (TR 30, TE 8, 2mm thickness, 0mm gap, 256X192 matrix, FOV 24), and Axial Flair (TR 9000, TE 161, IT 2000, 5mm thickness, 2mm gap, 256X192 matrix, FOV 22), and CT scan (hi-speed CTI) KV 120, ma 250, thickness 7mm, spacing 2mm, 0 tilt) both non-enhanced and enhanced Axial Tomogram were obtained.

**RESULTS**

The first patient found to have suprasellar enhancing mass involving the pituitary stalk and the optic chiasma in addition to enhancing lesion in the brain stem associated with basal meningitis. The second patient found to have diffuse T2 high signal intensity of the pontine isthmus and the mid brain with enhancing conglomeration lesions seen in the affected areas, with no evidence of basal meningitis. The third patient found to have Rt mesial temporal atrophy and markedly dilated Rt temporal horn as a result of previous Rt sided choroid plexitis that was associated with Rt hippocampal abscess and basal meningitis. First and the second patients showed both radiographic and clinical improvement with antituberculous treatment on follow up MRI studies. The third patient had Rt temporal lobectomy for his intractable seizure.

**CONCLUSION**

T.B. is a serious disease of global importance, isolated involvement of brain stem in adults is rarely encountered as well as involvement of the pituitary stalk, optic chiasma and the mesial temporal structures. Radiographic diagnosis may
be difficult in the absence of other classical signs of neurotuberculosis which warrant attention particularly in this geographical region.

**Key Words:** Intracranial, tuberculosis, rare

**Poster 96**

MR Characteristics of Dysembryoplastic Neuroepithelial Tumors

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**Purpose**
Dysembryoplastic neuroepithelial tumors (DNT) are supratentorially located cortical, mixed neuronal-glial tumors. They are the most common curable cause of partial seizures in children and young adults with cortical dysplasias and very convenient for epilepsy surgery with complete recovery of seizure. The differential diagnosis of DNTs from other cortical glial tumors and dysplasias, are critical for therapeutic planning. We defined MR imaging, spectroscopy, diffusion and perfusion characteristics of DNTs.

**Materials & Methods**
Twenty-two patients with DNTs and 14 healthy control subjects were prospectively evaluated by MR imaging, spectroscopy, diffusion and perfusion imaging before the surgical procedure. All patients had histopathologic confirmation. Besides MR imaging findings, NAA/Cho, NAA/Cr, NAA/Cho+Cr, Cho/Cr, ml/Cr ratios and apparent diffusion coefficients (ADC) and relative cerebral blood volume (rCBV) values were calculated and statistically compared with the results of age-matched control group by using independent sample t test assuming unequal variances for the survival data to assess significance of difference between parameters obtained tumors and normal tissue, by using SPSS release 11.0 program (SPSS for Windows; SPSS Inc., Chicago, IL). The correlation between different parameters was tested by two-tailed Pearson’s correlation coefficients. The mean difference was significant at the .05 level.

**Results**
All DNTs were solitary and located supratentorially. Ten of 22 DNTs had located in temporal lobe, eight in parietal and four in frontal lobes. They all placed in cortical and subcortical regions. All DNTs were isointense or slightly hyperintense relative to cerebral cortex on T1-weighted images and hyperintense on T2-weighted and FLAIR images. No prominent mass effect or peritumoral edema detected. Six of 22 DNTs had cystic appearance and one out of 22 showed prominent nodular enhancement after administration of contrast material. No significant difference detected in NAA/Cho, NAA/Cr, NAA/Cho+Cr and Cho/Cr ratios between DNTs and normal brain. Dysembryoplastic neuroepithelial tumors had significantly higher ml/Cr ratio (p<0.001) and ADC values (p<0.001), and relatively lower cerebral blood values (p<0.001) than those of normal parenchyma. Among significantly different parameters, ADC (r=0.910, p<0.001) had the highest correlation with tumor type following by rCBV (r=−0.794, p<0.001) and ml/Cr ratio (r=0.663, p<0.001).

**Conclusion**
Higher ml/Cr ratio and ADC values and lower rCBV values of DNTs help to differentiate them from cortical glial tumors, which had significantly higher rCBV and lower ADC values than normal parenchyma (1). Increase in ml/Cr ratio is an indicator of low-grade malignancy (2). Normal-appearing MR spectra with mild decrease in NAA/Cr ratio and increase of ml/Cr ratio in DNTs, which correspond histologically to WHO grade I, is consistent with the literature and helps to differentiate them from high-grade glial tumors (2). Furthermore these findings also provide to differentiate them from cortical dysplasias, which are disorganized normal parenchyma with similar ml/Cr ratio, ADC, and rCBV values to normal parenchyma.

**References**

**Key Words:** Dysembryoplastic neuroepithelial tumors, MR imaging, MR spectroscopy

**Poster 97**

Relative Cerebral Blood Volume Measurements of Low-Grade Gliomas Predicts Patient Outcome Better than Histopathology in a Multiinstitution Setting

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**Purpose**
To determine whether relative cerebral blood volume (rCBV) can predict patient outcome, specifically tumor progression and death, in low-grade gliomas (LGGs) at multiple, independent institutions.

**Materials & Methods**
Sixty-nine patients were studied with dynamic susceptibility contrast-enhanced perfusion MRI (DSC MRI) at both institutions. The pathologic diagnoses were: 34 low-grade astrocytomas, 20 low-grade oligodendroglioma, nine low-grade mixed oligo-astrocytomas, one ganglioglioma, and five with indeterminate histology. Wilcoxon tests were used to compare patients in different response categories (complete response, stable, progressive, death) with respect to baseline rCBV. Kaplan-Meier time-to-progression curves were generated. Log-rank tests were used to predict the association of CBV with survival and time to progression using both numeric values and binary indicator variables for rCBV (the latter refers to rCBV values greater or less than 1.75). Measurements of rCBV were obtained by choosing the highest regional intratumoral rCBV after excluding large intratumoral vessels.
RESULTS
The mean rCBV for patients with no adverse event (complete response or stable disease) was 1.71 ± 0.86 (mean ± SD), whereas that of patients with an adverse event (progressive disease or death) was 2.56 ± 1.52 (p value = 0.0138). There was no significant difference in rCBV values between patients with complete response and those with stable disease (p=0.583). However, there was a significant difference in rCBV values between patients with progressive disease and those who died of disease (p=0.0381). The odds ratio to assess the utility of rCBV for the detection of adverse events is 1.87 (95% confidence interval: 1.14, 3.08). Using the log-rank test, rCBV was significantly negatively associated with time to progression (p=0.0059 and 0.0057 for numeric and binary representations of rCBV, respectively). Furthermore, there was no indication (p>0.4) that the association of rCBV with time to progression was different at both institutions. The median time to progression among subjects with rCBV > 1.75 was 365 days (95% confidence interval: 355 to 742 days). While the median time to progression among subjects with rCBV < 1.75 could not be estimated (since more than 50% of these subjects were progression-free at time of last observation), there is 95% confidence that the median in this cohort is at least 889 days.

CONCLUSION
The current standard of histopathologic glioma grading has limitations. Consequently, the triage, treatment and survival statistics of low-grade gliomas remain unclear. Patients with misclassified gliomas may not receive optimum treatment. DSC MRI has been shown to be effective in predicting time to progression and in differentiating between high- and low-grade glioma at a single institution (3, 4). Our study suggests that cerebral blood volume measurements correlate more accurately with time to progression than initial histopathologic grading and that the findings can be replicated at multiple institutions, which supports the application of rCBV as an adjunct to pathology in predicting glioma biology and in determining optimum treatment.

REFERENCES

KEY WORDS: Low grade glioma, perfusion MR imaging, relative CBV

Poster 98

Improving Enhanced MR Imaging of Cerebral Gliomas: A Comparison of Gd-BOPTA and Gd-DTPA

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PURPOSE
The treatment of gliomas is dependent on accurate determination of the size and location of the lesion(s) and accurate assessment of lesion borders. Previous work has shown that contrast enhancement may underestimate the true extent of gliomas relative to T2 imaging, and that the success of surgical resection is highly dependent on accurate presurgical determination of tumor margins. We evaluated whether the high relaxivity contrast agent gadobenate dimeglumine (Gd-BOPTA) provides added benefit for treatment planning in patients with cerebral glioma compared to equimolar gadopentetate dimeglumine (Gd-DTPA).

MATERIALS & METHODS
Forty-seven patients with diagnosed cerebral gliomas underwent two MR examinations at 1.5T, one performed with 0.1 mmol/kg bodyweight Gd-BOPTA and the other with Gd-DTPA at an identical dose, each given at 2 mL/sec. The agents were given in randomized order with 2-7 days between MR examinations. T1-w weighted SE and T2w-weighted FSE sequences were acquired predose with post-dose repetition of the T1-weighted SE sequence. Acquisition parameters and post-ose acquisition time were identical for the two examinations. Three expert blinded readers independently evaluated all images for lesion border delineation, definition of disease extent, visualization of lesion internal morphology, lesion contrast enhancement and global preference. Differences were evaluated with the Wilcoxon signed rank test. Reader agreement was assessed using weighted kappa (κ) statistics. Quantitative lesion enhancement [% enhancement, lesion-to-brain ratio (LBR) and contrast-to-noise ratio (CNR)] was determined.

RESULTS
Gd-BOPTA was found to provide superior lesion border delineation, definition of disease extent, visualization of the internal morphology of the lesions and lesion contrast enhancement as compared with Gd-DTPA (p < 0.0001 for all assessments). Gd-BOPTA was preferred by readers 1, 2 and 3 in 24, 30, and 30 subjects, respectively, while Gd-DTPA was preferred in just one case for all three readers. Reader agreement ranged from κ = 0.49 (63.8%) for lesion internal morphology to κ = 0.68 (80.9%) for definition of disease extent. Quantitative enhancement was significantly greater after Gd-BOPTA (% enhancement and LBR: p < 0.0001; CNR: p < 0.004).

CONCLUSION
At a dose of 0.1 mmol/kg Gd-BOPTA resulted in significantly improved lesion delineation, better definition of tumor extent and internal morphology and greater lesion enhancement as compared to equimolar Gd-DTPA. The improved enhancement seen with Gd-BOPTA may facilitate improved interventional planning and better patient management.

KEY WORDS: Brain, glioma, contrast media
Poster 99

Interobserver Comparison of a New Measurement Technique for the Assessment of Metastatic Brain Lesions with Unidimensional Measurement, Bidimensional Measurement, and Volumetric Analysis

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PURPOSE

Manual segmentation is currently the gold standard for volumetric evaluation of metastatic brain tumors on MR imaging; however, this method is time-consuming and often impractical. Therefore, lesion volume is typically estimated by unidimensional or bidimensional measurements. These methods are also limited by correlation with volumetric analysis and ability to reproducibly estimate volume. The purpose of this study is to compare a novel linear measurement technique with established unidimensional and bidimensional techniques in estimating metastatic tumor volume accurately and precisely.

MATERIALS & METHODS

We prospectively compared unidimensional, bidimensional, and volumetric analysis measurements of 6 metastatic brain lesions by 16 physicians with experience treating brain metastases (8 neurosurgeons, 7 neuroradiologists, and 1 radiation oncologist). All measurements were made on T1-weighted axial MR images. Lesions selected were heterogeneous with regard to size, shape, and enhancement. Per lesion, observers determined greatest diameter on any single axial slice (unidimensional), greatest diameter and orthogonal (bidimensional), and circumscribed the lesion on every slice (volumetric analysis, calculated with institutional software). We also tested a measurement technique devised by our group (UNC criteria) which calculates volume by incorporating number of axial slices containing tumor and distance between adjacent slices (based on collimation thickness) with bidimensional measurements. Volumes derived from each measurement method were statistically compared.

RESULTS

Across all observers measuring all lesions, the correlation of UNC criteria-derived volume measurements with volumetric analysis (r = 94.5%) was significantly higher compared to respective correlation of unidimensionally derived volume measurement and volumetric analysis (r = 90.5%, p = 0.05) and correlation of bidimensionally derived volume measurement and volumetric analysis (r = 88.5%, p = 0.01). No difference was detected between correlation of unidimensional measurement with volumetric analysis and bidimensional measurement with volumetric analysis (p = 0.49). Regarding variability between all observers measuring all lesions, unidimensionally derived, bidimensionally derived, and UNC criteria-derived volumes demonstrated percentage-converted standard deviations (SDs) of 26.9%, 29.9%, and 20.6%, respectively. For comparison, volumetric analysis yielded a standard deviation of 14.6%, implying that changes in lesion volume greater than 2 SDs (29.2%) should be considered significant.

CONCLUSION

Clinical trials for metastatic brain tumors rely on lesion size change to assess treatment response. These changes traditionally have been evaluated by estimating tumor volume derived from unidimensional and bidimensional measurement techniques. However, there has been no formal comparison of accuracy and precision of these methods to the gold standard for volume approximation, volumetric analysis. We determined that both precision and accuracy of these established linear measurement techniques are not optimal. However, correlation of volumes derived from a new measurement technique (UNC criteria) with volumetric analysis-derived volumes and interobserver reliability for UNC criteria appear to be significantly better. Therefore, we propose that the UNC criteria, incorporating axial slice count and bidimensional measurement, may have greater efficacy than existing techniques for estimating metastatic tumor volume. Based on the ease of application and ability to teach observers to use this new method, in conjunction with accuracy approaching true volume and limited variability, the UNC criteria may prove very useful for brain metastases clinical trials.

KEY WORDS: Metastases, measurement, MR imaging

Poster 100

Tissue Assessment in Gliomas: Comparison of Tumor Blood Volume, Vascular Permeability by Perfusion-weighted MR Imaging and TI-201 SPECT

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PURPOSE

Thallium-201 (TI-201) uptake levels are useful in assessing the glioma. Factors involved in TI-201 uptake after intravenous injection of TI-201 include blood supply (blood volume), disruption of the blood-brain barrier (vascular permeability), and preservation of TI-201 inside the tumor cell. However, the major contributor to TI-201 uptake has not been clearly documented. Perfusion-weighted MR imaging (PWI), which provides blood volume and vascular permeability information, allows us to evaluate the degree of glioma malignancy. We hypothesized that increased tumor blood volume could be responsible for the corresponding TI-201 accumulation. In this study, we compared the tumor blood volume, vascular permeability information provided by PWI and the level of TI-201 uptake.

MATERIALS & METHODS

Nine patients with glioblastoma multiforme (GBM) were included. Early (15 min postinjection) and delayed (3 hr) scan images were acquired after TI-201 administration. Perfusion-weighted imaging was performed on a 1.5T MR scanner using a double-echo gradient-echo sequence to obtain a T1-bias-free estimate of the time-concentration curve. For TI-201 images, TI-201 uptake ratios of tumors to contralateral normal white matter (T/N ratio) were calculated for both the early and delayed scans. For PWI, index of tumor blood volume and index of vascular permeability
RESULTS
In the quantitative analysis, the T/N ratios (early) were well correlated with the index of tumor blood volume ($r^2 = 0.68$, $p < 0.01$). In the delayed image, there was also significant positive correlation between T/N ratios and the index of tumor blood volume ($r^2 = 0.65$, $p < 0.05$). However, no significant correlation between T/N ratio and K(trans) was found. In the visual assessment, the degree of tumor blood volume on the parametric map was concordant with the degree of Tl-201 uptake in both early and delayed Tl-201 images (Fig 1).

CONCLUSION
In this study, significant correlation between T/N ratios and the index of tumor blood volume was demonstrated on both early and delayed Tl-201 images. However, no significant difference was observed between Tl-201 uptake and K(trans). Although preservation of Tl-201 inside the tumor cell was not discussed in this study, our results support the hypothesis that increased tumor blood volume is at least one of the responsible factors for the corresponding Tl-201 accumulation.

KEY WORDS: Perfusion, Tl-201, permeability

Poster 101
Comparison of Contrast Enhancement of Brain Tumors at 3T versus 1.5T
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PURPOSE
To compare and measure the difference in contrast enhancement of brain tumors at 3T versus 1.5T MR scanners.

MATERIALS & METHODS
Twenty-seven consecutive patients with primary or secondary brain neoplasm who underwent gadolinium-enhanced MR imaging on both 1.5 and 3.0T MR scanners were identified. In T1-weighted sequences, the ratio of lesion signal intensity normalized to normal brain tissue was measured for each abnormality at 1.5T and 3.0T. These ratios then were compared across field strengths. In addition, images at 1.5 and 3T were visually inspected qualitatively by two neuroradiologists. Statistical analysis consisted of Wilcoxon signed ranks test.

RESULTS
Twenty-four out of 27 studies showed increased contrast enhancement ratio at 3T versus 1.5T. The average percent increase (pre versus postcontrast) in the lesion to normal brain tissue ratio was 70.31 at 1.5T and 131.65 at 3T. The increased enhancement identified at 3.0T compared to 1.5T was statistically significant ($P = 0.003$). There was no statistical difference ($P = 0.66$) between the 1.5 and 3.0T intensity ratios of unenhanced lesions. These measured ratios were in agreement with hypothesis that though gadolinium relaxivity decreases with increasing field strength it is the increase in the native T1 that results in the increase in the signal ratio at 3.0T MR scanners.

Contrast-enhanced coronal T1-weighted imaging at 1.5T (A) and 3T (B) shows increased contrast enhancement of focal right temporal lobe tumor (ependymoma) in this patient.

CONCLUSION
Due to increase in native T1 at higher field strength, enhancement of brain tumors is significantly greater at 3.0 versus 1.5T for a given gadolinium concentration. This result raises an important question of whether increasing clinical application of 3T MR imaging will help to improve evaluation of intracranial brain tumors after standard dose of contrast agent.

KEY WORDS: Brain tumors, contrast enhancement, magnet strength

Poster 102
Contrast-enhanced Susceptibility-Weighted Imaging of Intraaxial Brain Tumors
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PURPOSE
High-spatial resolution susceptibility-weighted imaging (SWI) is an emerging MR imaging technique providing complementary information of venous vasculature, hemorrhage, and iron in the brain. This imaging technique shows promise for evaluating brain tumors, with gadolinium enhancement in particular. However, its contrast of intraaxial tumors remains to be known, compared with conventional MR sequences. The purpose of this study was to estimate postgadolinium enhanced SWI in patients with intraaxial brain neoplasms, compared with conventional imaging.
**Materials & Methods**

A total of 17 patients (7 women and 10 men) with intraaxial neoplasms participated in this study. All MR imaging were performed on a 1.5T MR imager (Signa HD ver.12, GE Healthcare, Milwaukee, IL USA). MR imaging protocol consisted of conventional MR sequences, pre and postgadolinium enhanced SWI and postgadolinium enhanced 3D T1-weighted gradient-echo imaging. Imaging parameters of SWI were as follows: TR/TE = 53/40 ms, matrix = 384 x 256, bandwidth = 15.6 kHz, FOV = 240 x180 mm, slice thickness/gap = 1.5/0 mm, flip angle = 30° and number of average = 1. All SWI images were evaluated visually by two neuroradiologists, compared with conventional sequences and postcontrast 3D on a slice by slice. For quantitative analysis, major diameter of the brain tumor was measured on postcontrast SWI and 3D T1-weighted images.

**Results**

Both low and high signal structures, which were shown as enhanced areas on contrast-enhanced T1-weighted images, were observed at the pathologic lesion on postcontrast SWI images. Postcontrast SWI images showed bright enhancement (Fig, arrow) that suggested leakage of contrast material due to breakdown of the blood-brain barrier surrounding the intraxial tumors. Susceptibility-weighted images showed the edema surrounding tumors to the same extent, compared with T2-weighted and FLAIR images and revealed blood products more clearly than T2*-weighted images. Major diameter of the brain tumor had no statistical differences (Student’s t-test) between postcontrast SWI and 3D T1-weighted images; however, abnormal enhanced diameter was wider in postcontrast SWI images in any cases.

**Conclusion**

In summary, SWI clearly visualized the characteristics and architecture of brain neoplasms. This imaging technique provides more information in addition to conventional sequences and is useful for evaluation of intraaxial tumors in vivo.

**Key Words:** Susceptibility-weighted imaging, brain neoplasm, MR imaging

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**Poster 103**

**Depiction of Metastatic Tumors of the Brain by Contrast-enhanced Multishot EPI-FLAIR: Comparison with Spin-echo T1-weighted, Fast Spin-echo T2-weighted, FLAIR, and Contrast-enhanced Spin-echo T1-weighted Images**

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**Purpose**

To compare contrast-enhanced multi-shot echo-planar FLAIR images [MS-EPI-FLAIR(+) with spin-echo T1-weighted [SE-T1WI(-)], fast spin-echo T2-weighted (FSE-T2WI), FLAIR, and contrast-enhanced spin-echo T1-weighted images [SE-T1WI(+)] in depiction of metastatic tumors of the brain.

**Materials & Methods**

A total of 303 MR slices from 14 patients with metastatic tumors of the brain were included in the present study. Primary tumors consisted of lung carcinoma (n = 4), breast carcinoma (n = 4), colon carcinoma (n = 2), renal cell carcinoma (n = 2), carcinoma of the prostate (n = 1), and carcinoma of the adrenal gland (n = 1). Two experienced radiologists, as study coordinators, conjointly reviewed and selected these MR slices. The MR imaging protocol consisted of SE-T1WI(+), FSE-T2WI, FLAIR, SE-T1WI(+), and MS-EPI-FLAIR(+). For qualitative evaluation, receiver operating characteristic (ROC) analysis was performed. For ROC analysis, two different readers (reader A and B) separately scored each sequence for the presence or absence of tumors: 1, definitely absent; 2, probably absent; 3, possibly present; 4, probably present; and 5, definitely present. If there were more than 2 tumors in a slice, the largest tumor was scored. For each MR sequence, a binominal ROC curve was fitted to the confidence-rating data. Areas under the ROC curve (Az values) for each sequence were compared using a two-tailed Student’s t-test. For quantitative analysis, another radiologist randomly selected 47 tumors. Tumors with marked hypointensity due to hemorrhage were excluded. In SE-T1WI(+) and MS-EPI-FLAIR(+), regions of interest (ROIs) were set in the tumor and peritumoral regions. ROIs in the tumor were set including the center of the tumor. ROIs ranged from 16 mm² to 60 mm² in size. Intensity ratios (intensity of tumor divided by intensity of peritumoral region) were calculated and compared using a paired t-test between SE-T1WI(+) and MS-EPI-FLAIR(+).

**Results**

In reader A, the Az value of SE-T1WI(+), FSE-T2WI, FLAIR, SE-T1WI(+), and MS-EPI-FLAIR(+) was 0.81, 0.84, 0.83, 0.96, and 0.92, respectively. In reader B, it was 0.79, 0.73, 0.74, 0.98, and 0.95, respectively. Both readers achieved superior performance in visualization of metastatic tumors using MS-EPI-FLAIR(+) than SE-T1WI(-), FSE-T2WI and FLAIR (p < .01). There was no significant difference in Az value between MS-EPI-FLAIR(+) and SE-T1WI(+) on both readers (p = .045 for observer A, p = .027 for observer B). For quantitative evaluation, there was no significant difference (p = .14) in the intensity ratio between MS-EPI-FLAIR(+) and SE-T1WI(+). Tumors in the posterior fossa also were seen clearly on MS-EPI-FLAIR(+).
CONCLUSION
Detectability of brain metastases with Ms-EPI-FLAIR(+) is superior to that with SE-T1WI(-), FSE-T2WI or FLAIR, and is similar to that with SE-T1WI(+). MS-EPI-FLAIR(+) can offer an alternative to SE-T1WI(+) for follow up of treatment response in patients with brain metastases. The time-saving advantages of MS-EPI-FLAIR(+) are also a major advantage.

KEY WORDS: EPI, FLAIR, metastasis

Poster 104
Apparent Diffusion Coefficient in Sellar and Parasellar Lesions Evaluated by Single-shot Fast Spin-echo Diffusion-weighted Imaging

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PURPOSE
We determined the utility of diffusion-weighted imaging for the diagnosis of sellar and parasellar lesions using single-shot fast spin-echo diffusion-weighted imaging (SSFSE-DWI) technique that is insensitive to susceptibility artifacts of the skull base.

MATERIALS & METHODS
Thirty-two patients were examined with MR imaging including pre and postcontrast coronal/sagittal T1-weighted, coronal T2-weighted, and SSFSE-DWI during the last 4 years at our institution. Patients include 13 with pituitary adenoma, five with Rathke’s cleft cyst, two with craniopharyngioma, two with arachnoid cyst, two with meningioma, two with metastasis, one with germ cell tumor, one with pituitary abscess, and four with lymphocytic hypophysitis. In all cases exclusive of lymphocytic hypophysitis, the final diagnoses were made pathologically by surgical specimens. Single-shot fast spin-echo diffusion-weighted images were acquired using the following scan parameters; TR/TE of 5000/72 msec, b value of 1000, 10 NEX, matrix size of 128 x 128, FOV of 20 cm, and section thickness of 4-5 mm with an intersection gap of 1.0 mm. The apparent diffusion coefficient (ADC) value measurements were performed from trace ADC maps by placing regions of interest (ROIs) over the tumors. ROIs measurements in the tumor demonstrated in the corresponding T2-weighted and contrast-enhanced T1-weighted imaging.

RESULTS
Single-shot fast spin-echo diffusion-weighted imaging provided diagnostic images with minimum susceptibility artifacts and enabled measurement of the ADC. The ADC values were obtained by pixel by pixel analysis. The ADC values were found to be symmetrically distributed in the corresponding regions. The ADC values were found to be greater in the adenoma group than in the metastasis and lymphocytic hyphophysitis groups. The ADC values were found to be greater in the adenoma group than in the metastasis and lymphocytic hyphophysitis groups. The ADC values were found to be greater in the adenoma group than in the metastasis and lymphocytic hyphophysitis groups.

KEY WORDS: Pituitary tumor, diffusion-weighted imaging

Poster 105
Comparison of MR Spectroscopy and Perfusion MR Findings among Patients with or without Concomittant Radiotherapy after Glial Tumor Operation

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PURPOSE
Evaluation of the residual tumor after glial tumor operation is an important feature to plan radiotherapy. Necrosis, edema and contrast enhancement of the cerebral tumoral region are the findings that can be seen on MR imaging of the patients under radiotherapy. It is important to find out whether these findings are caused by a relapsed tumor tissue or postradiotherapy findings to guide clinical follow up and treatment. We compared the MR spectroscopy (MRS) and MR perfusion (MRP) findings and searched their values on this differentiation.

MATERIALS & METHODS
We analyzed the data of 27 patients [age 19-72 years, mean 48 years; 19 (70%) were male] that 13 (48%) of those were preradiotherapeutic and 14(51%) of those were postradiotherapeutic [11 (40.7%) astrocytoma, 8 (29.6%) oligodendroglioma, 4 (14.8%) glioblastome multiforme and 4 (14.8%) oligoastrocytoma]. We performed perfusion and spectroscopy study on every patient.

RESULTS
Perfusion MR results were normal in 13 patients, depressed in two patients and increased in 12 patients. MR spectroscopy results were normal in 14 patients and increased in 13 patients. Choline amount in a very small segment was found to be increased in a postoperative, preradiotherapeutic patient but it was found to be a normal blood flow in this segment with perfusion MR imaging. But blood flows were found to be increased with perfusion MR imaging in all other patients in whom the choline amounts were found to be increased. We found a very strong, positive and statistically significant correlation among the spectroscopy and perfusion imaging modality results by bidirectional spearman correlation analysis (Spearman ρ = 88, p < 0.05).
CONCLUSION
MRS and MRP are useful and compatible modalities to diagnose the postoperative residual or postradiotherapeutical relapsed tumors.

KEY WORDS: MR spectroscopy, MR perfusion, postoperative glial tumor

Poster 106

Neuroimaging Features of Primary Intracranial Meningeal Sarcomas

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PURPOSE
Primary meningeal sarcomas are uncommon but highly aggressive lesions. We describe the neuroimaging findings of patients with primary meningeal sarcomas.

MATERIALS & METHODS
We retrospectively reviewed the CT and MR studies in 14 patients with histo-pathologically proved primary meningeal sarcoma. The lesion location, tumor characteristics and enhancement pattern were evaluated.

RESULTS
Twelve out of fourteen tumors had radiologic features of an extra-axial mass lesion. One patient presented with subdural hematoma and one had features of an intra-axial mass. Precontrast, the tumor was hypointense or isointense on T2-weighted images. Heterogeneous enhancement pattern was noted in ten patients (71.4%) with areas of tumor necrosis, and hemorrhage was seen in two patients (14.2%). Invasion into the adjacent brain parenchyma was present in nine patients (64.3%) and there was contiguous bony destruction in six patients (42.8%). Although thirteen patients underwent surgical resection and radiotherapy, 1-year survival rate was only 35.7%.

CONCLUSION
Meningeal sarcoma is a malignant neoplasm with a high mortality rate. Neuroimaging features of necrosis, secondary brain invasion and bone destruction are common findings in primary meningeal sarcomas. However, these findings may overlap with those of meningiomas.

KEY WORDS: Meninges, sarcoma, CT, MRI

Poster 107

Comparison of Postcontrast T1 SE, T1 IR and 3D FFE for Intracranial Lesions at 3T

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PURPOSE
3T imaging is finding wider applications in neuroradiology, especially because of many desirable effects of increased signal to noise ratio (SNR) which can be traded for faster scan times or high-resolution imaging. However, it is still largely unclear as to which is the best T1-weighted imaging sequence to perform after gadolinium administration given the varying reports from different institutions, often in form of anecdotal examples. In this study we aim to compare and measure the difference in contrast enhancement of intracranial lesions on T1-weighted spin-echo (SE), T1 inversion recovery (IR) and 3D fast field-echo (FFE) at 3T.

MATERIALS & METHODS
We analyzed data from the last 6 months for patients who had brain MR imaging performed on 3T magnet (Achieva, Philips Medical Systems, Best, The Netherlands) using gadolinium-enhanced T1 SE, T1 IR and sagittal 3D T1 FFE sequences. Twenty-five studies performed in twenty-five patients were selected for comparison. Each of the selected studies showed an enhancing intracranial abnormality of neoplastic (n = 20), inflammatory (n = 2) or vascular (n = 3) etiology. Contrast ratio (defined as average region of interest (ROI) signal in lesion divided by average ROI signal in normal tissue) was measured on each of these three sequences. These ratios then were compared using ANOVA variance test. Images also were viewed qualitatively by two independent reviewers for overall quality of image and for total number of lesions seen on each of these sequences.

RESULTS
The average contrast ratio between lesion and normal tissue before contrast agent administration was 0.94. The contrast ratio after gadolinium administration was 1.739 on T1 IR, 1.754 on T1 FFE and 1.634 on T1 SE respectively and the difference was found statistically not significant (P > 0.22). However, on visual inspection the lesion depiction was found better in 4/25 studies (16%) and in 4/25 studies (16%) for performing this sequence. With increasing application of 3T in routine clinical imaging, the results of our study hope-
Posters

Poster 108

Efficacy of Contrast-enhanced MR Angiography for Noninvasive Optimal Vessel Analysis as a Means to Visualize Intracranial Arteries with Endoprostheses and Aneurysmal Clips

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PURPOSE
Noninvasive optimal vessel analysis (NOVA-VasSol, Inc., Chicago, IL, USA) is a MR procedure utilizing MR angiography (MRA) imaging with actual volumetric flow rates of intracranial arteries. NOVA MRA studies are increasingly being utilized to noninvasively follow patients with intracranial endovascular prostheses such as stents and coils and with aneurysmal clips. These materials interfere with accurately imaging their associated vessel by producing magnetic susceptibility artifacts which can produce signal loss and nonvisualization of the artery. In order for the NOVA studies to provide accurate volumetric flow rates of the arteries, localization of the specific arterial vessel from the MRA images must be obtained for accurate analysis. Time bolus contrast-enhanced MRA is a method that can be used with the NOVA study to improve image quality of these vessels. Therefore, this study is to compare the precontrast NOVA with the timed bolus contrast-enhanced NOVA and correlate these studies with the conventional cerebral angiographic study.

MATERIALS & METHODS
NOVA studies were performed on a 1.5T MR scanner with the NOVA hardware and software package. Imaging of the brain consisted of a precontrast 3D time of flight (3D TOF) with maximum intensity pixel (MIP) images of the arterial vessels, postcontrast 3D TOF with MIP images and phase contrast flow quantification volumetric analysis pre and postcontrast. A test timing bolus scan using 3 ml of gadolinium was performed immediately prior to the postcontrast MRA to determine accurate timing for the contrast material to reach the intracranial vessels for the postcontrast 3D TOF. The postcontrast MRA was performed using 20 ml of gadolinium at 2 ml per second power injection followed by a 20 ml saline flush. The study consisted of 57 patients, 24 males and 33 females ranging in age from 36 to 79 years. All of these patients had underlying arterial stenosis and/or aneurysms that required a stenting and/or coiling endovascular procedure and/or aneurysmal clipping. They all had conventional cerebral digital subtraction angiograms before and after the endovascular and/or surgical procedure. Three diagnostic neuroradiologists interpreted the NOVA studies.

RESULTS
Time bolus contrast-enhanced MRA reduced the severity of the susceptibility artifact and allowed accurate delineation of the arterial vessel with stents and coils in 90% of the cases, demonstrated residual filling of aneurysms not evident on precontrast MRA, accurately delineated arterial stenosis, improved localization of the arterial vessel for volumetric analysis in the majority of cases resulting in slightly higher flow rates compared to precontrast analysis and closely correlated in 90% of the case with the conventional angiographic study. In the 10% of case where the postcontrast MRA did not adequately evaluate the arterial vessel, the problems were technical related to inadequate timing of the bolus and/or multiple endovascular material with aneurysmal clips.

CONCLUSION
Time bolus contrast-enhanced MRA is an extremely useful technique to help eliminate the magnetic susceptibility artifact from endovascular material and thus improving arterial vessel delineation and analysis. It correlates with the conventional cerebral digital subtraction angiogram in 90% of the cases.

KEY WORDS: Technique, MRA, bolus timing

Poster 109

Comparison of MR Perfusion and Diffusion Tensor Imaging Parameters Obtained on 1.5 and 3.0 Tesla MR Units in a Group of Healthy Volunteers

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PURPOSE
High field MR scanners (≥ 3 Tesla) are becoming increasingly available, which is particularly relevant in the context of advanced MR imaging techniques such as MR perfusion (PWI), diffusion tensor imaging (DTI) and functional MRI. The majority of published data and established reference values for these techniques come from studies performed on 1.5 T MR units; there are only few reports comparing measurements obtained on different field-strengths in the same subject population. This study aims to evaluate differences in measured values of cerebral blood flow (CBF), cerebral blood volume (CBV), apparent diffusion coefficient (ADC) and fraction anisotropy (FA) in healthy volunteers examined on both a 1.5T and a 3T MR scanner.

MATERIALS & METHODS
Eleven healthy volunteers (9 male, 2 female; age 28-59 years, mean 47.7 years) examined on both a 1.5T scanner (LX EchoSpeed, GE Medical Systems) and a 3T scanner (Achieva, Philips Medical Systems). PWI was performed with following parameters on 1.5T: GRE-SSEPI, FOV 22, matrix 100x100, TR/TE 2000/60ms, 14 slices, slice thickness 6mm, flip angle 60, 1 NEX, 36 dynamic phases and on 3T: FFE-SSEPI, 8 CH coil, SENSE 3, FOV 230, matrix 112x109, TR/TE 1500/50 ms, 19 slices, slice thickness 4.4, flip angle 40, 45 dynamic phases. CBV and CBF maps were generated on both the 1.5T and the 3T images and manually-drawn regions of interest

fully will have a wider impact on choosing the best imaging sequence for postcontrast T1-weighted images on 3T systems.

KEY WORDS: High field strength imaging, imaging sequence, contrast enhancement
sequences. The other simple techniques, like heavily overlaying the site of origin of the metal distortion with presaturation pulses and swapping phase and frequency directions can produce significant improvement and make a previously unreadable scan diagnostic.

**RESULTS**

This technique results in improved image quality and reduction of susceptibility artifact without an increase in imaging time.

**CONCLUSION**

The interplay of various machine parameters are used effectively to reduce the metal artifact and effect of these parameters on the spatial and contrast resolution of image and signal-to-noise ratio also is considered.

**KEY WORDS:** Artifacts, MR imaging

**Poster 111**

**Contrast Extravasation on CT Angiography and Contrast-Enhanced CT Predicts Mortality in Patients with Primary Intracerebral Hemorrhage**

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**PURPOSE**

To determine the significance of contrast extravasation on CT angiography (CTA) and contrast-enhanced CT (CECT) with respect to clinical and radiologic outcome.

**MATERIALS & METHODS**

All patients with primary intracerebral hemorrhage who underwent CTA and CECT from 1/1/2003 to 9/30/2005 were identified retrospectively. Two neuroradiologists independently reviewed admission noncontrast CT exams (NCT), CTA, and CECT for hematoma size and active contrast extravasation, as well as follow-up NCT prior to discharge/death. Univariate and multivariate logistic regression analyses were performed to evaluate the significance of various clinical and radiologic variables on clinical outcome and mortality.

**RESULTS**

Of 56 patients, contrast extravasation was seen in 24.1% of patients on initial CTA and in 17.9% of patients on initial CECT. Extravasation was observed on CTA/CECT up to 48 hours following symptom onset. Univariate analysis showed that presence and number of foci of extravasation on CTA and CECT, admission intracerebral hemorrhage (ICH) clinical score, Glasgow Coma Score (GCS), severity of hematoma and volume of hemorrhage on admission CT were associated significantly with mortality. On multivariate analysis, only contrast extravasation on CTA (p = 0.020) and on CECT (p < 0.001) independently predicted hospital mortality. Extravasation on CTA (p = 0.005) and CECT (p = 0.016) also predicted 30-day mortality.
CONCLUSION
Active extravasation on CTA and CECT in patients with primary intracerebral hemorrhage independently predicts mortality. Contrast administration during CT evaluation of patients with intracerebral hemorrhage is important not only to evaluate for underlying causes of hemorrhage, but also to prognosticate outcome.

KEY WORDS: CT, hemorrhage, extravasation

Poster 112
Feasibility of Superficial Temporal Artery as Input Artery in Cerebral Perfusion CT

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PURPOSE
Perfusion computed tomography (PCT) allows the generation of quantitative maps of cerebral blood flow (CBF), cerebral blood volume (CBV), and mean transit time (MTT). This technique requires the user to select input variables, including an arterial input function. It has been suggested that a diseased vessel should not be used as the arterial input; however, this may be problematic if the diseased vessel is not known or if there is multifocal disease. This study was designed to determine if the superficial temporal artery (STA) as input artery can generate accurate perfusion maps, with significant correlates for CBF, CBV, and MTT compared to anterior cerebral artery (ACA) as the input artery.

MATERIALS & METHODS
One hundred perfusion CT exams performed on 90 patients (51 females, 39 males) were reviewed retrospectively and postprocessed by one investigator at an Advantage Windows workstation using CT perfusion software (GE Medical Systems). From the existing perfusion CT examinations, color-coded CBF, CBV, and MTT maps were constructed. Values were derived by varying the input artery (e.g., STA versus ACA), and the effect on the mean CBF, CBV, and MTT values in 6 region of interests (ROI) (1 ROI in each ACA, MCA and PCA territory) were calculated.

RESULTS
All graphs of correlation between ACA and STA input arteries produced significant results with p < .0001. There was excellent correlation between ACA and STA in CBF values (pearson correlation coefficient of 0.96; concordance correlation coefficient of 0.96), in CBV values (pearson correlation coefficient of 0.97; concordance correlation coefficient of 0.97) and in MTT values (pearson correlation coefficient of 0.97; concordance correlation coefficient of 0.97). Linear regression lines produced strong agreement between ACA and STA [CBF (y = 1.03 x +0.65); CBV (y = 1.05 x -0.09); MTT (y = 0.92 x +0.21)].

CONCLUSION
Preliminary results demonstrate that using extracranial vessels (e.g., superficial temporal artery) as the input artery can generate comparable perfusion maps to intracranial vessels (e.g., anterior cerebral artery). This can be useful if the proximal intracranial vessels typically used for the arterial input are diffusely diseased (such as with diffuse vasospasm or atherosclerosis) or are not included in the FOV for the perfusion CT.

KEY WORDS: Perfusion CT, computed tomography, atherosclerosis

Poster 113
Brain MRI of Pseudotumor Cerebri: Neuroimaging Signs

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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 MRI have little predictive value for this disease. This study examines additional neuroimaging findings that may provide greater accuracy in the non-invasive diagnosis of PTC.

MATERIALS & METHODS
Patients presenting to our medical center with possible PTC over the past year were evaluated retrospectively (n=10). In all cases the clinical presentation included classical symptoms of PTC, with elevated CSF pressures documented by lumbar puncture. All patients also had brain MRI scans, including MR venograms (MRV). MR images were examined for parameters related to changes in intracranial pressure, including ventricular size, prominence of optic nerve sheaths, sellar and pituitary size, and stenosis of venous sinuses.

RESULTS
The ventricular system was normal or slightly small, but did not generally show classical slit-like narrowed ventricles. However, other abnormalities were detected in most cases, including diffuse or focal narrowing of the venous sinuses that could be detected not only on MRV’s but also on conventional MRI’s. Additional signs such as enlarged or empty sellas and optic nerve sheath prominence were also noted. Brain MRI’s showed no other abnormalities.

CONCLUSION
PTC can be associated with various neuroimaging findings on brain MRI that can be used in the non-invasive evaluation of this disease. These include narrowing of the venous sinuses, empty sella and optic nerve sheath prominence. 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, MR imaging, neuroimaging signs
Poster 114
Crossing Lesions of the Corpus Callosum

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Many disease processes can involve both hemispheres of the brain. Few of these diseases are able to begin in one hemisphere and actually cross to the opposite hemisphere by penetrating the corpus callosum. We present a pictorial essay of such diseases.

KEY WORDS: Corpus callosum, crossing lesions

Poster 115
Overnight Preliminary Head CT Interpretations Provided by Residents: Locations of Misidentified Intracranial Hemorrhage

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PURPOSE
The purpose of this study was to assess the performance of radiology residents in the interpretation of head CT images and to determine patterns of error in the detection of intracranial hemorrhage. Follow-up studies were also reviewed to determine if there was any adverse effect on patient outcome as a result of these preliminary interpretations.

MATERIALS & METHODS
Radiology residents prospectively interpreted 22,590 head CT examinations while on-call from January 1, 2002 to July 31, 2006. The following morning the studies were interpreted by staff Neuroradiologists and discrepancies from the preliminary report were documented. Patient charts were reviewed for clinical outcomes and any imaging follow-up.

RESULTS
There were a total of 1037 discrepancies identified of which 141 were due to intracranial hemorrhage. The most common types of intracranial hemorrhage that were missed were subdural and subarachnoid hemorrhage occurring in 39% and 33% of the cases respectively. The most common location for missed subdural hemorrhage was either parafalcine or frontal in location. The most common location of missed subarachnoid hemorrhage was in the interpeduncular cistern. There was one case of non traumatic subarachnoid hemorrhage that was not described in the preliminary report. Fourteen patients were brought back to the emergency department after being discharged for short term follow up imaging.

CONCLUSION
The proportion of discrepancies due to intracranial hemorrhage is not insignificant and is usually due to cases of subdural or subarachnoid hemorrhage. A more complete understanding of the locations of the missed hemorrhage can hopefully help decrease the discrepancy rate to help improve patient care.

KEY WORDS: Trauma, SDH, subdural hematoma

Poster 116
Predicting Which Conservatively Managed Subdural Hematomas Will Enlarge

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PURPOSE
Small asymptomatic subdural hematomas (SDHs) frequently are caused by trauma and often are managed nonoperatively with good neurologic outcome. Our goals were to determine the frequency and timing of enlargement of acute SDHs that are not immediately surgically evacuated as well as to identify factors associated with rehemorrhage.

MATERIALS & METHODS
Of 259 consecutive patients with acute traumatic SDH who were treated in the year 2004, 163 were managed nonoperatively. Their CT scans, imaging reports, and medical records were reviewed retrospectively. Parameters analyzed as possible predictors of rehemorrhage during nonoperative management were size of the SDH, patient age, midline shift, and presence and number of additional associated brain injuries such as parenchymal, epidural, or subarachnoid hemorrhage, calvarial fracture, and cisternal effacement.

RESULTS
The SDH enlarged in 12 (7%) of the 163 patients during conservative management. The median time to enlargement was 6.5 hours and the mean time to enlargement was 23 hours after CT diagnostics. SDH enlargement occurred within 69 hours after injury in over 92% of cases. Of the parameters analyzed, midline shift greater than 5 mm, 2 or more other types of brain injuries, and a patient age greater than 70 years old correlated significantly with SDH rehemorrhage.

CONCLUSION
Subdural hematoma enlargement occurs relatively infrequently, but specific factors including patient age, the presence of midline shift, and two or more associated brain injuries can be used to predict which SDHs will enlarge. Furthermore, repeat imaging with CT is most appropriate within 72 hours after injury.

KEY WORDS: Trauma, SDH, subdural hematoma

Poster 117
Changes of Morphology of Ulceration Plaque in Carotid Artery Received Stenting

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PURPOSE
Carotid ulceration plaque is a powerful risk factor for stroke and systemic vascular risk. The purpose of this study is to see the morphology of ulceration and its changes after carotid artery stenting (CAS) immediately and at follow up.
Materials & Methods
A total of 143 successful CAS in 124 patients from January 2004 to July 2006 were included. Ulceration plaque was identified in 92 arteries of 81 patients: 17 (21%) asymptomatic and 64 (79%) symptomatic. A residual ulcer immediately after CAS was detected in 56 (61%) of 92 arteries in 50 patients. Patients with less degree of stenosis (50-69% stenosis) prior to stent procedure (incidence 74%), a type-3 (incidence 53%) and type-4 (incidence 60%) ulcers, were more prone to have ≥50% residual ulcer (P = 0.035). Ulcers located distal to most stenosis site (incidence 67%) and ulcers extended outside of the imaginary lateral border of the normal carotid artery (88% incidence) were also more prone to have ≥50% residual ulcers (P = 0.000). Follow-up angiograms that were performed in 32 arteries of 29 patients with a mean duration of 10.1 months (range 3-28 months) after CAS showed that residual ulceration disappeared in 17 lesions (53%) and became smaller in 15 lesions (47%). Neointimal hyperplasia was observed in 7 lesions (22%), no significant restenosis occurred (restenosis range 18-46%) and no additional intervention was required.

Results
During follow up, no ipsilateral neurologic symptoms appeared in any of the 29 patients with a mean follow-up duration of 20.1 months (range 9-41 months).

Conclusion
Ulceration morphology and percentage of stenosis prior to stent procedure had an impact on ulcer coverage after CAS. Residual ulcers will disappear or improve eventually and do not cause embolic strokes with proper medication.

Key Words: Carotid artery, ulceration plaque, stenting

Poster 118
Diameter Measurement of Carotid Stenosis on CT Angiography Correlates Well with Percent Carotid Stenosis on Digital Subtraction Angiography
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Purpose
To correlate the millimeter diameter measurement of carotid stenosis on CT angiography (CTA) with the percent carotid stenosis calculated as per the North American Symptomatic Carotid Endarterectomy Trial (NASCET) criteria using measurements obtained from CTA and digital subtraction angiography (DSA) studies.

Materials & Methods
Two radiologists independently conducted retrospective review of CTA and DSA studies of carotid arteries performed in the past 3 years. The CTA and DSA studies were performed within 4 months of each other. The narrowest segment of each internal carotid artery was measured in millimeters from the CTA axial source images. The diameter of the distal internal carotid artery was measured beyond the carotid bulb where the vessel walls were parallel. Percent stenosis was calculated as per the NASCET criteria for each internal carotid artery from diameter measurements obtained from the CTA studies. Similarly, NASCET percent stenosis was calculated for each internal carotid artery from measurements obtained from the DSA studies. The millimeter diameter measurement of stenosis obtained from CTA was correlated with NASCET percent stenosis calculated from both the CTA and DSA measurements using regression analysis. Sensitivity, specificity, PPV, and NPV were calculated. Interobserver agreement also was assessed. The data also were stratified and analyzed separately by gender.

Results
Data has been obtained from analysis of 39 CTA and 33 DSA studies of carotid arteries. Regression analysis of NASCET percent stenosis calculated from CTA measurements as a function of millimeter diameter stenosis on CTA demonstrates an inverse linear relationship, correlating 1.4 mm to 70% and 2.5 mm to 50% NASCET percent stenosis (r² = 0.90). Regression analysis of NASCET percent stenosis calculated from DSA measurements as a function of millimeter diameter stenosis on CTA also demonstrates an inverse linear relationship, correlating 1.3 mm to 70% and 2.4 mm to 50% NASCET percent stenosis (r² = -0.72). The threshold diameter of 1.3 mm for the stenosis on CTA to indicate severe carotid stenosis (70% or greater) as per NASCET criteria on CTA has a sensitivity of 93%, specificity of 100%, PPV of 100%, and NPV of 96% (n = 39). Similarly, the threshold diameter of 1.4 mm for the stenosis on CTA to indicate severe carotid stenosis (70% or greater) on DSA has a sensitivity of 59%, specificity of 94%, PPV of 91%, and NPV of 68% (n = 33). Analysis of data from a greater number of patients will be performed.

Conclusion
The preliminary data demonstrates an inverse linear relationship between the millimeter diameter measurement of carotid stenosis on CTA and the NASCET percent stenosis calculated from measurements obtained on CTA and DSA studies. Analysis of data from a greater number of patients will be performed, but the preliminary data suggests that a prediction of NASCET percent stenosis of carotid arteries may be obtained from direct millimeter diameter measurements on CTA.

Key Words: Carotid stenosis, CT angiography, digital subtraction angiography

Poster 119
Relationship between Anterior Cerebral Artery Variations and Aneurysms Detected by MR Angiography
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Purpose
MR angiography (MRA) is able to evaluate the anatomical structures around the anterior cerebral artery (ACA) and anterior communicating arteries(AcoA). The purpose of this study was to investigate the relationship between anomalous variations of ACA and AcoA, and the presence of saccular aneurysms.
RESULTS
A total of 95 (13.1%) had vascular variations in vicinity of ACA and AcoA. Fenestration of the AcoA (6.7%, n = 49), unilateral A1 hypoplasia (3.6%, n = 26), fenestration of continuous A1-A2 segments (0.8%, n = 6), A1 fenestration (0.6%, n = 5), A2 fenestration (0.5%, n = 4), accessory ACA (0.3%, n = 2), azygous ACA (0.1%, n = 1), and A3 fenestration (0.1%, n = 1) were identified. Seventeen cases (2.3%) had an AcoA aneurysm; nine cases (52.9%) were accompanied with unilateral A1 hypoplasia, and two (11.8%) were accompanied with AcoA fenestration. Six (35.3%) were normal vessels. Thus, compared to cases with no anomaly, incidence of AcoA aneurysms was higher in cases of A1 hypoplasia (9 aneurysms/26 cases of hypoplasia) but not different compared to cases with other anomalies (2 aneurysms/94 cases).

CONCLUSION
Aneurysms of the AcoA region were associated with unilateral A1 hypoplasia but not with other AcoA-region variations.

KEY WORDS: Anterior cerebral artery variation, aneurysm, MR angiography

Poster 120
Automated Measurement of Cerebral White Matter Hyperintensities: Comparison with Visual Rating Scales and Relation with Age and Cognitive Performance

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PURPOSE
A reliable scoring method for cerebral white matter hyperintensities (WMH) will help to clarify the causes and consequences of these brain lesions. In this study we compared a fully automated quantitative measurement of WMH to established visual rating scales.

MATERIALS & METHODS
MR imaging of the brain was performed on 154 participants from the Utrecht Diabetic Encephalopathy Study. WMH were measured by an automated probabilistic segmentation method which algorithm is based on information from T1-weighted, IR and FLAIR images and uses the K-Nearest Neighbor (KNN) classification method based on both spatial information and voxel intensities. KNN generates probabilistic segmentations, showing the probability (in gray values) per voxel being part of a WMH (Fig). Corresponding volumes were calculated by summation over the probability image and multiplication with the voxel dimensions. This method was compared with visual scoring of deep and periventricular WMH (DWMH and PWMH) with the Scheltens and the Rotterdam Scan Study (RSS) scale. The reproducibility of the three WMH scoring methods and their relations with age and cognitive function, using linear regression analysis, were also assessed.

RESULTS
Automated measured WMH volume was related to visual WMH scores, although this relationship was less strong for patients with a high lesion load, particularly with the RSS DWMH scale. Reproducibility of the automated method was superior (ICC = 1.0), compared to the interrater agreement of the visual scales (ICC = 0.749-0.839). The association with age was most evident for the automated measured WMH volume (β = 0.43 (0.29-0.57)) (Table). All WMH scoring methods, except the RSS DWMH scale, correlated with cognitive impairments. Statistically significant relations, after adjustment for age, were found between automated measured WMH volume (β = -0.22 (-0.40- -0.06)) or Scheltens DWMH [β = -0.26 (-0.42- -0.10)] and information processing speed, and between RSS PWMH and attention and executive function [β = -0.19 (-0.36- -0.02)].

CONCLUSION
WMH measurements with this fast automated quantitative segmentation method are accurate and thus very suitable for use in large patient and population-based studies.

REFERENCES

KEY WORDS: White matter hyperintensities, MR imaging, automated segmentation
**Poster 121**

**Diagnosis and Management of Intracranial Aneurysms Using CT Angiography in Patients with Subarachnoid Hemorrhage**

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**PURPOSE**

CT angiography (CTA) has increasingly become the first imaging test to evaluate patients with subarachnoid hemorrhage, especially in the emergency department and in elderly patients with tortuous vessels. The current resolution of helical CT permits 3-dimensional visualization of the cerebral vasculature and adjacent structures. The purpose of this study was to confirm that CTA may replace digital subtraction angiography (DSA) as the initial diagnostic study of choice and aid in the therapeutic management of aneurysmal subarachnoid hemorrhage.

**MATERIALS & METHODS**

Retrospectively any patient with the history of a subarachnoid hemorrhage who underwent CTA or DSA and follow-up CTA or DSA over a 3-year period was included into the study. The follow-up CTA or DSA study had to be performed within 2 months of each other. A true positive result was considered when the CTA and DSA demonstrated the same aneurysm. A true negative result was considered when the CTA did not demonstrate any aneurysm that DSA had depicted. The medical records were reviewed to assess if therapeutic management was based on the CTA alone.

**RESULTS**

CTA was highly accurate in aneurysm detection with 90.2% (76.9-97.2) CI sensitivity and 87.0% (73.7-95.0) CI specificity for 90 patients that meet the above criteria. The overall accuracy was 0.886 (0.800 to 0.944) CI. In a small subset of patients, therapeutic management was based on the CTA alone.

**CONCLUSION**

As expected, CTA is highly sensitive, specific, and accurate in detecting aneurysms in the proximal arterial locations and may allow for the pretreatment evaluation for the majority of cases of aneurysmal subarachnoid hemorrhage.

**KEY WORDS:** Aneurysm, CTA, subarachnoid hemorrhage

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**Poster 122**

**Comparison of Gadolinium-enhanced, Short-echo MR Angiography with Digital Subtraction Angiography in the Follow Up of Coiled Intracranial Aneurysms**

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**PURPOSE**

Conventional digital subtraction angiography (DSA) is the gold standard for follow-up evaluation of coiled aneurysms. However, MR angiography (MRA) provides a less invasive imaging modality for detection of residual aneurysm filling. We report our comparison of gadolinium-enhanced, short-echo MRA with DSA in the follow up of previously coiled intracranial aneurysms.

**MATERIALS & METHODS**

We prospectively obtained a centric phase encoded, 3D time of flight, contrast-enhanced MRA utilizing a short echo time (1.4 msec) with and without gadolinium in patients returning for DSA evaluation of previously coiled aneurysms. We evaluated these studies separately for the detection of a residual aneurysm neck or residual flow within the coil mass. Then, we compared results between MRA and DSA in individual patients.

**RESULTS**

Forty-two patients were evaluated, 31 anterior circulation, with average time to follow up of 164 ± 64.3 days. Residual filling was seen in 20 patients. MRA was falsely negative in three patients (Sensitivity 85%, Specificity 100%).

**CONCLUSION**

3D time of flight, contrast-enhanced MRA with short echo time is a minimally invasive alternative to DSA for follow-up evaluation of coiled intracranial aneurysms.

**KEY WORDS:** Aneurysm, MRA
Idiopathic Subarachnoid Hemorrhage and Venous Drainage: Are They Related?

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**PURPOSE**

Idiopathic subarachnoid hemorrhage (ISAH), also termed nonaneurysmal SAH, is a distinct form of nontraumatic SAH with a predominantly perimesencephalic pattern of hemorrhage and normal angiographic findings. SAH is considered idiopathic when nontraumatic and four-vessel angiography confirms the absence of aneurysms or other subjacent vascular lesions accountable as a source of hemorrhage. The etiology of ISAH has not been determined yet. Clinical and radiologic data as well as several studies suggest that the source of ISAH may be, in fact, venous and not arterial. Our purpose was to determine if there is a relationship between ISAH and midbrain venous drainage anomalies.

**MATERIALS & METHODS**

We reviewed a series of patients with idiopathic SAH attended in our Center and who underwent angiography. We assessed venous phase lateral projection images of selective carotid angiographies in 91 patients with diagnosis of ISAH from 1992-2004 searching for possible irregularities in the midbrain venous structures, expressly in the basal vein of Rosenthal (BVR). Midbrain venous drainage patterns were classified by two neuroradiologists and two neurosurgeons independently according to the classification established by Watanabe et al into three groups as: Type A or normal continuous (the BVR is continuous with the deep middle cerebral vein and drains mainly into the Galenic system), type B or normal discontinuous (discontinuous dual drainage, anteriorly to uncal veins and posteriorly to the vein of Galen (VG)), and type C or primitive (drainage mostly into dural sinuses instead of the VG). We correspondingly analyzed angiographies of a control group of 102 patients with nonaneurysmal SAH, is a distinct form of nontraumatic SAH with a predominantly perimesencephalic pattern of hemorrhage and normal angiographic findings. SAH is considered idiopathic when nontraumatic and four-vessel angiography confirms the absence of aneurysms or other subjacent vascular lesions accountable as a source of hemorrhage. The etiology of ISAH has not been determined yet. Clinical and radiologic data as well as several studies suggest that the source of ISAH may be, in fact, venous and not arterial. Our purpose was to determine if there is a relationship between ISAH and midbrain venous drainage anomalies.

**RESULTS**

Agreement for classification of type of midbrain venous drainage was moderate with mean kappa value of 0.70. Patients with idiopathic SAH had the primitive pattern of drainage of the BVR (41.8%) (any side type B or C) more frequently than those with aneurysmatic SAH (21.4%) (p < 0.001). Bilateral normal type A venous drainage was very infrequent among patients with idiopathic SAH (13%) while in patients with aneurysmatic bleeding the frequency was higher (48%) (p < 0.001). Primitive pattern of drainage was also more frequent among patients with perimesencephalic pattern of bleeding than the rest of patients suffering idiopathic subarachnoid hemorrhage (92% vs 80%).

**CONCLUSION**

The fact that primitive drainage of the BVR is more frequently present in patients with idiopathic SAH supports the theory of a venous origin of bleeding in these patients, although the physiopathology still remains unknown. The direct connection of perimesencephalic veins with dural sinuses could be a predisposing condition for sudden increases in venous pressure and consequent rupture and hemorrhage.

**KEY WORDS:** Idiopathic subarachnoid hemorrhage, venous drainage, perimesencephalic

Poster 124

**Role of 16-Row CT Angiography in the Assessment of Intracranial Aneurysms: Comparison with 3D Rotational Angiography and Conventional Digital Subtraction Angiography: Two Years’ Experience**

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**PURPOSE**

To evaluate the efficacy of 3D CT angiography (CTA) in the pretreatment assessment of intracranial aneurysms compared to 3D rotational angiography (RA), considered as the best supplement technique to 2D digital subtraction angiography (DSA).

**MATERIALS & METHODS**

During 2 years we evaluated 41 consecutive patients harboring 50 aneurysms (13 with SAH and 28 asymptomatic) by 3D CTA (GE Lightspeed 16 rows): in each case MPR average and MIP, and 3D thick slab and whole brain VR images were obtained after injection of 90 ml of iodinated contrast agent at 3 ml/sec. Each patient performed previously a 3D RA examination (Philips Allura). The results of both studies were compared after blind evaluation by two experienced neuroradiologists.

**RESULTS**

Three-dimensional rotational angiography allowed a better assessment of the aneurysms when compared to 2D DSA. Three-dimensional CT angiography, compared to 3D RA, in 35/50 lesions showed similar results regarding the site, size, shape, structure, and relationship of the lesions with parent and adjacent vessels. In five patients harboring aneurysms adjacent to bone structures 3D RA allowed a better and complete depiction of the morphology, compared with the limited results of 3D CTA VR images, due to artifact generated by the similar density of bolus-enhanced vessels. In four other cases, located in the cavernous ICA, the multiple 2D and 3D surface and VR CTA images allowed the demonstration of the precise relationships with the clinoid processes, that was fundamental for the surgical approach. In four cases 3D CTA permitted the identification and definition of intraneurysmal thrombus, not visible at 2D and 3D RA. Finally, in two cases 3D CTA images allowed the discovery of small (1.5 mm) aneurysms on the inferior wall of the ophthalmic carotid.
CONCLUSION
In our experience 3D CTA, compared with 2D and 3D RA showed similar, or better, accuracy in the assessment of intracranial aneurysms. It allowed a complete pretreatment evaluation in order to choose the best therapeutic option and provide all the data useful to the surgeon and/or interventional neuroradiologist for the treatment strategy. Moreover it is less invasive, with reduced risks for the patients, and cost effective, being an outpatient procedure. 3D CTA is similar to 3D RA in detecting cerebral aneurysms, and should be recommended in the initial evaluation and follow up of such patients.

KEY WORDS: CT angiography, cerebral aneurysm

Poster 125
Vertebral Arterial Calcification on CT: Analysis of High-resolution CTA Images Using 64 Multidetector Scanner
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PURPOSE
There have been few reports concerning vertebral arterial characteristics on diagnostic images in the past literature. The purpose of this study is to visualize vertebral arterial characteristics on diagnostic images, and to evaluate calcification of the intracranial vertebral artery on CT images, which could predict atheromatous plaque and narrowing of the lumen.

MATERIALS & METHODS
There were 270 consecutive patients (145 women and 125 men, from 32 to 88 (mean 65.5) years old who underwent 3D CTA using a 64 multidetector scanner. CTA was performed 18 seconds after bolus injection of contrast media (4 ml/sec), and all scans covered the area from the level of the first cervical spine to the distal MCA in each patient. Vertebral arteries in each patient were evaluated using 0.5 mm thickness axial source images and 0.5 mm thickness short axis images reconstructed by coronary artery analysis software on a workstation. Three experienced neuroradiologists evaluated 508 vertebral arteries (32 arteries were excluded for PICA terminal) for wall calcification and atheromatous plaque. Wall calcification was defined as positive when hyperdense objects of more than 400 HU were visualized in the arterial wall on any CTA images. We categorized calcification into three types based on their morphology (type 1: thin discontinuous or punctate, type 2: thin continuous or thick discontinuous, type 3: thick continuous or tubular). Plaque was defined as positive when intraluminal hypodense objects of less than 140 HU were visualized on any CTA images. On a workstation, luminal diameter was measured based on WASID criteria. Relationships between calcification, plaque, and narrowing of the lumen were evaluated statistically.

RESULTS
Wall calcification was detected in 109 arteries and plaque was detected in 117 arteries, respectively. Among 109 calcified arteries, CTA showed plaque in 80 arteries (73.3%), whereas CTA showed plaque in only 37 of 399 arteries (9.3%) without wall calcification. The finding of calcification on CTA images predicted plaque in the same artery with high specificity (92.6%) and negative predictive values (90.1%). The artery without calcification (n = 399) showed a mean 29.2% (SD 13.7%) narrowing of the lumen. The artery with type 1 calcification (n = 35) showed a mean 40.4% (SD 24.4%) narrowing of the lumen. The artery with type 2 calcification (n = 61) showed a mean 47.9% (SD 22.9%) narrowing of the lumen. The artery with type 3 calcification (n = 13) showed a mean 62.3% (SD 12.2%) narrowing of the lumen. There were statistically significant differences (one-factor ANOVA, P < 0.05) between the degrees of lumen narrowing in each group.

CONCLUSION
Calcification of the intracranial vertebral artery on CTA images showed high specificity and a negative predictive value for the existence of atheromatous plaque in the same artery. The shape of calcification correlated well to narrowing of the lumen.

KEY WORDS: CT angiography, vertebral artery

Poster 126
Automated Intracranial Hemorrhage Detection with Prior Knowledge
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PURPOSE
Intracranial hemorrhage (ICH) is a common consequence of traumatic brain injuries or acute neurologic disturbances. Intracranial hemorrhage is clinically diagnosed by experienced radiologists, who review brain images acquired with X-ray (CT) and search for the intracranial tissue that has a CT number within the range of acute bleeding. As manual reading is both subjective and laborious, it would be of considerable interest to have computer algorithms that perform this routine, especially in emergent settings where expert radiologic interpretation is not immediately available (1). The purpose of this work is therefore to develop a robust software system for automated detection of ICH.

MATERIALS & METHODS
We propose to detect ICH based on both CT numbers and prior knowledge. To apply the knowledge, which is defined with respect to the anatomy of the human brain, anatomy identification is required. Therefore, the method involves two stages: anatomy identification and CT number analysis. In the anatomy identification stage, we locate the bone structures by thresholding and morphologic operations (2). Then we identify brain tissue with close proximity to the bone, the interhemisphere fissure, lateral ventricles, and other structures where normal tissue has similar CT numbers to hemorrhage and thus false detection frequently occurs. In the CT number analysis stage, we begin with finding candidate ICH regions by employing an adaptive thresholding method, in which the thresholding window is adjusted according to the anatomical location of each voxel. Then based on t-test, regions significantly different from the neighboring tissue are detected as the real ICH.
RESULTS
We applied the method to 20 patients with ICH, and have gained promising results. The upper row of the figure below displays two original slices, while the lower row shows the extracted brain and the detected ICH. The solid arrow indicates the region detected as ICH. The dashed arrow points to a false positive region that would otherwise be detected as ICH if prior knowledge were not used.

CONCLUSION
We have developed a robust software system for automated detection of ICH with CT images, which holds a great promise in improving the efficiency of ICH diagnosis. Our future work involves utilizing both morphologic and anatomical information to further eliminate false-positive regions.

REFERENCES

KEY WORDS: Intracranial hemorrhage, computed tomography, image processing

Poster 127
Susceptibility-weighted Images Compared with Fast Spin-echo T2 and Gradient-echo T2*-weighted Images for the Screening of Familial Cerebral Cavernous Malformation
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PURPOSE
To compare susceptibility-weighted images (SWI), fast spin-echo (FSE) T2 and gradient-echo (GE) T2*-weighted MR images for the screening of familial cerebral cavernous malformation.

MATERIALS & METHODS
Fifteen patients (8 male and 7 female; mean age 33 years) of seven families with multiple cerebral cavernous malformations were studied. The exams were performed in a 1.5T scanner (Magneton Avanto, Siemens, Germany) with conventional protocol, including FSE T2-weighted images and GE T2*-weighted images. In addition, 3D susceptibility-weighted images (TR/TE = 57/40 ms; matrix 256 x 512 mm; slice thickness 2 mm) were obtained. The three sequences were reviewed independently by two neuroradiologists, who counted the number of cavernous malformations, defining the doubtful cases by consensus.

RESULTS
The mean number of cavernous malformations seen in the FSE T2, GE T2* and SWI were 13.4, 26.3 and 45.6, respectively. In addition, we subjectively observed that the lesions were larger on the SWI compared with FSE T2 and GE T2*-weighted images.

CONCLUSION
The SWI demonstrate more lesions than the FSE T2 and GE T2*-weighted images in patients with familial cerebral cavernous malformations. The SWI should be considered for the screening of families with cerebral cavernous malformation.

KEY WORDS: Cerebral cavernous malformation, MR imaging

Poster 128
Fusiform Aneurysmal Cerebral Arteriopathy Associated with HIV Infection in an Adult
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PURPOSE
Cerebrovascular involvement in HIV infection includes extracranial large vessel arteriopathy, vasculitis, embolic phenomena, hemorrhage, saccular aneurysms, intracranial arterial dissection, and fusiform cerebral aneurysms (1-3). The latter two presentations almost exclusively occur in the pediatric age group and have been described in adults in only two prior reports (1, 2). We would like to present an adult patient with diffuse fusiform cerebral arteriopathy and no evidence of subarachnoid hemorrhage, which, to our knowledge, has not been reported.

MATERIALS & METHODS
A forty-three-year-old female, with advanced HIV infection presented with seizures without clinical or CT evidence for subarachnoid hemorrhage. A CT angiogram demonstrated fusiform aneurysms of the distal right middle cerebral artery and the supraclinoid segment of the left internal carotid artery. These findings were verified by a cerebral arteriogram that additionally revealed similar involvement of the mid-basilar artery. Serial blood cultures for bacteria, fungi and mycobacteria as well as serologic tests for syphilis and histoplasmosis were negative. An echocardiogram showed no valvular vegetations to suggest septic embolization and presence of mycotic aneurysms.
RESULTS
The patient refused endovascular or surgical treatment. She was kept under antiviral and empiric antibiotic treatment. A 3-month follow-up CT scan with contrast demonstrated no change in size or configuration of the middle cerebral artery aneurysm or the size of the left supraclinoid carotid artery. She was neurologically unchanged at 3 months.

CONCLUSION
Fusiform aneurysmal arteriopathy in HIV patients is not exclusive to the pediatric age group and may be encountered in the absence of subarachnoid hemorrhage. As noted in our patient, these aneurysms may not regress under short-term conservative management.

REFERENCES

KEY WORDS: Cerebral aneurysm, HIV infection, mycotic aneurysm

Poster 129
Multi-Detector CT Angiography in the Evaluation of Nontraumatic Intraparenchymal Cerebral Hemorrhage

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PURPOSE
To evaluate the role of multidetector CT angiography in patients presenting to the Emergency Department with nontraumatic intraparenchymal cerebral hemorrhage.

MATERIALS & METHODS
A retrospective study of 96 consecutive patients over age 40 who presented to the Massachusetts General Hospital Emergency Department from January 1st, 2004 to December 31st, 2005 with nontraumatic intraparenchymal cerebral hemorrhage, and were evaluated with a noncontrast head CT examination followed by a CT angiography examination of the intracranial circulation. Medical records were reviewed for (1) gender, (2) age, (3) history of hypertension, and (4) evidence of coagulopathy or anticoagulation. The noncontrast head CT and CT angiography examinations were reviewed by an experienced neuroradiologist to assess (1) hemorrhage location (infratentorial, deep gray matter, or lobar), and (2) evidence of a vascular etiology on CT angiography.

RESULTS
Mean patient age was 68 years (range 41 - 93 years), 54% of patients were female and 46% male. Sixty-six patients (69%) presented with lobar hemorrhage. Of these, in nine cases (14%) CT angiography demonstrated a vascular etiology (3 aneurysms, 5 arteriovenous malformations and 1 venous infarct). Of the 57 remaining patients in this group, 28 (42%) had hypertension, six (9%) had coagulopathy, nine (14%) had both hypertension and coagulopathy, two (3%) had hemorrhagic metastases, two (3%) had septic infarcts, three (4.5%) had evidence of amyloid angiopathy on subsequent MRI examination, and seven (10.5%) had no identifiable risk factors. Twenty patients (21%) presented with deep gray matter hemorrhage (4 thalamic, 16 basal ganglia). Of these patients, 19 had a nonvascular etiology: Thirteen (65%) had hypertension, one (5%) had coagulopathy, and five (25%) had both hypertension and coagulopathy. Only in one case (5%) CT angiography demonstrated a vascular etiology (2 arteriovenous malformations and 1 hemorrhagic PICA infarct). Overall, CT angiography demonstrated a vascular etiology for the intraparenchymal hemorrhage in 13 of the 96 patients (13.5%), six of which (46%) also had preexisting hypertension and/or coagulopathy.

CONCLUSION
CT angiography plays an important role in the evaluation of patients over the age of 40 who present to the Emergency Department with nontraumatic intraparenchymal cerebral hemorrhage, demonstrating a vascular etiology in 13.5% of cases, even in the setting of preexisting hypertension and/or coagulopathy. While the yield of CT angiography for vascular etiology is high in infratentorial and lobar hemorrhage (30% and 14%, respectively), it is comparatively lower for deep gray matter hemorrhage (5%). Cost-efficiency studies should be performed to confirm its utility in this last group.

KEY WORDS: CT angiography, intraparenchymal, hemorrhage

Poster 130
Demonstration of the Circumventricular Organs by Contrast-enhanced 3D FLAIR at 3.0 Tesla

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PURPOSE
To demonstrate the circumventricular organs on postcontrast FLAIR imaging.

MATERIALS & METHODS
MR imaging (MRI) was performed in five healthy volunteers under an IRB-approved protocol. MR imaging was performed at 3.0T using an 8-element 6-channel head coil. 3D FLAIR was performed using TR 10000 ms, TI 2650 ms, TE 210 ms, bandwidth 294 Hz. Geometric parameters were: 170-195 slices; 384 x 320 matrix, phase sense factor 2, slice sense factor 3. Acquired voxel size was 0.63 x 1.45 x 2.0 mm3 which was reconstructed to 0.47 x 0.47 x 1.0 mm3.
Scan duration was 8:40 to 10:00 minutes. 3D FLAIR was performed prior to contrast and following a slow 2-minute infusion of 0.3 mmol/kg GdDTPA.

RESULTS
Comparison of pre and postcontrast 3D FLAIR demonstrated enhancement in the expected locations of the following structures: area postrema, median eminence, organum vasculosum of the lamina terminalis, and the subfornical organ. The subcommisural organ was not clearly identified. Enhancement of the pineal gland and the choroid plexus of the lateral, third, and fourth ventricles also was noted.

CONCLUSION
The circumventricular organs are small midline neural structures which play a vital role in body fluid homeostasis. Unlike the rest of the CNS, the circumventricular organs are invested with permeable fenestrated capillaries and, hence, lack the blood-brain barrier found throughout the brain. Therefore, these structures should be demonstrable by contrast-enhanced MRI, although this has not been reported. Because of the communication of these organs with the CSF as well as the blood, it is likely that some of the contrast leaks into the adjacent CSF. It is well known that FLAIR is more sensitive to the presence of contrast in CSF as compared with T1 sequences. Furthermore, the 3D FLAIR sequence eliminates high signal intensity artifacts in the CSF spaces allowing for high resolution without such artifacts. The combination of these two factors allows for the reliable demonstration of these unique structures on postcontrast 3D FLAIR at 3.0T.

KEY WORDS: Blood brain barrier, cerebrospinal fluid, permeability

Poster 131
Anatomo-Clinical and Radiologic Approach of Diseases Involving Both Thalami
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PURPOSE
To assess and illustrate the pathologies more frequently affecting both thalami. To highlight thalamus anatomy and the many clinical syndromes that may result from its affection.

MATERIALS & METHODS
Clinical findings and neuroradiological features (CT, MR, Angio-MR and MRS) of 11 patients (7 females and 4 males) with bilateral simultaneously or subsequently thalamic lesions were retrospectively evaluated.

RESULTS
Many diseases can involve both thalami in a focal or diffuse way. In our series tumors (gliomas including a bithalamic glioma and lymphoma) and vascular pathologies (top of basilar artery syndrome, variant of Percheron artery occlusion and deep cerebral venous thrombosis) were the most frequent pathologies associated with simultaneously affection of both thalami. The clinical pictures included a wide spectrum of symptoms and signs and were related with specific affected thalamic nuclei and with the age of the patient. This situation reflects the role that this deep gray structure accomplishes in sensorial and motor function, but also in behavior, cognition, nociception, humor and motivation.

CONCLUSION
Involvement of both thalami although rare, is extremely interesting from a clinical and radiological view, because all cortical syndromes can be mimicked by thalamic lesions, especially when they are bilateral. Contribution of images to assess this entity is of great value to establish diagnosis, showing in many cases characteristic radiological findings such as in the bithalamic glioma.

KEY WORDS: Thalamus, thalamic nucleus
Poster 132

Bilateral Segmental Agenesis of the Vertebrobasilar Junction: Developmental and Angiographic Anatomy

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Purpose
Bilateral vertebrobasilar junction agenesis is an exceptional anatomical variation. The angiographic characteristics of this variant and its embryological mechanisms are described.

Materials & Methods
Two observations of bilateral agenesis of the vertebrobasilar junction are reported. A case of atheromatous disease of the vertebrobasilar junction is shown in order to highlight characteristics distinguishing such a lesion from the reported variant.

Results
In the two reported cases, the distal segment of both vertebral arteries (VA) and the proximal portion of the basilar artery (BA) are absent. In addition, distal connections of the BA with the posterior cerebral arteries (PCA) are also lacking. As a consequence, the remaining portion of the BA is isolated from its usual sources of blood supply, which is provided by a persistent carotid-basilar anastomosis. Figure 1 shows an oblique projection of the left carotid angiogram in the first case, in which blood supply to the isolated segment of the BA is provided by a persistent trigeminal artery (arrowhead).

Conclusion
The developmental mechanism underlying bilateral agenesis of the vertebrobasilar junction likely involves the anterior radicular artery of C1. This branch of the pro-atlantal artery normally becomes the adult distal VA and proximal BA. Figure 2 shows the components of the vertebrobasilar junction derived from the pro-atlantal artery (shaded area). The lack of cranial connection of the BA with the PCA may be secondary to the proximal vertebrobasilar agenesis and the resulting paucity of antegrade flow within the BA. Alternatively, the absence of both the proximal and distal connections of the BA could be the result of a similar, yet unknown developmental mechanism. From a clinical standpoint, this vascular anomaly was discovered incidentally in our two patients, a finding consistent with the assumed congenital nature of the variant.

Key Words: Anatomical variation, angiography, embryology

Poster 133

Imaging Findings of Glossopharyngeal Neuralgia due to Neurovascular Compression

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Purpose
Idiopathic glossopharyngeal neuralgia is rare and there have been few radiologic literatures. We evaluated preoperative imaging findings of the patients with glossopharyngeal neuralgia due to neurovascular compression.
MATERIALS & METHODS
This retrospective study included 10 patients (6 females and 4 males, 43-71 years of age). Eight patients had CTA, eight had CISS, eight had FISP or FLASH with contrast and two had MR angiography.

RESULTS
Neurovascular compression was confirmed surgically due to PICA in eight patients and AICA in other two. On preoperative imaging, all patients showed arteries close to the ninth, tenth and eleventh nerve complex. PICA with consistent superior loop formation around the supraolivary fossette was noted in eight patients. No remarkable configuration was noted in two patients whose nerves were compressed by AICA.

CONCLUSION
Preoperative CT and MR imaging were useful to visualize the artery close to the glossopharyngeal nerve. PICA with superior loop formation around the supraolivary fossette was characteristic in patients with neurovascular compression due to PICA.

KEY WORDS: Glossopharyngeal neuralgia, neurovascular compression, MR imaging

Poster 134
Probabilistic Diffusion Tensor Tractography of Human Spinal Cord and Spinal Nerves at 3T
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PURPOSE
Diffusion tensor tractography (DTT) of the spinal cord remains a challenge due to image distortions, inadequate resolution, subject’s motion and poor SNR. Thus, the fiber tracking is commonly limited to the spinal cord tracts. In the present study we demonstrate a probabilistic tractography (1) of the human spinal cord, extending the tracts towards the nerve roots.

MATERIALS & METHODS
Spinal cord studies were carried out on a 3T Philips Achieva MR system in 4 healthy subjects and 2 patients with intramedullary tumor (ganglioglioma, ependymoma). Seventy-five axial diffusion-weighted (DW) images (1.3x1.3x2 mm³, b=700 s/mm², 15 directions) were acquired using a single-shot spin-echo EPI sequence in 7.3 minutes and covered the entire cervical spine. To correct for the subject’s breathing motion, DW images were aligned against the b=0 s/mm² image using non-rigid registration (2). To estimate the fiber connectivity along the cord, axial regions of interest (ROI) were placed at the level of C1 and C6. The cervical nerves were tracked by placing a sagittal ROI laterally to the spinal channel, and an axial ROI either at the level of C1 or C6.

RESULTS
In the control subjects, probabilistic tractography revealed 81% of the cervical spinal nerves (Fig. 1A). The majority of the detected nerves emerged from the posterior root, while only 18% of the anterior roots were identified. Preserved fibres passing through the lesion, or pushed aside, were successfully reconstructed in the ganglioglioma case (Fig. 1B). In the ependymoma patient, no fibres passing through the axial ROIs were found. However, the combination of the sagittal and axial ROIs resulted in the reconstruction of the fibres displaced by the lesion.

CONCLUSION
Posterior roots are approximately three times as large as the anterior roots: this anatomical feature could partially explain why the posterior fibres are more frequently depicted in our study. Tractography of the cervical nerve roots together with spine may represent an important step towards more specific surgical planning.

REFERENCES

KEY WORDS: Spinal cord, diffusion tensor tractography, spinal nerve roots

ACKNOWLEDGEMENT
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**Poster 135**

**Landmarks for Identification of Broca’s Area in MR and CT Scans of the Head**

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**PURPOSE**

To interpret MR and CT images in patients with focal cerebral lesions in the frontal lobe, the identification of Broca’s area may be important. While its location is known to be in the inferior frontal lobe, the landmarks for identifying the precise location on axial images are less well known. We reviewed the relationship of Broca’s area to frontal lobe landmarks that are readily identified on axial MR and CT scans.

**MATERIALS & METHODS**

A consecutive series of functional MR imaging (fMRI) studies was reviewed to identify patients who had left hemispheric language dominance, no frontal lobe pathology and comparison CT and MR scans of the head. In the MR and CT studies, the Sylvian fissure and ascending rami, precentral sulcus, and inferior frontal sulcus were identified. The location of activation secondary to word generation was noted. The direction and distance between the edge of this activation and these landmarks was measured. The distances were tabulated for each landmark. In axial CT images, the cases in which the precentral sulcus and ascending rami of the Sylvian fissure were reliably identified without reference to images in other projections were counted.

**RESULTS**

Thirty-six patients were identified with the appropriate fMRI findings and MR studies; 16 of these patients had correlative CT scans. The MR studies included sagittal, axial and coronal images and T1 and T2 weighting. The CT images had 5 mm slice thickness and were acquired on either 4 or 16 slice conventional CT scanners using a helical acquisition. An area of activation in the inferior-posterior left frontal lobe was identified secondary to letter-word and antonym generation in each case. In relationship to posterior ascending ramus, activation was on average 15 mm cephalad (range 0 to 30 mm, median 14 mm). In relationship to the precentral gyrus, the activation was on average 11 mm anterior (range 0 to 28 mm, median 14.5). In two patients, the activation was immediately posterior to the precentral gyrus. On CT, the precentral gyrus was reliably identified in all patients (100%). The posterior ascending ramus was identified in 11 out of 16 patients (69%).

**CONCLUSION**

In axial MR or CT images, the region including the precentral sulcus to 3 cm anterior to it and the region from the top of the ascending ramus of the Sylvian fissure to 3 cm superior to it encompass Broca’s region. The precentral sulcus and posterior ascending ramus can be identified reliably in MR images. They can be identified in 100% and 69% of CT scans, respectively.

**KEY WORDS:** Anatomy, Broca’s area

**Poster 136**

**Estimation of White Matter Maturation during Childhood and Adolescence Using T2-weighted Imaging**

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**PURPOSE**

It has been suggested that structural maturation of the white matter of the brain, including an increase in the diameter and myelination of axons, continues from infant to children and early adolescents. We hypothesized that an increase of axonal diameter may be related with an increase of T2 relaxation time because most of water in the white matter is present in the axon and interstitial tissue. The purpose of this study was to investigate whether the signal intensity may change in the splenium of the corpus callosum on T2-weighted imaging during childhood and adolescence.

**MATERIALS & METHODS**

A total of 424 normal brain MR images were selected from the patients with minor neurologic disorders (211 women, 213 men; age range, 3-24 years). The regions of interest were drawn in each center of genu and splenium of the corpus callosum on T2-weighted images in order to obtain the genu-to-splenium signal-intensity ratio (G-S ratio). Linear regression analysis was performed to test whether the G-S ratio was changed with age. Kruskal-Wallis test was performed to test difference of the G-S ratio among older adolescents and adults (24 years old).

**RESULTS**

The G-S ratio was decreased significantly with age ($r^2 = .776, p < .001$) (Fig A), but its change was not associated significantly with gender ($p = .191$). No significant decrease of the G-S ratio over 16 years was determined (Fig B).
CONCLUSION
The G-S ratio gradually decreases during childhood and adolescence, suggesting maturation of the white matter.

KEY WORDS: Human development, brain, MR imaging

Poster 137

Developmental Anatomy of the Distal Vertebral Artery in Relation to Variants of the Posterior and Lateral Spinal Arterial Systems

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PURPOSE
A certain number of anatomical variants involving the distal vertebral artery (VA) are explained by variations in size and connection of the lateral spinal artery (LSA). This report looks at the possible role of another branch of the VA, the posterior spinal artery (PSA), in the development of similar vascular variations.

MATERIALS & METHODS
Four types of distal VA variations, including the C1 and C2 origins of the posterior inferior cerebellar artery (PICA), the duplication of the distal VA, and the aberrant course of the distal VA, are illustrated by nine angiographic observations.

RESULTS
For each type of VA variant listed above, examples resulting from variations in size and connection of the LSA and PSA could be matched. Fig 1A, 1B, and 1C show the normal anatomy of the PSA, and its role in proximal origin of the PICA and VA duplication, respectively. Figure 1D, 1E, and 1F show the normal anatomy of the LSA, and its role in proximal origin of the PICA and VA duplication, respectively.

CONCLUSION
Variation in size and connection of the PSA are at the origin of a set of anatomical variations of the distal VA similar but not identical to the vascular variants linked to the LSA.

KEY WORDS: Angiographic anatomy, vertebral artery, PICA

Poster 138

Regional Variations in T2 Relaxation Times in the Corpus Callosum

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PURPOSE
T2 relaxation times of the white matter of human brain show regional difference; T2 relaxation time of the genu is lower than those of the splenium or posterior limb of the internal capsule. However, T2 relaxation times of the body and isthmus of the corpus callosum have not been reported. The purpose of this study was to investigate T2 relaxation times of each region of the corpus callosum.

MATERIALS & METHODS
Twelve normal healthy volunteers (each of 6 women and men; mean age, 28.8 years) underwent both midsagittal multi-echo T2 relaxometry and magnetization transfer (MT) imaging at 3.0T. T2 relaxometry was performed with eight echo times with increment of 20 ms (20 - 160 ms). Five regions of interest (ROIs) were carefully drawn along the margin of the corpus callosum on the image of the highest echo time out of the images obtained from T2 relaxometry according to the modified Wiltelson’s scheme (Fig A; NeuroImage 2006;32:989-994). The ROIs were copied onto the MT images. Kruskal-Wallis test was performed to test regional difference of T2 relaxation times and MT ratios, followed by post hoc test if indicated.

RESULTS
The mean T2 relaxation times of the regions I-V of the corpus callosum were 70.14 ± 3.7, 77.37 ± 4.27, 83.09 ± 4.11, 84.4 ± 4.53, and 79.3 ± 3.1, respectively. T2 relaxation time of the region I (T2I) was significantly lower than those of the other regions (Tukey post hoc test, p < .001). T2II was significantly lower than T2III and T2IV (p = .005 and p < .001, respectively). T2IV was significantly higher than those of T2I, T2III, and T2V (p < .001, p < .001, and p = .012, respectively). T2III and T2V were not different (p > .05) (Fig B). No significant difference was found among MT ratios of each region.
CONCLUSION
T2 relaxation times of the regions III and IV of the corpus callosum, corresponding to the motor and sensory projections, respectively, were significantly higher than those of the other regions.

KEY WORDS: Corpus callosum, MR imaging

Poster 139
Exceptions to the Blood Brain Barrier at Cranial Nerves Exit Sites: Demonstration by Contrast-enhanced 3D FLAIR at 3.0 T

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PURPOSE
To demonstrate accumulation of contrast in the CSF originating from cranial nerve exit sites.

MATERIALS & METHODS
Contrast-enhanced 3D FLAIR at 3.0T was performed in five healthy volunteers under an IRB-approved protocol. Data were acquired using a TR of 10000 ms, T1 2650 ms, and TE 210 ms using an 8-element 6-channel SENSE array coil. Acquisition voxel size was 0.63 x 1.45 x 2.0 mm3 reconstructed at 0.47 x 0.47 x 1.00 mm3. Scan duration was 8:40 to 10:00 minutes for 170 to 195 slices. Baseline scans were obtained prior to intravenous injection of 0.3 mmol/kg GdDTPA and for at least 60 minutes afterward.

RESULTS
3D FLAIR resulted in complete suppression of the CSF prior to administration of contrast, with no pulsation artifacts. Hyperintense signal gradually increased in the CSF spaces associated with cranial nerve exit zones, and then diffused centrally towards the basal cisterns. For the optic nerve, enhancement was seen initially in the distal optic nerve sheath immediately posterior to the optic disk. With time, the entire optic nerve sheath enhanced. No enhancement was seen to extend anteriorly into the vitreous, although the optic papilla appeared to enhance. For the Vth nerve, enhancement was seen initially at the floor of Meckel's cave, and gradually filled the entire CSF space within Meckel's cave. For the VII-VIII nerve complex, enhancement was seen initially in the fundus of the porus acusticus. With time, this hyperintense signal propagated posteriorly to fill the internal auditory canal. Similarly, enhancement could be noted on delayed FLAIR in the pars nervosa of the jugular foramen adjacent to the cranial nerve IX-XI complex.

CONCLUSION
Although much of the intracranial compartment is isolated from GdDTPA by the blood-brain barrier (BBB), certain exceptions to this are present (e.g., choroid plexus and pituitary). By using a "triple dose" of GdDTPA and 3D FLAIR imaging at 3.0T, the sensitivity of MR imaging to detect sites of BBB is increased. Our data indicate that the regions of the cranial nerve exit zones have a higher permeability to GdDTPA than structures isolated by the BBB. For the optic nerve, a lack of BBB has been demonstrated at the prelaminar optic nerve head in monkeys, accounting for our findings (1). It is not clear whether this defect in the BBB serves a functional role (as it does in the circumventricular organs) or whether it is an epiphenomenon related to the transition from the central to the peripheral nervous system that occurs in the cranial nerves.

REFERENCES

KEY WORDS: Gadolinium, permeability, optic nerve

Poster 140
The Duplicated Middle Cerebral Artery on Multiple Imaging Modalities and Other Middle Cerebral Artery Variants Revisited

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PURPOSE
In 1973, Teal, et al classified middle cerebral artery (MCA) variants according to their origins. By Teal's classification, an accessory MCA is an aberrant artery which arises from the A1 segment of the anterior cerebral artery and courses parallel to the MCA. The term duplicated MCA is used when the aberrant vessel originates from the distal internal carotid artery (ICA). Subsequently, in 1998, Komiyama, et al, through stereoscopic angiography, determined that the duplicated MCA consistently supplies the anterior temporal lobe. Since then, this vessel has been described on magnetic resonance angiography (MRA). We further demonstrate this vascular variant by multiple, commonly performed imaging modalities.

MATERIALS & METHODS
We reviewed available neuroimaging studies which demonstrated a "duplicated MCA" in eight patients. The imaging studies included magnetic resonance imaging (MRI), MRA, CT angiography, and conventional angiography.
RESULTS
This MCA variant can be identified on MRI, MRA, CT angiography, and conventional angiography. Familiarity with and recognition of this variant is important, especially in patients with vascular pathology.

CONCLUSION
Given its cortical supply, the "duplicated MCA" might, more accurately, be called a "replaced anterior temporal artery". This variant anatomy can be recognized on a variety of commonly performed, noninvasive studies, as well as by conventional angiography. Proper identification or exclusion of a replaced anterior temporal artery is important in planning treatment for intracranial pathology.

KEY WORDS: Anterior temporal artery, middle cerebral artery

Poster 141
Ewing Sarcoma of the Head and Neck
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PURPOSE:
Primary Ewing's sarcoma arising from the head and neck region is extremely rare. We present four cases of Ewing's sarcoma in the facial bones with one case having intracranial extension. The incidence, radiographic features and differential diagnosis of Ewing's sarcoma in the head and neck will be discussed.

MATERIALS & METHODS
Four cases of pathology proved Ewing's sarcoma of the head and neck were collected over a 3-year period at our hospital. Two cases involved the mandible, one case involved the zygoma, and one case involved the left sphenoid sinus with intracranial extension. All patients had CT examination with and without contrast and one patient had MR imaging (MRI) of the head. Retrospective review of patient history, operative report, and pathology results were performed and cases were compared for radiographic features of Ewing's sarcoma as described previously in the literature and to other neoplasms occurring in the head and neck.

RESULTS
Ewing's sarcoma accounts for 4-6% of all bone tumors. This tumor typically affects the long bones in white males between 5-14 years of age. In patients older than 20 years, Ewing's more commonly occurs in the flat bones. However, only 1-4% of cases involve the head and neck. The maxilla and the mandible are the most common sites followed by the ethmoid sinus and the nasal fossa. To our knowledge, Ewing's sarcoma of the sphenoid sinus with intracranial extension has not been reported in the literature. Radiographically, long bone Ewing's sarcoma is a lytic lesion in 2/3 of cases with a perpendicular or onion-skin periosteal reaction. The CT appearance of head and neck Ewing's sarcoma is a lytic expansile bony lesion with an associated enhancing soft tissue mass. There is no calcification or reactive sclerosis. On MRI, Ewing's sarcoma is low-signal intensity on T1-weighted and high inhomogenous signal on T2-weighted sequences. Post gadolinium sequences, there is enhancement of the mass. The radiologic differential diagnosis of Ewing's sarcoma of the facial bones includes osteogenic sarcoma, neuroblastoma, lymphosarcoma, histiocytosis X, rhabdomyosarcoma, osteomyelitis and metastatic carcinoma. The presence of large soft tissue masses aided differentiation of Ewing's tumor from osteomyelitis and eosinophilic granuloma. The age of the patient ruled out the possibility of neuroblastoma, which is common in less than 5 years age group. However, histopathologic examination is necessary to confirm the nature of the tumor.

CONCLUSION
The classical appearance of long bone Ewing's sarcoma (i.e., onion-pearl type periosteal reaction), usually is not present in the head and neck. All four of our cases of Ewing's sarcoma involving the maxillofacial region had similar CT findings of osteolytic expansile destructive lesion and an associated enhancing soft tissue mass. Such radiographic findings in young age should suggest the possibility of Ewing's sarcoma as a differential diagnosis.

KEY WORDS: Ewing’s sarcoma, mandible, paranasal sinuses

Poster 142
Glossopharyngeal Schwannoma of the Suprahyoid Carotid Space: Case Report and Discussion of the Relationship to the Carotid Artery
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PURPOSE
The distinction between lesions of the deep parotid space and those of the carotid space has been greatly facilitated by cross-sectional imaging, particularly MR imaging (MRI). Due to 1) good assessment of parapharyngeal fat displacement, and 2) reliable and consistent identification of the carotid artery. While masticator space masses consistently displace the carotid artery posteriorly, it is generally assumed that carotid space masses, particularly schwannomas, displace the carotid artery anteriorly. We present two companion cases, with CT, MRI and angiographic data to demonstrate opposite patterns of carotid displacement depending on the nerve of origin, and briefly review the diagnostic findings in masses of the carotid space.

MATERIALS & METHODS
A 38-year-old female presented with headaches and a pharyngeal sensation of a foreign body without dysgeusia and dysphagia. CT and MRI showed a left carotid space mass, suggestive of a schwannoma, although the internal carotid artery was displaced posteriorly. The mass was hypovascular at angiography. The patient underwent surgical excision of her lesion via a transparotid approach. A 49-year-old male...
presented with drooling, cough, hearing loss and atrophy of the left hemitongue with right tongue deviation, consistent with Collet-Sicard syndrome. CT and MRI showed a left carotid space mass which extended inferiorly from the pars nervosa of the jugular bulb, and caused anterior displacement of the carotid artery. Marked atrophy and fatty replacement of the left hemitongue were present. The left hypoglossal canal was not enlarged. The patient was scheduled for surgery for this likely vagal schwannoma, but he decompensated and required a tracheostomy.

**RESULTS**
We report a patient with a carotid space mass that had all the features of a schwannoma, except for posterior displacement of the carotid artery. A glossopharyngeal nerve schwannoma was found at surgery. Schwannomas of the glossopharyngeal nerve are very uncommon, and those originating from the extracranial course of the nerve are extremely rare. In another patient, we describe the classic pattern for a vagal schwannoma, including anterior displacement of the carotid artery. In that patient, despite significant atrophy and fatty replacement of the hemitongue, the hypoglossal canal was not enlarged. Indeed, secondary dysfunction of the lower cranial nerves due to compression from a vagal schwannoma is a known occurrence.

**CONCLUSION**
Schwannomas of the suprahyoid carotid space most commonly arise from the vagus nerve and have a typical pattern, which includes anterior displacement of the carotid artery. A rare exception to this has been reported in schwannomas of the sympathetic nerve which may displace the carotid artery posteromedially. We report a schwannoma of the extracranial hypoglossal nerve, discuss the pattern of carotid displacement compared with that caused by a vagal nerve schwannoma, and briefly review the diagnostic findings in carotid space lesions.

**KEY WORDS:** Suprahyoid carotid space, Glossopharyngeal schwannoma, carotid displacement

**Poster 143**
CT Imaging Appearance of a Papillary Carcinoma Arising in a Thyroglossal Duct Cyst

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**PURPOSE**
Thyroglossal duct cyst (TDC) is the most common congenital neck mass. Rarely, in less than 1% of cases, the TDC may be associated with a focus of carcinoma. We present a case of papillary carcinoma arising within a TDC. The imaging features unique to carcinomas arising within a TDC are reviewed.

**MATERIALS & METHODS**
A 41-year-old patient presented with an enlarging neck mass. CT examination revealed a large cystic mass with a mural nodule within the midline neck, associated with the strap muscles and the hyoid bone. Surgical resection of the lesion revealed a papillary carcinoma arising within a TDC. Total thyroidectomy performed at the same setting revealed concurrent microscopic foci of carcinoma within the thyroid gland.

**RESULTS**
Carcinoma arising within a TDC should be suggested when the cyst demonstrates a solid nodule or areas of dystrophic calcification. The diagnosis also should be suggested when there is a solid mass within the expected region of a TDC. While the incidence of nodal metastases with TDCs complicated by carcinoma is low, there is a higher incidence of coincident carcinoma within the thyroid gland.

**CONCLUSION**
It is important for radiologists to recognize carcinoma arising within a TDC. Preoperative recognition may not only expedite treatment, but permit a concurrent total thyroidectomy for possible additional sites of carcinoma.

**KEY WORDS:** Thyroglossal, cyst, carcinoma

**Poster 144**
Optimizing Contrast-enhanced Protocols for Multichannel CT of the Brain and Head and Neck

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**PURPOSE**
The adoption of multichannel computed tomography (MCCT) scanners has dramatically changed the capabilities and speed of CT neuroimaging. Understanding relationships between contrast injection parameters (total volume, iodine concentration, flow rate, duration of injection, and dual injection) has become important to optimize protocols. This exhibit reviews the principles of contrast media (CM) opti-
mization for multichannel CT, and provides suggested protocols to take maximum advantage of the speed afforded by newer scanners, illustrated with relevant patient cases.

**Materials & Methods**
Optimal acquisition and reconstruction parameters vary across scanner manufacturers; however, the principles of contrast delivery generally remain constant across scanners. The use of contrast media with a higher iodine concentration (370 mgI/mL) with 16- or 64-row CT enables superior arterial enhancement with a smaller total contrast volume and total iodine dose. Presented herein are CT and CTA protocols optimized for rapid acquisition and high spatial resolution, illustrated for 16- and 64-row MDCT technology. Differences between images obtained from 16- and 64-slice scanners are illustrated.

**Results**
Faster MDCT scanners require an optimization of scanning protocols to obtain the best results from iodinated CM. Parameters for scan delay, bolus tracking and other acquisition and reconstruction parameters vary according to the scanner manufacturer. In general, CM injection principles remain constant across scanners, and an understanding of the interplay of CM injection parameters (e.g., volume, iodine concentration, flow rate) will help you implement the most efficient protocols for your scanner. By optimizing the duration of enhancement, and the intensity of parenchymal/arterial enhancement, you will be able to get better diagnostic results and potentially reduce your total CM dose. This exhibit identifies essential differences among MDCT scanners and presents protocols for contrast-enhanced 16- and 64-slice MDCT of the brain, head and neck.

**Conclusion**
Optimized protocols for neurologic CT require an understanding of several important parameters. Use of a contrast medium with a higher iodine concentration helps maximize the iodine delivery rate while minimizing the total administered contrast volume. Customizing your CT protocols will help you make the most safe and effective use of iodinated CM for multichannel CT neuroimaging.

**Key Words:** Contrast agents, helical CT, dose optimization

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**Poster 145**

**Early Imaging Follow Up of Osteoodontokeratoprosthesis Surgery on Multidetector Computerized Tomography**

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**Purpose**
Osteoodontokeratoprosthesis surgery (OOKP) is a novel sight-restoration procedure undertaken for patients with refractory corneal blindness. This study reports the early follow-up results of patients who underwent OOKP surgery on multidetector computed tomography (MD CT).

**Materials & Methods**
Fifteen patients who underwent OOKP surgery had pre and postoperative imaging on our 16-slice MD CT (Somatom Sensation 16, Siemens, Forchheim, Germany) scanner. Dimensions of the OOKP were measured at baseline (pre-Stage 2) and on follow-up MD CT scans. The angle between the papilla (optic nerve head) and the optic cylinder (POC) angle is also measured after Stage 2 surgery and on follow-up scans. These measurements were made by 2 readers on fixed window widths and levels. The measurements were correlated with the OOKP dimensions made at surgery, and the clinical visual acuity test.

**Results**
Since OOKP surgery started in our institution in 2004, 15 patients have undergone MD CT pre- and post-Stage 2 surgery. The imaging follow-up period ranged from 3-33 months. No significant resorption of the OOKP has been found so far. The POC angle ranged from zero to 20 degrees in either inferior-superior or nasal-temporal directions. Preliminary correlation of the POC angle with the clinical visual acuity test showed that the wide variation in the POC angle does not generally manifest as clinical loss of visual acuity.

**Conclusion**
No significant OOKP resorption has been found so far on follow up. Wide variation in the POC angle generally is not related to clinical loss of visual acuity.

**Key Words:** Osteoodontokeratoprosthesis, multidetector computerized tomography

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**Poster 146**

**Apparent Diffusion Coefficient of Subcutaneous Epidermal Cysts in the Head and Neck: Comparison with Intracranial Epidermoid Cysts**

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**Purpose**
Epidermal cysts are common, benign tumors that occur in the skin. The tumors commonly involve the scalp, face, neck, trunk, and back. Subcutaneous epidermal cysts and intracranial epidermoid cysts are pathologically identical: cysts filled with keratin debris and bounded by a wall of stratified squamous epithelium. However, only a few reports regarding MR imaging findings have been issued on subcutaneous epidermal cysts despite numerous reports on diffusion-weighted imaging (DWI) studies of intracranial epidermoid cysts. This study was intended to evaluate the apparent diffusion coefficient (ADC) of subcutaneous epidermal cysts of the head and neck in comparison with that of intracranial epidermoid cysts.

**Materials & Methods**
The MR studies were performed in 14 patients with head and neck subcutaneous epidermal cysts and 10 patients with intracranial epidermoid cysts using line scan DWI (LSDWI).
The LSDWI images were obtained with two different $b$ values (5 s/mm$^2$ and 1000 s/mm$^2$). The ADC was measured and compared between the two types of tumor. Statistical analysis was performed to detect significant differences in ADC values between subcutaneous epidermal cysts and intracranial epidermoid cysts.

**RESULTS**

Line scan diffusion-weighted imaging provided excellent diagnostic images and permitted ADC values to be measured without significant motion artifacts or susceptibility artifacts (Fig 1). The ADC (mean ± SD) was $0.81 ± 0.14 \times 10^{-3}$ mm$^2$/s in subcutaneous epidermal cysts, whereas the ADC was $1.06 ± 0.12 \times 10^{-3}$ mm$^2$/s in intracranial epidermoid cysts. A significant difference was found in ADC values between subcutaneous epidermal cysts and intracranial epidermoid cysts ($P = .0019$). The ADC values of two patients with subcutaneous epidermal cysts were high and overlapped with those of patients with intracranial epidermoid cysts.

**CONCLUSION**

Our preliminary study showed that the ADC of subcutaneous epidermal cysts was significantly lower than that of intracranial epidermoid cysts. Higher mean ADC of intracranial epidermoid cysts might be explainable for intervening CSF of the lesions. The ADC provides additional information concerning the same pathologic tumors but those in different anatomical locations and might be a useful adjunct to conventional MR imaging findings for the differential diagnosis of subcutaneous masses.

**KEY WORDS:** Diffusion-weighted imaging, apparent diffusion coefficient, epidermal cyst

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**Poster 147**

**Role of Diffusion-weighted Imaging and ADC Values in Orbital Lesions**

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**PURPOSE**

Role of diffusion-weighted imaging (DWI) is well established in evaluating various intracranial lesions including acute stroke, abscess, and certain tumors. Recent studies have shown a promising role of DWI and apparent diffusion coefficient (ADC) in characterizing various orbital lesions. However, diffusion imaging of the orbit is challenging due to significant bone and air interface artifacts. The aim of this exhibit is to discuss proper imaging technique and to illustrate usefulness of DWI and ADC values in the diagnosis and characterization of various orbital lesions.

**MATERIALS & METHODS**

We reviewed the MR and CT images with special emphasis on DWI and ADC images obtained from many patients with various orbital lesions. Both males and females of all age groups were included and attempt has been made to use DWI and ADC values in making correct diagnosis and better characterization of these lesions.

**RESULTS**

The exhibit will review the normal anatomy, contents, and important common pathologies of orbit. These include both neoplastic lesions such as meningioma, cavernous hemangioma, lymphoma, rhabdomyosarcoma, metastatic melanoma and nonneoplastic conditions such as optic nerve ischemia and trauma. A practical approach for making correct diagnosis especially using diffusion-weighted images and ADC values will be provided.

**CONCLUSION**

Understanding the proper imaging technique and usefulness of diffusion-weighted imaging and ADC values helps in diagnosing and characterizing both neoplastic and nonneoplastic orbital pathologies.

**KEY WORDS:** DWI, ADC, orbit lesions

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**Poster 148**

**Clinical Predictors of Transit Ischemic Attack: Stroke within 30 Days of Carotid Angioplasty and Stenting with Distal Balloon Protection**

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**PURPOSE**

Carotid angioplasty and stenting (CAS) has been accepted as an effective alternative to carotid endarterectomy (CEA), especially in CEA high-risk group. The purpose of this study was to determine potential clinical risk factors for the development of postprocedural deficits after CAS.
MATERIALS & METHODS
The clinical characteristics of 48 patients (40 men, 8 women; 31 in CEA high risk group, 17 in CEA low risk group; median age 69 years) who underwent CAS with distal balloon protection for 51 hemispheres/arteries (24 asymptomatic lesions and 27 symptomatic lesions) and the combined 30-day complication rates [transient ischemic attack (TIA), minor stroke, major stroke, or death] were analyzed.

RESULTS
Six patients experienced TIA (11.8%) and a patient had major stroke (2.0%) within 30 days. There was no mortality case, and hence the overall 30-day stroke and death rate was 2.0%. Chi-square test showed advanced age (≥ 75 years) as a clinical predictors of the 30-day outcome measures TIA, stroke, or death (p < 0.01). The length of stenotic lesion (≥ 15 mm), and intraprocedural hypotension were marginally associated with 30-day complication rates of neurologic ischemia (p = 0.062 and p = 0.067, respectively).

CONCLUSION
Our data suggest that CAS with distal balloon protection can be performed with periprocedural complication rates similar to those of CEA. When we conduct CAS, we must be more careful in the management of patients older than 75 years.

KEY WORDS: Carotid angioplasty and stenting, balloon protection, perioperative complication

Poster 149
Two Cases of Intradiploic Epidermoid Cysts of the Calvarium
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PURPOSE
We report two rare cases of intradiploic epidermoid cysts. One was found incidentally in an asymptomatic 27-year-old male patient. The second case we report was found in a 25-year-old female patient complaining of a progressively worsening headache and dizziness over one year.

MATERIALS & METHODS
Imaging review of CT and MRI as well as review of operative and surgical pathology reports was performed for both cases.

RESULTS
In the first case plain CT studies demonstrated an expansive, low-density lesion in the right posterior fossa of the occipital bone with scalloping and thinning of the inner bone table. MRI with and without contrast further characterized the lesion as well circumscribed with low T1 signal and heterogeneous T2 signal. In the second case (figure 1) CT with and without contrast demonstrated a left sided expansive mass measuring in the occipital bone involving the posterior mastoid and frontoparietal bones.

CONCLUSION
Intradiploic epidermoid cysts are rare lesions thought to arise from displaced epidermal elements during embryonic development. Over all they account for less than 1% of calvarial tumors. They are considered slow growing, benign lesions, but can occasionally produce neurologic symptoms. Most commonly patients complain of headaches and focal seizures. These lesions can also lead to erosion of the calvarium resulting in deformity of the skull. Intradiploic epidermoid cysts of the occipital bones represent 12-15% of cases. The typical radiologic appearance of epidermoid cysts on CT is an area of central bone destruction with sclerotic margins. On magnetic resonance imaging (MRI), lesions usually demonstrate low signal with T1 weighting and high signal with T2 weighting. Complete resection remains the treatment of choice for these lesions.

KEY WORDS: Epidermoid cyst, intradiploic, calvarium

Poster 150
Safety and Efficacy of Matrix Coils for the Selective Endovascular Treatment of Intracranial Aneurysms
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PURPOSE
To evaluate the clinical and anatomical results of the selective endovascular treatment of intracranial aneurysms using Matrix coils.
**Materials & Methods**
From January 2004 to October 2004, a prospective, multi-center registry was conducted in 16 French centers. 236 patients (females: 149, males: 87; age: 21 to 78 years; mean: 48.7 years) harboring 244 aneurysms were included. Aneurysms were ruptured in 58.5% of cases and unruptured in 41.5%. Aneurysms were located in anterior circulation in 93% and posterior circulation in 7%. Aneurysmal occlusion was evaluated by an independent core laboratory. Evaluation was performed postoperatively in all cases and 9 to 18 months after the treatment in 144 cases.

**Results**
Technical and clinical preoperative complications were encountered in 18% of cases. Postoperative morbidity and mortality related to the treatment were respectively 2.5% and 0.8%. At one year follow-up, 89 out of 103 patients with ruptured aneurysms (86.5%) had a modified Rankin Score (mRS) from 0 to 2; in unruptured group, mRS was 0 to 2 in 99% of patients. The anatomical evaluation provided by the performing clinician and by the core laboratory was often different. Postoperatively, classification by the core lab was complete in 44%, neck remnant in 25% of cases and aneurysm remnant in 31% of cases. At one year, occlusion was complete in 47% of cases, neck remnant in 26% of cases and aneurysm in 28% of cases according to the core lab analysis. At one year the recanalization rate was 26% (minor in 15% of cases and major in 11% of cases). An improvement of the occlusion rate was observed in 30% at one year. Factors affecting anatomical evolution of aneurysms treated with Matrix coils are reported.

**Conclusion**
According to the literature, the rate of complications, morbidity and mortality in patients treated with Matrix coils is not higher than in patients treated with bare coils. In our series, recanalization is observed in 26% of cases after aneurysm treatment with Matrix. Subsequent occlusion after Matrix treatment is reported in 30% of cases.

**Key Words:** Aneurysms, endovascular treatment

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**Poster 151**

Computational Fluid Dynamics Analysis of Flow Patterns in Anterior Communicating Artery Aneurysms

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**Purpose**
The purpose of this study was to characterize the hemodynamic pattern of anterior communicating artery aneurysms (AcoA) and to investigate possible associations to aneurysm rupture risk.

**Materials & Methods**
Thirty consecutive patients with AcoA aneurysms were identified from the INR database. Subject-specific computational models were constructed from 3D rotational angiography images. Computational fluid dynamics simulations were performed under pulsatile flow conditions derived from PC-MRA measurements in a normal volunteer. Numerical solutions of the incompressible Navier-Stokes equations were obtained using a fully implicit finite element formulation. Streamlines of the velocity field, velocity magnitude at selected cut planes and regions of elevated wall shear stress were used to characterize the intra-aneurysmal flow patterns. Flow patterns were analyzed and correlations with prior of history of intracranial hemorrhage were made.

**Results**
Aneurysms with bilateral A1s (60%) and unilateral (40%) showed no difference in the rate previous rupture. Aneurysm flow patterns could be separated into four types (figure 1). 75% of aneurysms were dominated by a single inflow jet (types B-D). Only 25% of aneurysms had symmetric patterns of inflow from both A1 segments. The two inflow jets collide, merge and diffuse inside those aneurysms, of which 75% were unruptured. 75% of the aneurysms with bilateral A1s had asymmetric inflows. The main jet in the parent artery splits in three secondary jets, one of which enters the aneurysm and the other two flow to the daughter A2 branches in type B. In type C, it splits in two secondary jets, one of each enters the aneurysm before flowing to one of the daughter A2 branches. In type D, the whole jets impacts into the aneurysm before being redirected toward the A2 segments of the anterior cerebral arteries. Ruptured aneurysms accounted for 60%, 87% and 100% of aneurysms in categories B, C and D, respectively.

**Conclusion**
AcoA aneurysms have complex intraaneurysmal flow patterns which can be divided into groups based on characteristics of the inflow jets. Symmetrical inflow from the bilateral A1s is the least common pattern and are mostly unruptured. Flow patterns dominated by a single inflow jet are the majority and more common in aneurysms with a previous history of rupture.

**Key Words:** Cerebral aneurysm, flow dynamics, computational fluid dynamics

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**Poster 152**

Stent-assisted Coiling of Fusiform Atherosclerotic and Dissecting Aneurysms: Clinical Outcome and Long-term Follow Up

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**Purpose**
The goal of this study is to evaluate the long-term outcome in patients treated with stent-assisted coiling for fusiform dissecting or atherosclerotic aneurysms.
Materials & Methods
Twenty-three patients underwent stent-assisted coiling to treat intracranial fusiform aneurysms that were either of dissecting or atherosclerotic origin. The most common presentation was headache (8/23) and other symptoms included hemiparesis, hemiplegia, subarachnoid hemorrhage, stroke, seizures, syncope, and dizziness or gait disturbance. The average age at the time of treatment was 53 years old and the majority of patients, 74%, were female. Aneurysm locations were the internal carotid artery (segments: petrous n = 2, cavernous n = 3, paracclinoid n = 4, and paraophthalmic n = 1), intradural vertebral artery (n = 4), basilar trunk (n = 4), and verteobasilar junction (n = 2) and middle cerebral artery (n = 3). Approximately half of the aneurysms originated from arterial dissection (12/23). The stents employed included coronary balloon-expandable stents and more recently the self-expanding Neuroform neurovascular stents employed included coronary balloon-expandable stents. The stents are constructed as an overlapping collection of spheres to replicate the geometry of the selected stent designs. The skeleton of the parent vessel is extracted and a cylindrical surface is created along the skeleton and made to conform to the vessel walls. Then, different stent designs are mapped to the cylindrical surface. Blood flows are modeled using the incompressible Navier-Stokes equations and numerically solved with an implicit finite element formulation.

Results
Immediate postprocedural angiographic outcome was: complete occlusion (9/23), neck remnant (7/23) and subtotal occlusion (7/23). One periprocedural complication resulted from wire perforation leading to subarachnoid hemorrhage which was controlled and remained asymptomatic. Following the procedure, one patient had hypothermia of the left, fourth digit and another patient had a mild sixth cranial nerve palsy, both of which resolved completely at follow up. Clinical and angiographic follow up was obtained in all patients at a mean of 14 months (minimum 1 month and maximum 60 months). Recanalization occurred in three patients at 5 months, 14 months, and 36 months, requiring retreatment in one patient. No in-stent stenosis was noted in these patients (Fig). Jailed perforators remained patent, however, in one case the jailed vertebral artery occluded at the junction with no adverse sequelae. During the follow-up period, one patient expired (mortality: 4%) 2 weeks after discharge due to collapse of the stent structure within the basilar artery. A delayed in-stent thrombosis occurred in another patient on dual antiplatelet therapy 3 weeks after treatment. A successful recanalization was achieved with improving neurologic sequelae (permanent morbidity: 4%).

Conclusion
Stent-assisted coiling is an attractive option for complex fusiform aneurysms. Further development in endovascular technology is required in order to reduce the high patient morbidity and mortality reported herein. Recanalization observed after one year emphasizes the need to perform long-term follow up imaging studies in these cases.

Key Words: Dissecting aneurysm, atherosclerotic aneurysm, endovascular

Poster 153
Patient-specific Computational Modeling of Intracranial Aneurysm and Stents: Effect of Stent Design on Intraaneurysmal Flow Patterns
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Purpose
The purpose of this study is to assess whether changes in stent design could cause differences in intraaneurysmal flow patterns using computational fluid dynamic simulations.

Materials & Methods
A representative ICA aneurysm case was selected from our database. Patient-specific geometry was obtained from a 3D rotational angiogram. Blood flows were simulated with a hybrid approach in which a body conforming finite element mesh is generated inside the vascular model and an adaptive unstructured grid embedding approach is used to model the stents. The stents are constructed as an overlapping collection of spheres to replicate the geometry of the selected stent designs. Four different stent designs (rhomboid, hexagonal, left and right helix) were deployed into the patient specific model. Flow calculations were then performed on the model pre-stent and with each of the four stent deployments. Streamline and wall shear stress (WSS) visualizations were performed for each case and compared.

Results
Placement of the stent caused obvious changes in the flow stream for all stent designs. The inflow jet was diverted from the distal wall to impacts on the dome. The flow jet was also reduced and dispersed. The left helical design had the greatest effect followed by the right helical, neuroform and hexagonal design. Similarly, the WSS was moved and dispersed compared with the unstented model. There was a marked reduction in peak WSS in the left helical designed compared with the other stent designs.

The left panel shows the 3D rotational angiography image used to construct the vascular model, the reconstructed anatomical model, and the two stent designs used in the simulations. The right panel shows the flow pattern (top row) and the WSS distribution (bottom row) before stenting (left column), and after stenting the aneurysm (center and right columns).
CONCLUSION
Stent placement causes a diversion and dispersion of the inflow jet which can be influenced by the stent design. The differences in the WSS between stents may indicate potential superiority of specific stent designs for a given patient. The CFD techniques can potentially be used to select the best stent for a given individual.

KEY WORDS: aneurysm, computational hemodynamics, stent

Poster 154
Relationship between Overdilation of Right Common Carotid Artery (RCCA) during Elastase Incubation and Aneurysm Volume: A Retrospective Study

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PURPOSE
Aneurysm models with appropriate volume are crucial for basic and preclinical aneurysm research. Our purpose was to confirm if overdilation of right common carotid artery (RCCA) during elastase incubation can induce larger aneurysms.

MATERIALS & METHODS
Elastase-induced aneurysms were created in 80 subjects. Digital subtractive angiograms (DSA) were performed at least 3 weeks following creation. Two groups were classified, including Group 1 (n = 40) without overdilation of RCCA during elastase incubation; and Group 2 (n = 40) with overdilation of RCCA during elastase incubation. Aneurysm sizes (neck diameter, width and height) and volume in the two groups were measured and calculated. The aneurysm sizes and volume between two groups were compared using the Student's t test.

RESULTS
The mean aneurysm width and height for Group 2 was significantly larger than that of Group 1 (4.1 ± .8 vs 3.5 ± .8 mm for Groups 2 and 1, respectively, p < .01; 9.8 ± 2.0 vs 7.5 ± 1.7 mm for Groups 2 and 1, respectively, p < .001, respectively). The aneurysm neck size in Group 2 was not significantly larger than that in Group 1 (3.1 ± 1.0 vs 2.9 ± 0.9 mm, p > .05). The aneurysm volume in Group 2 was significantly larger than that in Group 1 (137.9 ± 77.2 mm3 vs 80.7 ± 55.7 mm3, p < .001) (Figs 1 and 2).

CONCLUSION
The aneurysm volume of elastase-induced model can be controlled by overdilating RCCA during elastase incubation. Using overdilation of RCCA can create relatively larger aneurysms.

KEY WORDS: Aneurysm model, volume, control

Poster 155
A Method for Rapid Creation of Elastase-induced Model Aneurysms in Rabbits

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PURPOSE
The traditional method to create elastase-induced aneurysms requires at least 3 weeks after elastase incubation for complete dilation of the aneurysm cavity. In this study we report a method to yield aneurysms that can be used for acute study or training purposes immediately after elastase incubation.

MATERIALS & METHODS
Elastase incubation of the origin of right common carotid artery (RCCA) was performed for 20 minutes in 24 rabbits. The distal end of RCCA was cut off after elastase incubation, and a saccular aneurysm was formed. Intravenous digital subtractive angiography (IVDSA) was performed immediately after creation. Aneurysm sizes (neck diameter, width and height) were measured and calculated.

RESULTS
Aneurysms (defined as diameter of the widest part of RCCA was larger than 1.5 mm) were present in all the subjects immediately following elastase incubation. The mean aneurysm neck size was 2.9 ± 1.0 mm (from 1.2 to 5.5 mm). The mean aneurysm width was 3.1 ± 1.1 mm (from 1.9 to 6.4 mm). The mean aneurysm height was 5.5 ± 1.4 mm (from 2.7 to 7.6 mm) (Fig 1).
Figure 1. IVDSA. Right anterior oblique view. Showing aneurysm immediately after creation (right arrow). Aneurysm neck size, width, and height are 3.2 mm, 3.1 mm, and 6.3 mm, respectively.

CONCLUSION
This method to create elastase induced aneurysm model is quick and economic, which is especially useful for acute studies or training purpose for neurointerventional procedures.

KEY WORDS: aneurysm model, acute, rapid

Poster 156
Endovascular Reconstruction of Intracranial Aneurysms with Stents

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PURPOSE
To present our clinical experience and outcome of mid term follow up of complex aneurysms lesions treated with intracranial stenting reconstruction.

MATERIALS & METHODS
Between June 1996 and June 2004, 259 patients with complex aneurysms of cerebral circulation were treated with intracranial stenting technique. Patients were divided in two groups: 1. Patients treated with balloon expandable stents (BES). 2. Patients treated with Self-expandable stents (SES).

RESULTS
Group 1: 172 stents were implanted. 50.5% of the cases were small aneurysms, 32.5% big and 18.6% giants. 33% was treated with stents, 66% with stent and coils and 1% with stent and Onyx. The morbidity of the procedure was 4.3% and the mortality 2.1%. Group 2: 183 implanted stents. 55.8% small, 31.3% large and 12.7% giants aneurysms. 29.4% was treated exclusively with stents and 70.3% with stents and coils. The morbidity of the procedure was 2.8% and mortality of 2.7%.

CONCLUSION
In our experience the treatment with stents is feasible, safe and a effective technique for the endovascular reconstruction of wide neck aneurysms and segmental arterial defects, which can be used as unique treatment or combined with coils. The availability of neuro-stents design have improved the technical success in tortuous anatomy.

KEY WORDS: Aneurysm, balloon-expandable stents, self-expanding stents

Poster 157
Cinematic Angiography for Assessments of Blood Flow in Cerebral Aneurysms with Stents

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PURPOSE
The assessment of blood flow speed by imaging modalities is of increasing importance for endovascular treatment such as stent implantation, of cerebral aneurysms. The subtracted vortex centers path line method (SVC method) utilizes image postprocessing for determining flow measurement quantitatively. In current practice, the image is visualized by laser sheet translumination and digitally recorded with integration of an in vitro model. In this study, we applied this method to medical use with cinematic angiography (CA) to analyze hemodynamic changes before and after the stent implantations.

MATERIALS & METHODS
A transparent tubular model was constructed of silicone (ELASTRAT Sarl., Geneva, Switzerland). It included an aneurysm, 10 mm in diameter and having a 5 mm neck on a straight parent artery with a diameter of 3.5 mm and was integrated into a circulation system. By CA, successive images of 25 fps with injection of contrast were obtained. The SVC method was applied to the images and compared with results of the slipstream line method with colored fluid. The successive images were performed before and after stent, respectively. The image postprocessing to measure the contrast movements was constructed with commercial based software packages.

RESULTS
Rotating vortexes of contrast, which advanced along the wall of the aneurysm, were observed in successive images of the aneurysm cavity.

CONCLUSION
This phenomenon was also observed in the successive images by the slipstream line method. The vortexes were still constructed after stenting and possible to compare the change of movement on the successive images. After apply-
ing the SVC method to the successive images, the speed of the vortex center was measured, results showing that the speed of CA was the same as that of the slipstream line method. The speed decreases after the stent implantation. This indicates the possibility of applying the SVC method to medical imaging equipment for analysis of the flow in aneurysms containing medical devices such as stents.

**Key Words:** Cinematic angiography, cerebral aneurysm, subtracted vortex centered pathline

**Poster 158**

Comparison of Blood Inflow Patterns into ACOMA Aneurysms Determined with 3D DSA and Simulated with CFD

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**Purpose**

To compare blood inflow patterns into aneurysms of the anterior communicating artery (ACOMA) visualized with unilateral left and right and bilateral contrast injections using 3D digital subtraction angiography (DSA) and computational fluid dynamics (CFD) simulations.

**Materials & Methods**

In a retrospective study, we identified two subjects with ACOMA aneurysms who received a digital subtraction angiographic (DSA) exam including 3D DSA acquisitions of separate right and left unilateral contrast injections and of one bilateral (simultaneous) injection. Angiographic exams were performed using a FD bi-plane system (Siemens Medical Solutions, Germany). 3D surface reconstructions of the 3D DSA image data for the unilateral injections and the bilateral injections were created separately and then merged. Computational meshes for the CFD simulations were created from the 3D DSA data of the bilateral injection and solved using Fluent (Fluent Inc.).

**Results**

No significant difference in aneurysm volume obtained with the bilateral injection compared to aneurysm volume of the merged unilateral injections was noted in both cases. In subject 1, inflow into the aneurysm was dominated by the flow entering the aneurysm from the right anterior cerebral artery (ACA), while for subject 2, inflow into the aneurysms occurred nearly symmetrical from both the left and the right ACA. This result was obtained by comparing volume fractions of each unilateral injection to the total aneurysm volume obtained with the bilateral injection (left panel of figure 1 for subject 1). Pathlines computed from the CFD results were found to agree qualitatively with the results of the 3D DSA acquisitions (right panel of figure 1 for subject 1).

**Conclusion**

Separate left and right unilateral contrast injections and 3D DSA were able to show blood inflow patterns into two ACOMA aneurysms and comparable to simultaneous bilateral injections. The combination of surface reconstructions derived from the 3D DSA image data of these unilateral injections matches the surface reconstruction obtained from the 3D DSA data of a bilateral injection. Blood flow pathlines of CFD simulations using computational meshes derived from the 3D DSA data for the bilateral injection may be consistent with the observed flow patterns using unilateral 3D DSA.

**Key Words:** Aneurysm, computational fluid dynamics, image postprocessing

**Poster 159**

Intra-aneurysmal Hemodynamics in a Large Middle Cerebral Artery Aneurysm with Aneurysm Wall Atherosclerosis

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**Purpose**

To evaluate role of intra-aneurysmal hemodynamics on atherosclerotic changes of aneurysm wall.

**Material & Methods**

A large middle cerebral artery (MCA) aneurysm, which was observed to have atherosclerotic changes in the aneurysm wall during the surgical clipping was selected for hemodynamic evaluation. CT angiography of the MCA aneurysm was used to create an in vitro aneurysm model, followed by in vitro flow measurement using particle imaging velocimetry and laser Doppler velocimetry. Intra-aneurysmal hemodynamic pattern and distribution of wall shear stress were compared between the area with and without the atherosclerotic plaque.
RESULTS

The area of atherosclerotic changes was located near the aneurysm outflow zone. The value of wall shear stress tends to be smaller in the area with atherosclerotic changes than the area without those changes. There was no high oscillation of wall shear stress value on the atherosclerotic plaque area.

CONCLUSION

Some of these findings were in keeping with hemodynamic findings in other vascular diseases carotid atherosclerotic plaques.

KEY WORDS: Aneurysm, hemodynamics, remodeling

Poster 160

Preliminary Experience with Onyx Embolization for the Treatment of Intracranial Dural Arteriovenous Malformations

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PURPOSE

Dural arteriovenous malformations (DAVMs) are acquired abnormal arteriovenous connections within the dura that account for 10 to 15% of all intracranial vascular malformations. The current management of DAVMs includes endovascular, surgical, and radiosurgical treatments, either alone or in combination. Transarterial and/or transvenous embolization is typically performed with cyanoacrylate, coils, and/or particles. Onyx, an ethylene vinyl alcohol copolymer preparation, was recently approved for the treatment of pial AVMs, however, its use to treat DAVMs is not yet well established. We report our preliminary experience with the endovascular treatment of intracranial DAVMs using this non-adhesive liquid embolic agent.

MATERIALS & METHODS

We performed a retrospective analysis of 9 consecutive patients with intracranial DAVMs who were treated with Onyx as the single treatment modality at our institution between March and November 2006. Demographic, clinical, and radiographic presentations as well as outcomes are reviewed.

RESULTS

A total of 13 procedures were performed in 9 patients. In all cases, transarterial microcatheterization was performed with a Marathon microcatheter (Ev3, Irvine, CA) and Onyx-18 or a combination of Onyx-18 and Onyx-34 (Ev3, Irvine, CA) was used. Six patients were male and three were female. The mean age was 54 years (range, 31-73). The clinical presentation was intracranial hemorrhage in 4 patients, superficial siderosis in 1 patient, tinnitus in 2 patients, and severe headache in 1 patient. One patient was asymptomatic but had cortical venous drainage on angiography. Five lesions were classified as Cognard IV/ Borden 3; two lesions as Cognard III/ Borden 3; one lesion as Cognard IIa+IIb/ Borden 2; and one lesion as Cognard IIa/ Borden 1. Angiographic cure was achieved after only one procedure in five patients. Three patients had two or more procedures performed to achieve angiographic cure. In one patient, there was minimal residual fistula post embolization that resolved on follow up. Overall, 15 arterial feeders were selected to perform Onyx embolization in 13 procedures (mean 1.15 embolized feeders/procedure). The approximate volume of Onyx used was 4.8 mL per patient (range, 1.4-12 mL). No complications were noted. Six patients had angiographic follow-up with mean follow-up of 4.5 months. There was one small and asymptomatic recurrence at angiographic follow-up.

CONCLUSION

Endovascular treatment of intracranial DAVMs with Onyx is feasible, safe, and highly effective with small recurrence rate in the short-term follow-up. Further studies are needed to evaluate the long-term efficacy of this treatment.

KEY WORDS: Dural arteriovenous malformation, embolization, Onyx
Poster 161
A New Detachable-tip Microcatheter in Endovascular Embolization of Intracranial Vascular Malformations: Preliminary Clinical Experience

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PURPOSE
To report the preliminary clinical experience with a new microcatheter (Sonic; Balt, Montmorency, France) which has a detachable tip zone in prolonged Onyx injections in intracranial vascular malformations.

MATERIALS & METHODS
Nine patients (8 male and 1 female) with an age range of 4-57 (mean 29.44) were treated for intracranial vascular malformations using prolonged intranidal Onyx injection technique. Of these nine patients, eight were cerebral AVMs and one was dural AVF. Sonic microcatheter was used for single injections for each patient and was intended to be withdrawn at the end of the procedures.

RESULTS
Eight catheters with 25 mm and 1 catheter with 15 mm detachable tip zone were used. Total obliteration was achieved in one patient with Spetzler-Martin grade II AVM while the others were staged. In one patient, the microcatheter was ruptured at the tip within the detachable zone inside the feeder of the AVM during Onyx injection. Injection was continued since the penetration of Onyx was still intranidal, and then stopped. Including this ruptured one, all the microcatheters were detached from the detachment marker and withdrawn at the end of the procedure without any difficulties. No other procedural complications occurred.

CONCLUSION
Gluing of the microcatheter tip in prolonged intranidal Onyx injections is a concern in endovascular treatment of cerebral AVMs. This first limited experience with the new detachable-tip microcatheter revealed promising results; however, future experience with a larger number of patients may better define the safety and efficacy of this new device.

KEY WORDS: Cerebral arteriovenous malformation, endovascular treatment, Onyx embolization

Poster 162
Long-term Angiographic and Clinical Outcome after Elective Intracranial Artery Stenting

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PURPOSE
Although previous studies suggest that elective intracranial artery stenting (IAS) is safe and effective to treat an atherosclerotic stenosis, there have been few reports regarding long-term outcome after intracranial stenting. The purpose of this retrospective study was to evaluate the long-term angiographic and clinical outcome after elective IAS for the treatment of symptomatic atherosclerotic occlusive disease.

MATERIALS & METHODS
Intracranial lesions related to ischemic symptoms were treated. All procedures were performed at least 7 days after the last ischemic attack. Included for analysis were patients who underwent elective IAS for symptomatic atherosclerotic occlusive lesions between November 2000 and July 2005, and patients who were investigated angiographically to find restenosis 3 and 12 months after elective IAS. Angiographic lesion characteristics before elective IAS were evaluated. Procedural success or complications were evaluated. All deaths, any stroke death, any stroke, and ipsilateral ischemic stroke were analyzed for clinical outcome during the follow-up period longer than 1 year. Case records were retrospectively analyzed. Twenty-seven intracranial lesions (26 stenoses and 1 total occlusion) in 27 patients (24 men and 3 women, mean age 72.2 years) were treated with balloon expandable coronary stent following balloon angioplasty. In all patients, medical therapy had failed and all lesions show >70% luminal stenosis, long and tortuous stenosis or occlusion (Mori type B 14 and type C 13), not suitable for the treatment with balloon angioplasty alone. Lesions were located at intracranial ICA in 12, M1 in one, intracranial VA in seven, and BA in seven patients. Successful SAIA was achieved in 25 patients (92.6%). Stenosis rate was reduced from average 81.9% to 16.3% after SAIA. Periprocedural complications occurred in three lesions of Mori type C (11.1%), (1 TIA, 1 stent migration, 1 hyperperfusion syndrome).

RESULTS
Migrated stent was removed successfully without thromboembolic event, and hyperperfusion syndrome was over without permanent disability. There were no deaths, stent thrombosis, perforation, vessel rupture, or myocardial infarction. Periprocedural neurologic morbidity and mortality was 0%. All patients were followed up for mean 19 months (3-65 months). One-year angiographic investigation was available in all successful cases and angiographic restenosis occurred in three patients (10.3%)12 months after SAIA. There was no ipsilateral ischemic recurrence after successful SAIA during the follow-up period.

CONCLUSION
Elective SAIA is technically feasible and safe with minimal risk in patients with long, tortuous lesions or total occlusion of Mori type B or C. Long-term angiographic and clinical outcome is favorable.

KEY WORDS: Intracranial artery, stenting, carotid, basilar
**Poster 163**

Role of Contrast-enhanced Angiographic Computed Tomography (ACT, DynaCT) in the Evaluation of Stent Placement for Arteriosclerotic Stenoses using the Wingspan™ System

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**PURPOSE**
The purpose of this study was to evaluate the role of angiographic computed tomography (ACT) (DynaCT) in the assessment technical and morphologic results after stent placement for treatment of intracranial stenoses using the Wingspan system.

**MATERIAL & METHODS**
Thirty patients (13 M, 17 F, age: 25-85 years, mean: 62.8) were treated with a total of 38 stents (6 x 2, 1 x 3 stents) in the following locations: M1:19, ICA:7, VA:7, M2: 2, BA:3, A1:1. The degree of stenosis ranged from 47% to 95% (mean 73%). There were 34 patients with arteriosclerotic lesions and four patients with intracranial dissections. ACT (DynaCT) was performed in each patient using a C-arm mounted flat detector system (Axiom Artis dFC, Siemens, Medical Solutions, Germany) and the following parameters (1k acquisition): 20 seconds, 0.4° increment, 512 matrix in projections, 220° total angle, 20/sec, and 543 projections. FD-CTs (DynaCTs, Siemens Medical Solutions) were obtained by performing 3D reconstruction using volume-rendering technique (VRT) and maximum intensity projections (MIPs) on a commercially available workstation (Leonardo, Siemens, Erlangen, Germany). Contrast applications: 20% (300 mg Iodine), 40 ml, 2 cc/sec. The reconstruction parameters were as follow: manual mode, 512 x 512 image resolution, bone kernel with sharp image characteristics, and voxel sizes ranging from 0.057 mm to 0.061 mm. In three cases a newly developed 2K acquisition mode was used: 23 sec, 1.2° increment, 166 projections, 200° total angle, 8.7/sec.

**RESULTS**
Angiographic (DSA) results: Improvement of vessel diameter: 11% - 95%, mean improvement: 46.4%. Six months follow up: 10 patients (4 stable, 5 asymptomatic restenoses, 1 occlusion). ACT (DynaCT) results: focal in-stent filling defects developing in the FU-period were detected in all angiographically stenosed cases more easily than using DSA. In two cases these filling defects were not detected on standard 2D DSA. In one case of supraclinoid carotid lesion a circumferential intimal hyperplasia was documented after 6 months, not visualized as such on DSA. This was evident despite further stent expansion. In three cases stent expansion was documented after 6 months and measured between 0.1 and 0.4 mm, not measurable using 2D DSA. In two cases the image quality was poor due to motion artifacts. The 2k mode provided, despite more background noise, higher spatial resolution and less blooming artifacts as compared to the 1k mode.

**CONCLUSION**
Contrast-enhanced ACT (DynaCT) is feasible to provide excellent visualization of Wingspan Stents and is superior to 2D DSA. It adds valuable 3D information on early in-stent filling defects and in-stent stenosis, not always detectable using modern 2 DSA. In addition ACT provides new information on deployment and expansion characteristics of self-expanding stents and thus improves knowledge and understanding of intracranial stenting. The use of the new 2k acquisition mode appears promising and needs further evaluation.

**KEY WORDS:** DynaCT

**Poster 164**

Preliminary Investigation and Potential Applications of a Novel Method for Dissolving Alginate-based Embolic Biomaterials. The EmboGel/EmboClear Solution

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**PURPOSE**
To describe an alginate-based embolic biomaterial (EmboGel) and its solvent (EmboClear).

**MATERIALS & METHODS**
EmboGel is a mixture of iohexol and alginate. A calcium chloride solution is used to induce its polymerization. EmboClear is a mixture of alginate lyase and anhydrous ethylenediamine-tetra-acetic acid solution. In vitro experiment: EmboGel was delivered into a glass aneurysm model, and then dissolved with EmboClear. In vivo experiments in rabbits: i) EmboGel was injected in the abdominal aorta, the pelvic and the carotid arteries, followed by injection of EmboClear. ii) A wide neck aneurysm model was filled with EmboGel in order to simulate embolic material migration in non-targeted vessels, followed by EmboClear injection in the same distribution.

**RESULTS**
In vitro: Injection of EmboClear successfully dissolved the EmboGel contained within the aneurysm into liquid by-products. In vivo: The distal abdominal aorta and pelvic arteries were occluded with EmboGel. Within a minute of EmboClear infusion, patency of the aorta and of most of the pelvic circulation was regained. The carotid artery occluded with EmboGel regained patency after administration of EmboClear. Reppearance of the ocular choroid blush indicated re-establishment of flow in small circulatory systems. During aneurysm embolization, EmboGel leaked into the subclavian artery and occluded numerous distal branches. Infusion of EmboClear within the aneurysm cleared the embolic material in both the aneurysm and the subclavian circulation.
Conclusions

EmboGel is a dissolvable alginate-based biomaterial that can be used for therapeutic delivery and controlled therapeutic agent release. EmboGel can be selectively dissolved with EmboClear, a solution of alginate lyase and calcium-chelating agent.

Key Words: Embolic material, embolization, alginate

Poster 166

CTA Appearance of In-stent Restenosis of Intracranial Arteries Treated with Wingspan

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Purpose

Intracranial angioplasty and stenting previously has been limited due to lack of dedicated neurovascular designed devices. The recent introduction of the Wingspan stent is the first stent designed for the treatment of ICAD. Given the limited utilization of this device to date it is no surprise that in-stent restenosis is observed. Nonetheless, while CTA may not accurately characterize a restenosis it may be useful as a noninvasive screening tool, obviating the need for invasive angiography for follow up unless an abnormality is noted on the CTA.

Key Words: CT angiography, stent, restenosis

Poster 166

MR X-Ray Fusion: Potential Clinical Applications: Experience in SRMC and RI

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Purpose:

To assess the clinical applications of MR X-ray fusion technique in neurovascular diseases.

Materials & Methods

Thirty-six patients of age group 15 - 75 years underwent the study during the period Feb 2003 - June 2006. These patients were diagnosed cases of aneurysm/AVM/AV fistula/DVAs by conventional angiogram/CT/MR imaging. 3D rotational angiogram was performed on Advantx LCN + with nonionic contrast omnipaque, of volume 18 ml at a injection rate of 3.5 ml/sec. MR imaging was performed in Magnetom Vision 1.5T with postcontrast T1-weighted images using Spinecho and 3D MPR sequences. The sections are of 2 - 3 mm thickness with no interslice gap. Fusion of these images was done on multimodality workstation. We report three patients where CTA identified evidence of abnormality within the stented MCA segment but with poor characterization of the process. When the CTA source images and thin slice reformatted images were viewed, the appearance was most suggestive of intraluminal thrombus as contrast circumferentially filled around the filling defect. However, the ensuing DSA appearance was consistent with in-stent restenosis. During subsequent angioplasty treatment of two of these cases the lesions behaved like restenosis with immediate remodeling after angioplasty.

Results

We report three patients where CTA identified evidence of abnormality within the stented MCA segment but with poor characterization of the process. When the CTA source images and thin slice reformatted images were viewed, the appearance was most suggestive of intraluminal thrombus as contrast circumferentially filled around the filling defect. However, the ensuing DSA appearance was consistent with in-stent restenosis. During subsequent angioplasty treatment of two of these cases the lesions behaved like restenosis with immediate remodeling after angioplasty.

Conclusion

The exact role of CTA in follow up of patient undergoing intracranial angioplasty and stenting is unclear at this time. The CTA clearly demonstrated the presence of an abnormal filling defect within the stent but characterization of the lesion was suspect given the discordant DSA appearance. This is a limited observation given lack of histologic corroboration, but DSA historically has been considered the gold standard. The addition of perfusion information may add further confidence that an abnormality exists as we have observed. Nonetheless, while CTA may not accurately characterize a restenosis it may be useful as a noninvasive screening tool, obviating the need for invasive angiography for follow up unless an abnormality is noted on the CTA.
the sulci and gyri. In patients of aneurysms, vital information was produced about the neck of the aneurysms and proximal arterial road map for the interventional neuroradiologists.

**CONCLUSION**
MR X-ray fusion images produce exquisite quality images that can determine the spatial orientation of the lesion in relation to the eloquent and noneloquent areas of the brain, which is helpful for the endovascular therapists, neurosurgeons and stereotactic radiosurgeons.

**KEY WORDS:** MR imaging, X-ray, fusion

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**Poster 167**

Testing Methods and Standards for Magnetic Resonance (MR) Safety and Compatibility of Neurologic Devices

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**PURPOSE**
MR safety and image compatibility are recognized internationally as important issues for medical devices. ASTM International F2503-05 provides comprehensive marking requirements. FDA guidelines, first European EN (European Committee for Standardization) and international ISO (International Organization of Standardization) standards contain MR safety and imaging compatibility requirements. Medical devices and items that can be exposed to an MR environment must be tested to several different interactions (e.g., magnetically induced forces, torques, RF heating, induction of voltages and safe functioning) as well as MR image artifacts. Standardized test results will increase patient safety and provide important information to the MR user and device manufacturer.

**MATERIAL & METHODS**
Magnetically induced displacement forces can be measured via the deflection angle generated by the magnetically induced force. The forces are dependent on the static magnetic field, the gradient $\nabla B$ in the fringe field and the magnetic saturation of the device material. Magnetically induced torque aligns the device relative to the orientation of the main magnetic field. The torque depends on the device dimensions and the magnetic saturation and is measured at the magnet isocenter. Testing methods of force and torque are provided by ASTM F2052 and F2213 e.g. for aneurysm clips, stents but also for other devices like neurostimulators. Radio frequency (RF) induced heating is an important MR safety issue. Radio frequency pulses are in the area of MHz and apply the main amount of heating energy. This topic is complex and multiparameter dependent. Not only device properties like electric conductivity, dimension, etc. have to be considered, but also geometric arrangement relative to the specific MR environment (e.g. configuration and orientation of neurostimulator leads). ASTM F2182 provides a basic test method. Computer simulation of electromagnetic fields, SAR and temperature distribution is an important tool and assist in heating testing. Gradient magnetic fields contribute negligibly to heating effects due to the lower frequencies in kHz range. However, as well as RF pulses, switched gradients can induce voltages in conductive wires, loops and structures and can increase the risk of unintended tissue stimulation or can lead to burns or even fire by spark discharges. So far, no appropriate standardized test method for induced voltages is available. The safe functioning is a concern for the MR system and the device respectively. Devices as for example neurostimulators must undergo an individual test procedure as well as hydrocephalus valves or pressure sensor units. MR imaging artifacts can lead to significant lack of information and thus shall be included in device labeling with results from ASTM F2119 standard test method.

**RESULTS**
Comprehensive investigation of all interactions and worst-case scenarios is necessary. MR test methods for magnetic force, torque, RF heating and MR artifacts already are established and need continuous redefining. Further issues have to be examined for standardization. Multiparameter dependent issues need implementation of computer simulation.

**CONCLUSION**
Standardized MR testing of neurologic medical devices is compulsory for minimizing patient risk, providing the MR user with a comprehensive safety labeling and guide manufacturers in device development.

**KEY WORDS:** MR imaging safety, magnetic resonance imaging, stent, coil, clip, valve, stimulator, sensor

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**Poster 168**

Phase Contrast MR Angiography with Quantitative Analysis of Blood Flow Rates in Assessment of Intracranial Stenosis before and after Treatment with a Self-expanding Stent

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**PURPOSE**
Balloon angioplasty and stenting are becoming common treatment options for the treatment of symptomatic intracranial stenosis caused by atherosclerosis. It was our purpose to assess the ability to obtain hemodynamic evaluation using quantitative MR angiography (QMRA) before and after angioplasty and stenting in patients treated with a new self-expanding stent designed for use in the intracranial circulation.

**MATERIALS & METHODS**
Between November 2005 and September 2006, 32 patients were treated in our institution with a self-expanding stent designed for use in the intracranial circulation (Wingspan®). In five of these subjects QMRA was performed before and within 24 hours after stenting. Results of the immediate prestenting and poststenting digital subtraction angiograms (DSA) were compared to those obtained with the QMRA.
RESULTS
The average percentage of initial stenosis was 73% (range, 60%-85%); this was reduced to 25% (range 4%-40%) after stenting. The mean increase in arterial flow rate was 121 ml/min (range, 11-221 ml/min) after the procedure. There was no immediate complication after stent deployment. All patients were either clinically stable or improved at the time of their last follow up after (3 to 5 months).

CONCLUSION
In this small series, use of the Wingspan® was safe and effective in the treatment of symptomatic intracranial stenoses. QMRA provides a noninvasive way for measuring blood flow before and after endovascular treatment. Although more extensive study is required, this method seems to have considerable potential as a tool for both improving patient selection for treatment as well as in follow up of patients that have been treated with angioplasty and stenting.

KEY WORDS: Quantitative MR angiography, blood flow, stent

Poster 169

Intrinsic Pathway-mediated Apoptosis in Elastase-induced Aneurysms in Rabbits

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PURPOSE
The pathophysiology of saccular aneurysms is complex and multifactorial. The aim of the present study was to understand the mechanism of apoptosis in elastase-induced aneurysm model in rabbits.

MATERIALS & METHODS
Elastase-induced saccular aneurysms were created at the origin of the right common carotid artery (CCA) in 24 rabbits. Aneurysm samples were harvested at 2 and 12 weeks after aneurysm creation. Expression of apoptosis-associated proteins (caspases and Bcl-2 proteins) were assessed by Western blots (n = 6 at both time points), TUNEL staining, which indicates the presence of apoptosis, was performed in tissue sections (n = 6 at both time points). The contralateral CCA was used as a control.

RESULTS
Expression of active caspase-3 (final executioner of apoptosis) and caspase-9 (mediator of intrinsic mitochondrial pathway) was found in aneurysms at 2 weeks only, whereas the expression of activated caspase-8 (mediator of extrinsic death receptor pathway) was absent at both time points. Expression of anti-apoptotic proteins, Bcl-2 and Bad, was down-regulated at 2 weeks, whereas there was no change in Bcl-2 and Bad expression at 12 weeks. These results were confirmed by the presence of TUNEL positive cells in aneurysms at the early time point.

CONCLUSION
Activation of apoptosis in elastase-induced aneurysms is mainly mediated by Bcl-2 mediated-intrinsic pathway through the activation of caspase-9.

KEY WORDS: Aneurysm, apoptosis
CONCLUSION
Our study investigates the growth behavior of an AcoA aneurysm and examines the feasibility of using growth behavior to define risk of rupture for small AcoA aneurysms.

KEY WORDS: Aneurysms, hemodynamics

Poster 171
Effect of Antiplatelet Therapy on Thromboembolic Complications of Elective Coil Embolization of Cerebral Aneurysms

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PURPOSE
Thromboembolic events are the most common complications of elective coil embolization of cerebral aneurysms. Administration of oral clopidogrel and/or aspirin could lower the thromboembolic complication rate.

MATERIALS & METHODS
Records over a 10-year period were reviewed in a retrospective cohort study. For 369 consecutive elective coil embolization procedures, 25 patients received no antiplatelet drugs, 86 received antiplatelet drugs only after embolization, and 258 received antiplatelet drugs before and after embolization.

RESULTS
Symptomatic thromboembolic complications (transient ischemic attack or stroke within 60 days) occurred in 4/25 (16%) when no antiplatelet drugs were given, in 2/86 (2.3%) when antiplatelet drugs were administered only after embolization, and in 5/258 (1.9%) when antiplatelet drugs were administered before and after embolization. The lower symptomatic thromboembolic complication rate in the patients who received any antiplatelet therapy was statistically significant (p = .004). Intraprocedural angiographically visible clots were not associated with postprocedural symptoms in 4/258 (1.6%) in whom antiplatelet drugs were administered before procedures and in 5/111 (4.5%) in whom they were not (ns), but 7/9 of such clots were lysed or mechanically disrupted. Extracerebral hemorrhagic complications occurred in 11/344 (3.2%) who received antiplatelet drugs and in 0/25 (0%) who did not (ns).

CONCLUSION
Oral clopidogrel and/or aspirin significantly lowered the symptomatic thromboembolic complication rate of elective coil embolization of cerebral aneurysms. There were trends toward a lower rate of intraprocedural clot formation in patients given antiplatelet drugs before procedures and a higher hemorrhagic complication rate in patients given antiplatelet drugs. Benefits of antiplatelet therapy appear to outweigh risks.

KEY WORDS: Cerebral aneurysm, coil embolization, thromboembolic complication

Poster 172
Gene Expression Profiling of Experimental Saccular Aneurysms Using DNA Microarrays

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PURPOSE
The molecular characteristics of the pathophysiology of saccular aneurysms remain poorly understood. The purpose of study is to investigate the expression of various groups of genes in elastase-induced saccular aneurysm in rabbits using DNA microarray experiments.

MATERIALS & METHODS
A microarray of rabbit genes of interest was constructed using rabbit nucleotide sequences from GenBank. Each of these candidate genes was chosen based on potential involvement in processes considered key in aneurysm pathophysiology, including vessel wall remodeling, extracellular matrix degradation, transcription factors, oxidative stress, and apoptosis. Elastase-induced saccular aneurysms were created at the origin of the right common carotid artery (CCA) in 12 rabbits. Two weeks (n = 6) and 12 weeks (n = 6) after aneurysm creation, RNA was isolated from the aneurysm as well as the contralateral, left CCA and used for microarray experiments. The left CCA was used as the control. Quantitative reverse transcriptase-polymerase chain reaction (RT-PCR) was performed on randomly selected 10 genes for the validation of microarray results.

RESULTS
Out of 209 genes, 158 (75%) genes at 2 weeks and 82 (39%) genes at 12 weeks demonstrated statistically significant differential expression between aneurysm tissue and the control tissue (p < 0.05). Expression of cell adhesion molecules and antioxidant enzymes were down-regulated at 2 weeks but were not significantly different from controls at 12 weeks. The genes implicated in the blood coagulation cascade and in vessel wall remodeling were found to be elevated at 2 weeks and at 12 weeks. Tissue-type plasminogen activator was down-regulated at the early time point and urokinase plasminogen activator was up-regulated at the later time.
Effect of Spatial Resolution of Voxel Data on the Accuracy of Wall Shear Stress Calculation

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PURPOSE
Hemodynamics, especially wall shear stress (WSS), plays a very important role in the development and growth of vascular diseases such as aneurysms and atherosclerosis. We are now developing in-house software for calculating WSS based on the data of both 3D cine PC MR imaging, which provides us with 4-dimensional information of flow including space and time, and MR angiography. Spatial resolution of voxel data, such as 3D cine PC MR imaging, is estimated to have a great effect on the accuracy of calculated WSS. The purpose of our study was to investigate the effect of spatial resolution of voxel data on the accuracy of WSS calculation based on the data obtained by computational fluid dynamics (CFD).

MATERIALS & METHODS
We created tetrahedral mesh for seven virtual vascular models (L-shaped model, two T-shaped models (one vertically and one horizontally positioned), Y-shaped model, stenotic model, aneurysm model and U-shaped model) with main trunk diameters of 7 mm and performed CFD for the models with the use of finite element method. Constant flow of 45 cm/s was applied to the inlets of the main trunks and Reynolds number was set at 874. Using the CFD data on unstructured grid we created voxel data sets, which includes 3-directional flow information, with a voxel spacing of 0.8 mm, 0.4 mm, 0.2 mm, and 0.1 mm. Our in-house software calculated the WSS from both the CFD data and the voxel data sets based on three interpolated shearing velocities at regular intervals (d = 1.05 times as compared with voxel spacing) of the normal to the wall. We compared the WSS obtained by the CFD data on unstructured grid and the WSS obtained by the voxel data.

RESULTS
When the regular interval (d) of the three interpolated shearing velocities was the same in the calculation of WSS, there was good correlation between WSS obtained by CFD data on unstructured grid and WSS obtained by voxel data. However, WSS varied depending on the value of the regular interval (d) of three interpolated shearing velocities. Spacing of voxel data should be as short as possible. Real WSS was thought to be obtained from the voxel data with voxel spacing less than 0.2 mm.

CONCLUSION
Spatial resolution of voxel data, such as 3D cine PC MR imaging, had a great effect on the accuracy of calculated WSS. Spacing of the voxel data should be as short as possible. Real WSS was thought to be obtained from the voxel data with voxel spacing less than 0.2 mm.

KEY WORDS: Wall shear stress, cine phase contrast MR imaging, computational fluid dynamics
CONCLUSION
Endovascular treatment is an effective method for the treatment of anterior communicating artery aneurysms allowing late rebleeding prevention. However, additional caution is warranted since there is an increase incidence of early rebleeding episodes.

KEY WORDS: Aneurysms, endovascular treatment

Poster 175
Multisequence 3T MR Angiography for Improved Noninvasive Evaluation of Aneurysms Treated with Endovascular Detachable Coils

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PURPOSE
Long-term follow-up is necessary for intracranial aneurysms treated with endovascular detachable coils. The purpose of this study was to improve the current noninvasive MR angiography (MRA) techniques utilized to evaluate for aneurysm residua using various alternative MRA pulse sequences at high field (3T).

MATERIALS & METHODS
We enrolled 11 patients in our study and utilized multiple MRA techniques to evaluate treatment outcome. Each patient received routine 3D time-of-flight (3D-TOF) MRA, ultrashort TE 3D-TOF MRA, bolus contrast-enhanced TRICKS MRA, and high-resolution (small FOV centered on the aneurysm, 384 x 384 matrix) 3D-SPGR contrast-enhanced MRA. Each patient had 3D-TOF imaging performed followed by bolus tracking TRICK MRA, and finally 3D-SPGR MRA. MultiHance contrast material (0.2 ml/kg) was utilized due to its increased T1 relaxivity. All patients were imaged on a 3T GE MR imaging system. Each MRA study was interpreted by two neuroradiologists at a dedicated 3D workstation (GE AW 4.1), and comparison was made to recent digital subtraction angiography results for each patient.

RESULTS
All MRA techniques provided useful information for postsurgical evaluation of endovascular aneurysm repair; however, 3D-SPGR MRA provided the most additional information. The extremely high spatial resolution of the SPGR technique coupled with its broad contrast noise ratio allowed for the most detailed depiction of residual aneurysms, especially those at the internal carotid artery bifurcation, basilar artery, and ACOM region. 3D-SPGR allowed for a more accurate depiction of contrast filling at the neck/base of the aneurysm, often times showing filling in and around coils not appreciated with the other modalities. 3D-SPGR MRA provided the greatest agreement in comparison to DSA, in some cases offering valuable information not available with DSA. Bolus contrast TRICKS MRA was useful for evaluation of aneurysms in the cavernous and proximal supraclinoid segments of the internal carotid arteries. TRICKS MRA also provided useful temporal flow characterization of the circle of Willis. However, TRICKS MRA was hampered by its lower spatial resolution compared to 3D-TOF and 3D-SPGR MRA techniques.

CONCLUSION
Targeted high-resolution contrast-enhanced 3D-SPGR MRA and bolus contrast TRICKS MRA techniques offer many unique advantages to routine and short TE 3D-TOF MRA in evaluation for residual flow in treated aneurysms. Both TRICKS and 3D-SPGR MRA should be considered useful clinical adjuncts to the currently employed MRA techniques utilized to follow treated aneurysms.

KEY WORDS: Aneurysms

Poster 176
Endovascular Therapy of Very Small Ruptured Aneurysms Is Associated with Higher Perforation Risk

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PURPOSE
Cerebral aneurysm perforation during endovascular therapy of intracranial aneurysms is associated with a mortality rate of more than one third. Aneurysms in a ruptured state are a known risk factor for procedure-related perforation. The purpose of this study was to evaluate 1) whether very small ruptured aneurysms are associated with higher perforation risk 2) the impact of balloon-assist remodeling as a life-saving, hemostatic adjunct.

MATERIALS & METHODS
We reviewed our series of all ruptured aneurysms coiled from 1993 to 2006 (n = 616). We defined very small aneurysms as 3 mm or less, and identified 59 (51 aneurysms
were 3 mm and 8 aneurysms were 2 mm). Aneurysms were located in the anterior (n = 44) and posterior circulation (n = 15). Procedural perforation, defined by contrast extravasation during procedure, was recorded.

RESULTS
Procedural perforation occurred in 6/59 (10%) very small aneurysms, compared to 16/557 (2.9%) of aneurysms greater than 3 mm (p = 0.013). Protamine was administered immediately in all cases when contrast extravasation was identified. Four of the six patients with very small aneurysms that perforated had a balloon positioned adjacent to the aneurysm prior to perforation. Immediate inflation of the balloon for hemostasis was performed in three patients for 2 to 3 minutes resulting in bleeding arrest in all three. In the fourth patient, bleeding stopped rapidly while coiling. One patient developed hemostasis at the perforation site before a balloon could be positioned. The last patient developed increased intracranial pressure so rapidly that access for balloon navigation could not be visualized. This patient died, despite placement of a ventricular drain and optimal medical therapy. The Glasgow Outcome Score (GOS 4 or 5) was good in the remaining five patients.

CONCLUSION
Endovascular coiling of very small (3 mm or less) ruptured cerebral aneurysms is associated with a higher procedure-related perforation risk. Placement of a balloon near the aneurysm should be considered prior to coiling and could be life-saving in the event of perforation.

KEY WORDS: Aneurysm, endovascular therapy, complication

Rapid Clearance of Cisternal Clot in Acute Endovascular Surgery for Aneurysmal Subarachnoid Hemorrhage

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PURPOSE
The purpose of this study is to compare the rapidity of subarachnoid blood clearance, the incidence of delayed ischemia and shunt-dependent hydrocephalus (SDHC) and short term outcome in aneurysmal subarachnoid hemorrhage (SAH) patients treated by endovascular and microsurgical techniques.

MATERIALS & METHODS
Our retrospective analysis was comprised of 48 endovascularly (group A) and 46 microsurgically treated SAH patients (group B). To evaluate the clot clearance we assessed the semiquantitative SAH scores in each patient on serial computed tomograms (CT) obtained on admission and in the following periods of the 1st-3rd, 4th-6th, 7th-9th, and 10th-12th day after the ictus by the method of Hijdra et al. to determine the amount of cisternal blood on CT images. Briefly, the amount of extravasated blood in each of 10 individual cisterns and fissures (i.e., the interhemispheric- and the bilateral lateral- and basal Sylvian fissures, and the bilateral suprasellar- and ambient-, and the quadrigeminal cisterns) was graded (0 = no blood, 1 = small amount of blood, 2 = moderately filled with blood, 3 = completely filled with blood) and the summed score of subarachnoid blood (SAH score), ranging from 0 - 30, was calculated by adding these 10 individual scores derived from serial CT images. The incidence of delayed ischemia and SDHC and the short term outcome was determined by reviewing serial CT images and clinical records.

RESULTS
In group A, the mean SAH score on admission and in each of the following periods was 19.0, 11.3, 3.9, 1.6, and 0.5, respectively. In group B, these scores were 19.2, 13.1, 8.1, 3.6, and 1.8 (Fig). Statistical analysis revealed that after the period of 4th–6th post-SAH day, the SAH scores of group A patients were consistently lower than in group B. Cerebral infarction due to delayed vasospasm occurred in five (10.4%) group A patients and 12 (26.1%) patients in group B. These results in two groups differed significantly (P < 0.05). Seven (14.6%) group A and 11 (23.9%) group B patients required a CSF shunt for chronic hydrocephalus. The intergroup difference was not statistically significant. The median and mean value of the modified Rankin Scale at discharge was 0 and 1.0 in group A and was 1 and 1.2 in group B. The intergroup difference was not statistically significant.

CONCLUSION
Endovascularly treated patients manifested more rapid cisternal blood clearance and a lower incidence of delayed ischemia and SDHC than patients treated by microsurgery, whereas the short-term prognosis did not demonstrate significant difference among these treatment groups.

KEY WORDS: Subarachnoid hemorrhage, clearance, comparative study
Poster 178

Will This Help My Headache? Headache in Coiled Aneurysm Patients

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PURPOSE
The mechanism of headache in patients with ruptured cerebral aneurysms is thought to be the result of meningeal irritation from subarachnoid hemorrhage (SAH). Endovascular coiling (EC) of aneurysms is a less invasive but effective treatment; however it does not allow for removal of subarachnoid blood. We report our experience of unexpected headache relief in patients undergoing EC.

MATERIALS & METHODS
We reviewed our registry of consecutive patients undergoing endovascular interventions. We then prospectively surveyed these patients for the presence of headache, headache characteristics, and pain management. We also reviewed charts for inpatient pain medication administration. From this population we selected those patients who underwent EC of aneurysms for our results.

RESULTS
We identified 26 surviving patients, 6 men, mean age 63 ± 26.9 years. All patients received standardized pain management during their hospitalization. Nineteen patients reported preprocedural headache (PrPHA), 9 reported postprocedural headache (PoPHA) (p = 0.012). Of patients with SAH, 100% reported PrPHA, while only 30% reported PoPHA (p = 0.005). Of the patients without SAH, 54% reported PrPHA, and 34% with PrPHA (p = 0.69).

CONCLUSION
Endovascular coiling of aneurysms offered significant headache relief, especially in patients with SAH, despite the inability to remove blood. This suggests a mechanism for SAH headache different from that currently believed accurate.

KEY WORDS: Aneurysm, headache

Poster 179

Angiographic Outcome of Intraarterial Milrinone on Cerebral Vasospasm after Subarachnoid Hemorrhage

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PURPOSE
Cerebral vasospasm remains an important complication of subarachnoid hemorrhage (SAH). The goal of this study was to determine whether there is a change in arterial diameter after intraarterial milrinone infusion for cerebral vasospasm secondary to SAH.

MATERIALS & METHODS
We retrospectively reviewed the procedure reports, clinical charts, CT and angiograms of patients with symptomatic cerebral vasospasm after SAH. Eight independent vascular radiologists retrospectively reviewed angiograms of cerebral vessels treated (or not) by intraarterial infusion of milrinone. The arterial diameter assessment was blinded. For each vessel of interest, two images were presented in random order of a vasospastic vessel that was pre, post or without milrinone treatment. The study group included arteries that received milrinone with or without balloon angioplasty. Controls corresponded to arteries diagnosed with or without vasospasm and that did not receive milrinone. Changes in the arterial diameter were coded as 1; afterwards they were pooled and the mean score was compared.

RESULTS
Twenty-one patients underwent angiograms for symptomatic vasospasm after SAH between October 2004 and August 2006. Nine cerebral arteries treated with intraarterial milrinone were compared to nine control arteries for arterial diameter change. Improved arterial diameter was seen significantly more in arteries after milrinone than in controls (8/9, 88% vs.1/9, 11%, p = 0.003).

CONCLUSION
Intraarterial milrinone improves angiographic vasospasm after SAH. The durability of this effect is unknown. Further prospective studies comparing the intraarterial with or without complementary intravenous infusion result on intracranial artery diameter as well as clinical impact are warranted.

KEY WORDS: Vasospasm, milrinone, intraarterial
artery (n = 4), the anterior communicating artery (n = 1), and the basilar artery (n = 3). Aneurysmal rupture was attributable to microcatheter and delivery wire perforation in one case each, and to coil perforation in the other six cases. We used anesthesia records to assess rupture-associated changes in the blood pressure and pulse rate and compared these findings with the patients’ status after the endovascular procedure.

RESULTS
The mean time lapse between aneurysm rupture and confirmed hemostasis was 5.6 min (range 2-18 min). Three patients with rupture attributable to coil perforation exhibited no changes in their blood pressure and cardiac rate at the time of rupture; bleeding, lasting for a mean of 3.0 min was arrested by resumed coil insertion. In three patients the blood pressure was elevated moderately; three manifested systolic pressure as high as 160 mmHg and the intravenous administration of nicardipine hydrochloride decreased their blood pressure to below 120 mmHg. In these three patients there was no change in the cardiac rate. The mean bleeding time in these three patients was 4.6 min. Outcomes of these six patients were good, but two patients who accepted remarkable blood pressure rise and bradycardia after rupture died a few days after the operation. None of the six surviving patients, including two treated by ventricular drainage, developed symptomatic vasospasm or hydrocephalus. Digital subtraction angiography performed a mean of 14 months postoperatively showed no evidence of recanalization requiring treatment, and none of the six patients suffered aneurysmal re-rupture in the course of 10-51 month follow up (mean 28.8 months).

CONCLUSION
Satisfactory treatment outcomes may be obtained in patients whose blood pressure can be controlled and whose cardiac rate does not change at the perioperative rupture of aneurysms undergoing endovascular embolization. On the other hand, the prognosis of patients manifesting a considerable, uncontrollable rise in their blood pressure and/or severe bradycardia are at risk for a fatal outcome. Early hemostasis by the continued embolization, blood pressure control, preoperative lumbar vertebral drainage, and postoperative ventricular drainage to manage intracranial pressure may limit the degree of brain damage in patients with perioperative aneurysmal rupture.

KEY WORDS: Aneurysm, embolization, rupture

Poster 181

Poster Circulation Stroke following Embolization of Glomus Tympanicum: Relevance of Anatomy and Anastomoses of Ascending Pharyngeal Artery

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PURPOSE
Embolization in the territory of ascending pharyngeal artery can be unsafe even after detailed pretherapeutic angiographic evaluation due to change in hemodynamics and opening of anastomotic channels. The terrain and major anastomoses of ascending pharyngeal artery are reviewed with a case of posterior circulation stroke following embolization of glomus tympanicum tumor.

MATERIALS & METHODS
A 60-year-old female was referred to department of otolaryngology by general practitioner with a 2-year history of left-sided pulsatile tinnitus. Otoscopy revealed a red, smooth, pulsatile lesion behind the tympanic membrane. CT and MR scan confirmed the presence of a small soft tissue mass in the left middle ear cavity inferior to the middle ear ossicles consistency with glomus tympanicum tumor. A diagnostic angiogram was performed to evaluate the vascular anatomy and the feeder of the glomus tumor. Selective left ascending pharyngeal angiography showed an intense tumoral blush in the left petrous temporal bone region being fed by the inferior tympanic artery, a branch of neurovascular division of ascending pharyngeal artery. Selective cannulation of inferior tympanic artery is achieved by coaxial microcatheter system. The glomus tympanicum tumor was emoblized using contour PVA particles of 150-250 um. At the end of the particulate injection the patient became disoriented and confused, neurologic examination was otherwise unremarkable. The check angiogram showed near total devascularization of the tumor and filling of left vertebral artery through anastomotic channel between the left ascending pharyngeal artery and the vertebral-basilar artery. MR imaging performed 5 days later showed a focal wedge-shaped infarct in the right medial and inferior cerebellar hemisphere and multiple small hyperintense foci in bilateral posterior cerebral artery territory, in temporal-occipital lobes and thalami. The appearance was consistent with the reflux of particles in posterior circulation. However patient made a good clinical recovery following posterior circulation stroke in 6 weeks and was successfully operated for the glomus tumor.

RESULTS
In this case the glomus tympanicum tumor was supplied by inferior tympanic artery, a branch of ascending pharyngeal artery. There was no connection seen between ascending pharyngeal and vertebral artery on pretherapeutic diagnostic angiogram. However patient suffered a posterior circulation stroke following embolization of glomus tumor probably secondary to change in hemodynamics and opening of anastomotic channel between ascending pharyngeal and vertebral artery allowing reflux of particles in posterior circulation. The ascending pharyngeal artery has potential anastomoses to all neighboring major arteries, and that anastomoses to the vertebral artery are through the hypoglossal branch and the musculospinal branch. This case highlights the importance of potential vascular anastomotic channels as a cause for ischemic complication during embolization procedure. It also highlights the fact that dangerous anastomoses may only be visualized in later phase of embolization probably due to change in the hemodynamic pressure.

CONCLUSION
The ascending pharyngeal artery has importance in multiple clinical situations in which interventional neuroradiology management plays a central role. Apart from the technical skills and embolization technique, the detailed knowledge of anatomy, anastomoses, and hemodynamics is mandatory for safe embolization procedure in ascending pharyngeal artery territory.

KEY WORDS: Glomus tympanicum, ascending pharyngeal artery, embolization
Poster 182
Cerebral Micro Arteriovenous Malformations: A Series of 20 Cases
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PURPOSE
Microarteriovenous malformations (microAVMs) are a rare subgroup of brain AVMs representing less than 10% of these, and are characterized by a nidus of less than 1 cm. Few collected series have been reported. Our purpose was to assess the clinical presentation, radiologic features, therapeutic management, and outcomes of these lesions.

MATERIALS & METHODS
We analyzed a series of 20 patients with microAVMs. We retrospectively reviewed all angiographies performed at our Institution (from 2000-2006) for diagnosis of AVMs. We selected a total of 20 patients who presented AVMs with a nidus diameter of less than 1 cm or without clearly identifiable nidus but had an early draining vein. MR imaging and dynamic MRA with contrast was performed in 13 patients. Clinical history and all neuroradiologic studies (CT, MR, MRA and angiography) were examined. We also evaluated therapeutic management and final prognosis.

RESULTS
Average age at presentation was 39.4 years. All patients, except one in whom the AVM was found incidentally on a carotid angiogram, presented with intracranial hemorrhage. We demonstrated 16 supratentorial and four infratentorial micro AVMs. The identification of an arterialized draining vein with an almost imperceptible nidus communicating with very small afferent vessels was the most common finding. MR imaging and dynamic MRA with contrast was performed in 13 patients. Clinical history and all neuroradiologic studies (CT, MR, MRA and angiography) were examined. We also evaluated therapeutic management and final prognosis.

CONCLUSION
MicroAVMs typically present with generally large intracranial hemorrhages with associated significant neurologic deficit in young adults. A high index of suspicion is necessary to detect microAVMs especially since these lesions may go undetected on routine diagnostic workup. If initial angiography is negative or dubious, delayed or superselective angiography is recommended. Innovative tools such as dynamic contrast MRA or conventional T2-weighted imaging with very thin slices may reveal the existence of these lesions even in cases with negative DSA, although these techniques can be difficult to be performed in the emergency context.

KEY WORDS: Micro arteriovenous malformations, intracranial hemorrhage, angiography

Poster 183
Cementoplasty of Maxillofacial Arteriovenous Malformations Involving Bone
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PURPOSE
To describe this complementary therapeutic approach in patients with facial arteriovenous malformations involving bone.

MATERIALS & METHODS
Retrospective revision of three patients with high flow arteriovenous malformation of maxillofacial region treated in our center by means of superselective arterial embolization, soft tissue direct puncture and/or bone puncture with thick needle and polymethylmethacrylate injection.

RESULTS
The age of patients was 8, 12, 19 years. They had history of repeated episodes of hemorrhages demanding transfusions and several transarterial embolization sessions. Angiography study showed complex high flow arteriovenous malformations with bone compromise in plain films, CT and MR imaging. Percutaneous puncture and polymethylmethacrylate injection was performed under fluoroscopy as complementary treatment to intraarterial embolization. In all cases the procedure produced immediate hemostasis in acute bleeding and no new hemorrhagic episodes have been registered at 1, 2 and 4 years respectively at follow up.

CONCLUSION
Bone direct puncture with thick needle and polymethylmethacrylate injection as complementary therapeutic procedure of maxillofacial arteriovenous malformation seems to be safe and useful, in terms of hemostasis and preventing new bleeding.

KEY WORDS: Arteriovenous malformation, polymethylmethacrylate, maxillofacial
Poster 184
Imaging Findings of a Patient with Incomplete Phenotypical Expression of the Syndrome PHACES
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PURPOSE
PHACES syndrome is a very rare disorder with around 150 cases presented upto date. Its name derived from various findings which may include posterior fossa malformations, hemangiomas, cardiac defects and coarctation of aorta, eye abnormalities, sternal and abdominal raphe defects. In a recent paper, Baccin et al reported dolichoectatic type segmental elongation of intracranial arteries in two patients with PHACES. We present a 10-year-old girl with dolichoectatic elongation in right supraclinoid internal carotid artery (ICA) and M1 segment of middle cerebral artery (MCA)

MATERIALS & METHODS
We present thorax CT, cranial MR and MRA and DSA of aorta and cranial arteries.

RESULTS
Cranial MR and MRA demonstrated a persistent trigeminal artery on the right side with elongation and complex coiling of the right supraclinoid ICA and M1 segment of the MCA. A drainage vein consistent with an AVM, was absent. A1 segment of the right anterior cerebral artery was absent as well. Another interesting finding was presence of dilated perivascular spaces in the right basal ganglia. Patient lacked any posterior fossa or cerebral malformation; with a normal perivascular spaces in the right basal ganglia. Patient lacked any posterior fossa or cerebral malformation; with a normal

CONCLUSION
Four different types of arterial anomalies associated with PHACES include: agenesis of cervical carotid arteries, persistent embryological vessels, arterial stenoses and dolichoectatic type intracranial arteries, the last one being not reviewed extensively in the literature. This last type which is the dominant feature of this syndrome in our patient, may easily be misdiagnosed for aneurysm or AVM. Baccin et al emphasized that presence of a hemangioma in a child with such changes of intracranial arteries should raise the suspicion of PHACES syndrome. Our case constitutes an exact example for that issue.

KEY WORDS: PHACES syndrome, dolichoectasia
**CONCLUSION**

The clival DAVF could be treated safely and effectively through transarterial embolization with liquid material.

**KEY WORDS:** Dural arteriovenous fistula, embolization, clivus

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**Poster 186**

Endovascular Management of Trapped Lateral Sinus Dural Arteriovenous Malformations via Direct Extradural Transcranial Route: Strategies and Techniques

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**PURPOSE**

Endovascular treatment of lateral sinus dural arteriovenous malformations (DAVM) which are trapped because of transverse sinus and jugular bulb occlusion is challenging because transarterial embolization is unlikely to be curative and percutaneous access not feasible. We describe our experience with transcranial endovascular management of these lesions using novel technical modifications. We demonstrate that endovascular cure of trapped lateral sinus DAVM can be achieved by embolization with coils and liquid agents via direct extradural transcranial route.

**MATERIALS & METHODS**

We reviewed all cases of lateral sinus DAVM treated between January 1996 and July 2006 via transcranial route at 2 neurovascular tertiary referral centers. Clinical records and imaging studies were analyzed. Clinical outcomes were assessed by modified Rankin Scale (mRS). Results

Three trapped lateral sinus DAVM (Borden type 2 or 3) were treated via transcranial route under general anesthesia. Two presented with venous hypertensive encephalopathy and one with cerebral hemorrhage (ICH). All had previous transarterial embolization with N-butyl cyanoacrylate (NBCA) or Onyx®. Positioning was modified supine in two and prone in one. Intra-op angiography was via transfemoral arterial sheath in all. Burr holes were localized using roadmap angiography. Direct transdural puncture of the trapped lateral sinus was performed through burr holes with a 14 or 20 gauge angiocath in two, and a 23 gauge butterfly needle in one. In one case intraoperative Doppler also was used for localization. All punctures were confirmed by direct contrast injection under fluoroscopy. The trapped lateral sinus was occluded by embolization with NBCA + liquid coils in one case, NBCA in one case and Hydrocoil® + Onyx® with dual microcatheters in one case. In every case post-op angiography demonstrated DAVM cure. There was no procedure-related morbidity. The mRS at discharge was 0-1 for two patients and three for the patient with ICH.

**CONCLUSION**

Endovascular management of trapped lateral sinus DAVM can be performed via direct extradural transcranial route with excellent angiographic and clinical results. Coils + liquid embolics can be used effectively. Prone positioning and dual microcatheter approach are technically advantageous.

**KEY WORDS:** Endovascular, embolization, DAVM

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**Poster 187**

Evaluation of Neuroform3 Stent Expansion in an Animal Vascular Model: An ex vivo Study Using C-Arm Mounted Flat Detector CT

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**PURPOSE**

The expansion characteristics of the currently available self-expandable Neuroform3 (NF3) in vascular structures stents are unknown. The purpose of this study is to evaluate the expansion characteristics of this stent in an ex vivo animal vascular model using C-arm flat detector CT (CFD CT).

**MATERIALS & METHODS**

A NF3 stent (3 x 15 mm, Boston Scientific) was deployed in a canine carotid artery. Rotational radiograms using a single C-arm angiographic system (Axiom Artis dFC, Siemens, Medical Solutions, Germany) of stent were obtained using the following parameters: 20 seconds, 0.4° increment, 512 matrix in projections, 220° total angle, 20°/second, and 543 projections. FD CTs (DynaCTs, Siemens Medical Solutions) were obtained by performing 3D reconstruction using volume rendering technique (VRT) and maximum intensity projections (MIPs) on a commercially available workstation (Leonardo, Siemens, Erlangen, Germany). The reconstruction parameters were as follow: manual mode, 512 x 512 image resolution, bone kernel with sharp image characteristics, and voxel sizes ranging from 0.057 mm to 0.061 mm. To evaluate the expansion characteristics of the NF3 stent, rotational radiograms of the stent were obtained at 2 hours, 3 hours, 25 hours, and 48 hours after deployment. In order to avoid shrinkage of the vessel wall by Formalin possibly stent deformation, the vessel was kept in a solution of saline and antibiotics.

**RESULTS**

Evaluation of the FD CTs demonstrated further expansion of the stent during the 48-hour period. The FD CT acquisitions obtained within first 3 hours after the deployment showed maximum expansion the stent diameter by 0.03 cm. Acquisition done at the twenty-fifth hour illustrated expansion of the stent by another 0.02 cm, and the forty-eighth-hour acquisition showed an additional 0.01 cm expansion. The FD CT acquisition done during the 48-hour period documented total expansion of the NF3 to be 0.06 cm in that time period. In addition, the stent demonstrated a decreasing trend to expand over time, where the maximum expansion took place during the first few hours after deployment of the stent.
CONCLUSION
NF3 stents show after deployment additional further expansion during a 48-hour time period that gradually decreases. This study indicates, that full expansion of NF stents is not seen immediately poststenting but not until 2-3 days postprocedure. Angiographic evaluation at the end of stent placement results may be insufficient to demonstrate the true "poststenting result." Further studies, including in vivo data are needed to fully understand expansion characteristics of self-expandable stents and their potential clinical impact.

KEY WORDS: Stent

Poster 188
A Rabbit Model of Vulnerable Plaque for Endovascular Research

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PURPOSE
There is increasing recognition of the importance of vulnerable plaque (VP) from acute plaque rupture leading to thrombosis, in carotid artery stent placement (CAS) for patients with carotid artery stenosis. This is fueling a number of developments, including novel imaging modalities, endovascular devices, and potential plaque stabilization therapies. In addition, histopathologic analyses cannot be performed because in CAS treatments we cannot directly remove a specimen from a lesion as is possible in a carotid endarterectomy. However, to date, no adequate animal model of VP has been established. We have, therefore, evaluated widely used animal models as a first step to establish animal models of VP in order to perform CAS safely. In this pilot study, we investigated a time course of the effect of a balloon injury to the aorta of rabbits fed with a high cholesterol diet using immunohistochemical and histologic examinations.

MATERIALS & METHODS
Eight male Japanese white rabbits with an initial mean weight of 3.2 kg (range 2.9-3.4) were used in this study. All animals were fed a 1% cholesterol diet for 22 weeks. We injured the aorta with a 4Fr Fogarty balloon catheter via an endovascular approach 6-13 weeks before sacrificing the animals. Standard paraffin-sectioning techniques and staining with hematoxylin and eosin, azan, macrophage (RAM 11) and 1A4 were performed to determine the presence of atherosclerotic changes.

RESULTS
Plaque formation in the aorta was prominent 9 weeks after balloon injury (Fig). In addition, immunohistochemical study revealed that plaque was rich in lipid (azan) and smooth cell actin (1A4).

CONCLUSION
Our results revealed histologic findings to be nearly consistent with the most common type of VP composed of a lipid core, a thin fibrous cap and infiltration with an increased number of macrophages. Although these findings are still preliminary, these results suggest there is a good possibility for establishing rabbit models of VP for use in investigating endovascular therapies such as CAS.

KEY WORDS: Vulnerable plaque, animal model

Poster 189
Influence of Stent Location and Orientation on Beam Hardening Artifacts in C-Arm Flat Detector CT

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PURPOSE
The poor radiographic visibility of intracranial Nitinol stents due to their small size, low radiopacity, and surrounding bony structures, is additionally compromised by beam-hardening artifacts. These artifacts are mainly caused by added platinum marker at the proximal and distal ends and can severely degrade image quality. The purpose of this study was to evaluate the role of location and orientation of a self-expandable Nitinol stent (Neuroform-3, BSC) on image quality using C-arm flat detector CT (CFD CT).

MATERIALS & METHODS
A self-expandable Nitinol intracranial stent (Neuroform 3, Boston Scientific) was used to evaluate the image artifacts of the stent in various orientations within a dry skull. The stent was deployed in a polytetrafluoroethylene (PTFE). Analogous to the normal cerebral vascular anatomy, the tube was placed within the skull in the most common stenting locations: M1, A1, basilar, vertebral artery, and carotid siphon. Rotational radiograms using a single C-arm FD system (Axiom Artis dFC, Siemens, Medical Solutions, Germany) of stent were obtained, using the following parameters: 20 seconds, 0.4° increment, 512 matrix in projections, 220° total angle, 20°/second, and 543 projections. CFD CT (DynaCT, Siemens Medical Solutions) were
obtained by performing 3D reconstruction using volume rendering technique (VRT) and maximum intensity projections (MIPs) on a commercially available workstation (Leonardo, Siemens, Erlangen, Germany). The reconstruction parameters were as follow: manual mode, 512 x 512 image resolution, bone kernel with sharp image characteristics, and voxel sizes ranging from 0.060 mm to 0.076 mm.

RESULTS
CFD CT demonstrated variations in stent visualization, image quality and the degree of artifacts caused in different locations and orientations. The effects of the stent orientation within the skull illustrated a greater amount of artifacts for both M1 and A1 segments. These artifacts were more pronounced around the stent’s platinum markers. The reconstruction for basilar and vertebral artery and the carotid siphon showed less artifacts.

CONCLUSION
This study confirms that quality of Neuroform-stent imaging using FD CTs is negatively affected by beam hardening artifacts which degree depends on the location and orientation of the stents. This should be considered when using CFD CT in clinical practice. Simple maneuvers such as head tilting may be useful in reducing disturbing beam hardening artifacts.

KEY WORDS: Stent

Poster 190

Improved Visualization of Self-Expanding Nitinol Stents Using 2K Matrix for Angiographic CT

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PURPOSE
Angiographic CT (ACT) with a C-arm-mounted flat detector has proved valuable for imaging of intracranial stents. Spatial resolution of current acquisition modes is limited due to necessary “binning” of detector elements. The purpose of this study was to evaluate the image quality obtained by using an “unbinned” acquisition mode.

MATERIALS & METHODS
Total of five patients underwent angiographic treatment for intracranial aneurysm and atherosclerotic stenosis. One of these cases was treated for intracranial aneurysm using Neuroform 3 Stent (Boston Scientific), four cases were treated for atherosclerotic stenosis using Wingspan Stent (Boston Scientific). ACTs were obtained using a bi-plane angiographic system with flat detector (AXIOM Artis dBA, Siemens Medical Solutions, Erlangen, Germany). In each patient, two different ACT programs were used with the following parameters: 1) 20s1k DR H (DynCT): 20 second rotation, 0.4° increment, 219° total angle, 1024/512 matrix, 543 projections/frames, small focus (0.6 mm), 1240 X 960 matrix, rotational speed of 11°/s, 27.2 frames/s, and system dose of 1.2 uGy. 2) 23s 2k DR H (DynCT): 23 second rotation, 1.2° increment, 166 projections/frames, micro focus (0.3 mm), 2480 x 1920 matrix, rotational speed of 8.7°/s, 7.2 frames/s, and system dose of 1.2 uGy. Image postprocessing was performed using volume rendering technique (VRT) and maximum intensity projections (MIPs) on a commercially available workstation (Leonardo, Siemens, Erlangen, Germany). The reconstruction parameters were as follow: manual mode, 512 x 512 image resolution, bone kernel with sharp image characteristics, and voxel sizes ranging from 0.1 mm to 0.15 mm.

RESULTS
The ACT provided excellent visualization of the entire stent architecture allowing for evaluation of each stents’ characteristics. The two acquisition modes used provided different degrees of stent visualization and image quality. The 1k mode provided smoother image contours with less background noise, whereas images obtained using the 2k mode were sharper while showing more background noise. The 2k images demonstrated clearly lesser beam hardening artifacts that were in the 1k images mainly seen around the distal and proximal stent markers, along with more blooming effects. Blooming effects were overall less prominent in the 2k images.

CONCLUSION
ACT using FD technology is capable to provide excellent in vivo visualization of self-expanding Nitinol stents. By comparison, the 2k mode proved superior to the 1k acquisition mode in terms of spatial resolution, beam hardening artifacts and blooming effects. The compromise of fewer projections (166 vs 543) is substituted by the 2-fold increase of spatial resolution (154 vs 308 microns).

KEY WORDS: Angiographic computed tomography

Poster 191

Angiographic Visibility of Cavernous Internal Carotid Artery Branches: Comparative Evaluation of an Image Intensifier and a Flat Detector Angiography System

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PURPOSE
Recent advancements in digital detector technology have contributed to the important role held today by digital x-ray imaging in the neurointerventional laboratory. The aim of our study was to compare the image quality of a new C-arm mounted flat detector (FD) with an image intensifier (II) previously used in our neurointerventional laboratory. Comparison of the image quality of the two systems was performed by assessing the visualization of small dual branchers of the cavernous segment of the internal carotid artery (ICA) such as the inferolateral trunk (ILT) and the meningo-hypophyseal trunk (MHT).

MATERIALS & METHODS
Retrospective review of 2246 cerebral angiography exams performed to identify patients with the minimum of one exam before and after replacing the II with FD system in September 2004. Eighty-three patients met this criterion of which 61 patients’ exam images were comparable. This study compared the images obtained from a biplane, multi-
field, flat detector (FD) (Axiom Artis dBA, Siemens Medical Solutions, Germany) with a biplane, multifield, image intensifier (II) system (Neurostar T.O.P., Siemens Medical Solutions, Germany) used for cerebral angiography in our neurointerventional laboratory. The lateral ICA projection of the standard angiography was chosen for this comparison. The detector matrix size was 1024 x 1024 for II and 960 x 960 for FD. For each patient, the used FD and II images had similar zoom factors and image matrix sizes. A scoring system was developed for the degree of visibility of the ILT, the MHT, and their branches; rating the visibility from 0 to 10. Images were reviewed by three independent readers. The overall scores obtained for each system were calculated by each reader. The mean of all three calculated overall scores for each system were used for comparison.

RESULTS
The mean of overall scores obtained for II system was 265.5 compared to 513 for FD system. The average visibility score for the MHT was 157.5 and 262 with II and FD respectively. The average visibility for the ILT was 108 and 251 with II and FD respectively.

CONCLUSION
FD system was superior to II system in visualizing small branches of ICA. The introduction of FD angiography system in the neurointerventional laboratory offer improvements in image quality of cerebral angiography over II system and enable radiologists to better detect small arteries in the cerebral circulation. It can be assumed that FD technology also improves the visualization of brainstem and basal ganglia perforators which may have significant clinical impact. Further studies need to be undertaken and are planned in our institution.

KEY WORDS: Digital detector technology

Poster 192

Puncture Site Management with Angio-Seal Closure Device after Diagnostic and Interventional Neuroradiologic Procedures

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PURPOSE
To evaluate the safety and efficacy of Angio-Seal closure device used to close arterial puncture sites in patients who underwent diagnostic and interventional procedures.

MATERIALS & METHODS
A total of 1443 Angio-Seal devices were placed in 1099 consecutive patients between March 2005 and August 2006. Of these, 670 procedures were interventional and 745 were diagnostic angiographic procedures. In 28 patients, bilateral puncture of the femoral arteries was performed for endovascular treatment. 5 Fr introducer sheath was used for the diagnostic procedures and 6 Fr for majority of the interventional procedures.

RESULTS
In 745 diagnostic procedures, six (0.80%) puncture-related complications were observed. Persistent bleeding due to device failure occurred after five (0.67%) procedures and femoral artery stenoses requiring surgery developed in one patient (0.13%). A total of 698 Angio-Seal closure devices were applied following 670 therapeutic interventional procedures. Hemostasis was successful in 665 (95.2%) closures. Major complication rate in the interventional group was 2.2% (21/968 closure). Of these, femoral artery stenoses requiring surgical repair occurred in one case (0.14%); groin hematoma requiring transfusion in five cases (0.71%); retroperitoneal hematoma requiring transfusion in five cases (0.71%) and groin infection associated with hematoma and pseudoaneurysm formation in one case (0.14%). Twelve patients (12/698, 1.7%) had oozing-type bleeding.

CONCLUSION
Our experience with relatively large series of patients supports that the use of the Angio-Seal STS vascular closure device is safe and effective in patients undergoing interventional procedures and diagnostic angiography with an acceptable rate of complication.

KEY WORDS: Closure device, puncture site, interventional

Poster 193

Community Hospital’s Experience with Intraarterial Fibrinolysis and Mechanical Embolectomy in Patients Who Present with an Acute Ischemic Event

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PURPOSE
Despite chemical thrombolysis for acute ischemic stroke being available since the 1990s, and more recently mechanical embolectomy, few hospitals outside of major academic institutions offer this therapy. The vast majority of patients with strokes present to nonacademic hospitals, and are unable to receive the benefits from either chemical or mechanical embolectomy. Our goal is to show a community hospital’s experience with intraarterial fibrinolysis and mechanical embolectomy in patients who present with symptoms of an acute ischemic event.

MATERIALS & METHODS
We retrospectively reviewed all patients presenting with an acute ischemic event treated with either the Merci Clot Retrieval Device (MERCI) or intraarterial fibrinolysis at a single community-based (nonacademic) hospital.

RESULTS
Between October 2005 and November 2006, a total of 21 patients were treated with either fibrinolytic and platelet disaggregating therapies or mechanical embolectomy, or a combination of both. The mean age for the cohort was 68 years (range, 29-87) and 43% were women. Ten patients received chemical thrombolysis, ten were treated with the MERCI system, and one received a combination of both. Mean symptoms to procedure time start time was 221 minutes (range,
30-420 minutes). In device only patients, partial recanalization was achieved in 20% (2/10), and complete recanalization, in 50% (5/10). In chemical thrombolysis only, partial recanalization was achieved in 50% (5/10), and complete in 50% (5/10). One patient was treated with mechanical and followed with intraarterial fibrinolysis, and achieved near complete recanalization. Three patients were unresponsive to device therapy, two had partial recanalization after suction aspiration and mechanical disruption of thrombus using rapid transit of microcatheters. Asymptomatic hemorrhage occurred in 9.5%, and symptomatic hemorrhage in another 9.5%. In-hospital mortality was 0%. Good functional outcome was achieved in 16/21 patients, while two patients had significant in-hospital morbidity.

CONCLUSION
The use of endovascular mechanical embolectomy and intraarterial fibrinolysis is an effective form of treatment at a community hospital. Good clinical outcomes occurred in over 75% of the patients, with symptomatic hemorrhage identified in less than 10%. The majority of patients with acute strokes present at community hospitals, and the use of chemical and mechanical fibrinolysis can be a safe and valuable treatment at these centers.

KEY WORDS: Mechanical embolectomy, intraarterial thrombolysis, community hospital

Poster 194
Assessment of Correlation of Baseline Poststenting Carotid Ultrasound with Poststenting Angiography
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PURPOSE
With growing acceptance of carotid angioplasty and stenting (CAS) in the treatment of carotid artery stenosis there is a need to accurately assess the degree of residual stenosis. The most common form of follow up is carotid Doppler ultrasound. The reliability of assessment of restenosis depends on an immediate baseline ultrasound study for comparison and the degree of concordance between that baseline study and the postprocedural angiographic measurement of residual stenosis. The purpose of our study is to evaluate the correlation of immediate baseline ultrasound to the postprocedural angiographic measurement of residual stenosis in carotid stent patients.

MATERIALS & METHODS
We conducted a retrospective review of 71 patients who underwent CAS stenting and immediate postprocedural ultrasound from June 2004 to December 2006. For each patient, the degree of residual stenosis immediately following stent deployment on angiogram [using the North American Symptomatic Carotid Endarterectomy Trial (NASCET criteria)] was compared to the percent residual stenosis on baseline ultrasound [defined by internal carotid artery (ICA) peak systolic velocity (PSV) and the ICA:common carotid artery (CCA) PSV ratio]. In cases of discordant results we attempted to identify anatomical features as a potential explanation for discordant results.

RESULTS
Seventy-one patients were studied. A relationship was observed between the poststent ultrasound and angiographic stenosis. Both the PSV and the ICA:CCA PSV ratio predicted the degree of stenosis (p < 0.05). However, kappa scores for agreement (κ = 0.02) were poor when both ultrasound and angiographic results were categorized in three (0-49%, 50-69% and 70-99% stenosis). Seventy-five percent of patients had poststent ultrasound measurements that were concordant with angiographic results; all of these were in the <50% category. In 25% of patients, ultrasound overestimated the stenosis, classifying the degree of stenosis 1 category more severe than angiography. This trend occurred most often in higher degrees of residual stenosis as measured by angiogram.

CONCLUSION
Ultrasound correlates well in patients with less than 30% residual stenosis on immediate postprocedural angiogram. In cases with a greater degree of residual stenosis the correlation is less reliable.

KEY WORDS: Carotid stenosis, ultrasound, restenosis

Poster 195
Intraarterial Thrombolysis of Occluded Middle Cerebral Arteries Using Collateral Pathways
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PURPOSE
Cervical internal carotid artery (ICA) occlusions associated with middle cerebral artery (MCA) embolic occlusion is associated with low recanalization rate and poor outcome after IV thrombolysis. Prompt revascularization is required to prevent disabling stroke. We report our results of endovascular treatment of eight patients presenting with acute cervical ICA occlusion with MCA embolic occlusion using collateral pathways.

MATERIALS & METHODS
We retrospectively identified eight patients with proximal ICA occlusion associated with MCA embolic occlusions treated with intraarterial thrombolysis (IA tPA). Access to the occluded MCA was obtained via cathether navigation through the intact collateral pathways including posterior communicating or anterior communicating arteries without passing a microcathether through the acutely occluded ICA. Clinical outcomes were assessed by using the modified Rankin scale (mRS) and National Institutes of Health Stroke Scale (NIHSS).

RESULTS
Eight patients with a mean age of 57 ± 4 years and median NIHSS of 14 were identified. Mean time from stroke onset to IA thrombolysis was 293 ± 16 min. The MCA was revas-
Use of SpiderX Protection Device-Protege Stent System in Carotid Artery Stenting: Initial Clinical Results with Midterm Follow Up

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PURPOSE
To evaluate the safety and efficacy of carotid artery stenting (CAS) procedure in the treatment of carotid artery stenosis using SpiderX (ev3, Minnesota,USA) protection device system and Protege stent (ev3, Minnesota,USA) combination.

MATERIALS & METHODS
Carotid artery stenting was performed in 189 patients (145 male, 44 female) with an age range of 22-84 years (mean, 67.2 years). SpiderX protection device system and Protege stent combination were used in all patients. All patients (189 patients, 214 stents) were evaluated clinically for stroke, death and myocardial infarction (MI) 1 month after the procedure. Moreover clinical follow up and Duplex scan at 6 months were done in 107 patients (125 stents). Of these, additional follow up was obtained at 12 months in 41 patients (46 stents). Postoperative diffusion MR imaging was performed in 100 patients.

RESULTS
Technical success was found to be 100% in our study. Rate of (stroke-death-MI) new adverse events (NAE) was 4.7% (9/189) in 1 month, 1.8% (2/107) in 6 months and none (0/41) in 12 months. Duplex scan showed mild restenosis in two patients (2/125, 1.6%). Both of these patients were asymptomatic and retreatment was not performed. Silent ischemic lesions were detected in postprocedural MR imaging in 35 of 100 patients (35%).

CONCLUSION
SpiderX protection device-Protege stent system is a useful combination for CAS procedures with high technical success and low NAE rates.

KEY WORDS: Carotid stenosis, embolic protection, stent
CONCLUSION
With already available better signal sensitivity of MR coils, partial parallel acquisition techniques, together with new perfusion evaluation techniques we can have much better insight to brain perfusion in different pathology states.

KEY WORDS: Perfusion, arterial input function (AIF), model

Poster 198
Combined Cerebellar and Cerebral Cortical Malformations

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PURPOSE
Radiologically, cerebral and cerebellar malformations usually are classified separately since a combined classification was proposed not to be feasible due to relative paucity of the coexistence. However same genetic mechanisms may underlie both conditions. We present two patients with cerebellar malformations and cortical anomalies; and discuss potential genetic defects that could lead to both cerebral cortical malformations and posterior fossa malformations especially cerebellar hypoplasia and dysplasia.

Materials & Methods
Case 1: A 41-year-old male patient had undergone MR imaging (MRI) for the first time in his life. He had a history of tonic-clonic convulsions a few times a year since he was 15 years old. His neurologic examination demonstrated nystagmus with the fast phase beating in the direction of gaze, truncal ataxia and mild mental retardation. MRI examination revealed severe cerebellar hypoplasia (near total absence). Brainstem was also hypoplastic. Supratentorial associating anomaly was a closed-lip type schizencephaly in the posterior or medial temporal lobe. Case 2: A 17-year-old male patient with a history of tonic-clonic convulsions since infancy presented with ataxia. He was on sodium valproate and free of seizures for the last 4 years. He had some abnormality of cerebellar tests on the right side. His mental status was normal. EEG was also within normal limits. Cranial MRI demonstrated hypoplasia of both cerebellar hemispheres more prominent with the right cerebellar hemisphere and also some folial dysplasia on the right side. His brainstem was normal in size. However bilateral periventricular nodular heterotopia (PNH) was present as the associating supratentorial anomaly.

RESULTS
The association of cerebellar dysplasia/hypoplasia with cerebral cortical malformations is unclear except lissencephaly with cerebellar dysplasia in which mutations of the reelin gene that is crucial for cell positioning in the brain or VLDLR for reelin signalling pathway are responsible. Regarding the first patient, EMX2 gene has been reported to be responsible for schizencephaly but its association with cerebellar hypoplasia is unknown. In the literature PNH, unlike the second patient, is reported to be usually a benign condition with no other existing anomalies. Abnormalities of the filamin 1 gene which is mapped to Xq28 is responsible and the disease also can be seen as X-linked dominant.

CONCLUSION
We do not know the genetical mechanism in the presented cases at least yet; however, the genetic studies are in progress.

KEY WORDS: Cerebellar hypoplasia, schizencephaly, periventricular nodular heterotopia

Poster 199
Human Primary Auditory Cortex Volume in Deaf and Normal Hearing Infants

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PURPOSE
This study investigates the relationship between primary auditory cortex (A1) volume and hearing status in infants with moderate to profound sensorineural hearing impairment. Although previous studies have shown similar A1 volumes in deaf and normal hearing adults (1), no study has illustrated this relationship in a pediatric population. Here we compare A1 volumes in hearing impaired versus normal hearing infants and correlate A1 volume with hearing loss in the hearing impaired infants.

MATERIALS & METHODS
Subjects include two groups of infants 9-17 months of age with normal hearing (NH, n=15) or moderate to profound sensorineural hearing impairment (HI, n=10). High resolution 3D T1 weighted images were obtained using a clinical 3T MRI scanner. ROIs were drawn by hand on contiguous coronal brain slices by an experienced reviewer in consultation with a pediatric neuroradiologist. Heschl’s gyrus was used to estimate auditory cortex volume. While marking landmarks, the anatomy was viewed concurrently in different 2D orientations. Volumes were calculated within the ROIs in left and right A1. Hearing thresholds were calculated for the HI group by averaging thresholds measured in dB over three sound frequencies (500, 1000, and 2000Hz).
RESULTS
A1 volumes of NH and HI subjects are presented in Table 1.

Table 1. Left and right A1 volumes (mm^3) in normal hearing and deaf infants

<table>
<thead>
<tr>
<th></th>
<th>Left A1 mean</th>
<th>Right A1 mean</th>
<th>Total A1 mean</th>
<th>Mean difference (L-R)</th>
<th>t-test</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>NH (n=15)</td>
<td>2.542</td>
<td>2.189</td>
<td>4.732</td>
<td>353</td>
<td>0.083</td>
<td></td>
</tr>
<tr>
<td>HI (n=10)</td>
<td>2.506</td>
<td>2.015</td>
<td>4.521</td>
<td>491</td>
<td>0.250</td>
<td></td>
</tr>
<tr>
<td>Mean difference (NH - HI)</td>
<td>36</td>
<td>174</td>
<td>211</td>
<td></td>
<td>0.923</td>
<td>0.721</td>
</tr>
</tbody>
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Differences in volume between left and right A1 in both HI and NH subjects were not statistically different. Additionally, there was no significant difference in total A1 volume between HI and NH groups. In the HI group, A1 volume correlated significantly (R = -0.719, p = 0.019) with hearing threshold (Figure 1).

CONCLUSION
Consistent with previous findings in adults (1), our preliminary results indicate that A1 volumes are not significantly different in NH and HI infants. The relationship between A1 volume in HI infants and hearing level indicates that early sound deprivation may alter auditory cortex development. Further investigation of gray and white matter composition within auditory cortex is warranted to better understand the relationship between auditory stimulus and brain development.

REFERENCES

KEY WORDS: Auditory cortex volume, infant, deaf

Posters

Diffusion-weighted Imaging in Cerebral Proliferative Angiopathy in a Premature Child Presenting with Stroke

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PURPOSE
Cerebral proliferative angiopathy or capillary ectasia is a rare ischemic disease of the brain that mimic diffuse arteriovenous malformation. The case presented depicts an extensive proliferative angiopathy in a premature child presented with ischemic signs and seizure probably secondary to hemodynamic disturbances induced by arteriovenous shunting. The ischemic change in the cerebral hemisphere is evaluated by diffusion-weighted imaging (DWI) and apparent diffusion coefficient (ADC) maps.

MATERIALS & METHODS
Case report: A 7-year-old child born premature at 33 weeks presented acutely with a right hemiparesis. He presented with sudden onset of right-sided weakness and slurred speech. He also developed right-sided focal seizure on day 3 of admission and was started on antiepileptic treatment. CT scan showed ischemic changes in the left frontal lobe with a small focus of calcification. MR imaging showed multiple tubular vessels with angiopathic changes and features of atrophy in left frontal lobe. Diffusion-weighted images (DWI) showed free diffusion in left frontal lobe. The ADC values at multiple region of interest (ROI) in the left frontal lobe showed facilitated diffusion with high ADC values. In spite of acute ischemic presentation there was no restricted diffusion or acute infarct seen on DWI images and ADC maps. Digital subtraction angiography (DSA) confirmed the diagnosis of proliferative angiopathy. The diffuse angiopathic changes were seen in the left cerebral hemisphere in anterior and middle cerebral artery territories with evidence of early arteriovenous shunting. The capillary blush was seen in the arterial, capillary, and early venous phase.

RESULTS
Chronic ischemia, with decreased local cerebral blood flow may show facilitated diffusion and high ADC values due to vasogenic edema and/or atrophic changes in the cerebral hemisphere. In spite of acute ischemic presentation there was no restricted diffusion or acute infarct seen on DWI images and ADC maps. It implies that local or remote hemodynamic stresses may overcome the autoregulation of the brain vasculature. The marginally perfuse parenchyma may become ischemic, triggering the cortical discharges.

CONCLUSION
There are many structural and hemodynamic cerebral abnormalities seen in proliferative angiopathy, which leads to the ischemic changes in the brain. The DWI and ADC values highlight the pathogenesis of chronic ischemic changes secondary to the disturbed perfusion in proliferative angiopathy.

KEY WORDS: Proliferative angiopathy, seizure, MR imaging
Succinic Semialdehyde Dehydrogenase Deficiency: MR Spectroscopy Findings

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**PURPOSE**
Succinic semialdehyde dehydrogenase (SSADH) deficiency or 4-hydroxybutyric aciduria (GHB) is a rare autosomal recessive disorder affecting the catabolism of the neurotransmitter γ-aminobutyric acid (GABA). In the absence of SSADH, the levels of both GABA and GHB increase in brain, blood, and urine. The purpose of this presentation is to study the spectral profile of the SSADH deficiency.

**MATERIALS & METHODS**
Case 1. A 6-year-old male, reported with delayed speech, psychomotor retardation, and seizures. Diagnosis of SSADH deficiency was reached by increased urine GHB levels. Case 2. The 3-year-old male had psychomotor retardation, seizures, hypotonia, and mild deficit in fine motor functions. Diagnosis of SSADH deficiency was confirmed by increased GHB in urine. MR Studies: Patients were examined by 1.5T superconducting MR scanner. In each patient, axial T1-weighted, spin-echo (SE), T2-weighted turbo SE and fast fluid attenuated inversion recovery images were obtained. MR Spectroscopic Evaluation: Multivoxel spectroscopy using double SE point resolved spectroscopy sequence (TE:35 ms) with one-pulse water signal suppression was obtained at the level of the globus pallida. Another anatomically matched set of spectroscopic data also was obtained from five aged-matched controls. Peak integral values were normalized to the internal Cr peak. Metabolite ratios of NAA/Cr, Cho/Cr, glutamate-glutamine complex/Cr were calculated.

**RESULTS**
Both cases had symmetrically increased signal intensity in globus pallida (Fig). There were no other signal intensity changes on conventional MR images. Among MRS parameters obtained from globus pallidum, siblings had higher NAA/Cr (1.73 ± 0.17 vs 1.70 ± 0.33 respectively), glutamate-glutamine complex/Cr (0.91 ± 0.1 vs 0.59 ± 0.12 respectively) and lower Cho/Cr (0.81 ± 0.13 vs 0.84 ±0.16 respectively) ratios than normal control group.

**CONCLUSION**
MR spectroscopy may be useful for noninvasive diagnosis and monitoring of SSADH deficiency and validating new therapeutic approaches.

**KEY WORDS:** Succinic semialdehyde dehydrogenase deficiency, metabolic brain disorder, MR spectroscopy

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Magnetization Transfer Ratio Measurements in Eight Patients with Tuberous Sclerosis Complex: A Semiquantitative Analysis of the Structural Brain Lesions

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**PURPOSE**
Tuberous sclerosis (TS) is an autosomal dominant disorder with variable clinical pattern and high penetrance. Conventional MR imaging is the imaging method of choice for showing lesions as: nodular foci in subependymal region, at the surface of the brain and WM lesions. Magnetization transfer (MT) acquisition improves conventional MR with a semiquantitative analysis MT ratio (MTR) of the structural brain lesions in tuberous sclerosis (TS). MT ratio may demonstrate each type of brain lesion in TS patients and give more information about normal-appearing white matter (WM) or gray matter (GM).

**MATERIALS & METHODS**
We performed the study on eight young TS patients (5 females and 3 males; mean age 6.5 years) and we compared their data with that of an age-matched reference group of 10 normal children. The MR scans analyzed were acquired at 1.5T. Our protocol included axial fluid attenuated inversion
recovery (FLAIR) sequence (TE 100 ms, TR 5000 ms, TI 2000 ms), T1-weighted spin-echo (T1SE) sequence before and after an injection of intravenous dimeglumine gadopentetate (Gd) and a non-enhanced T1 SE/MTC (TR 35 ms, TE 11 ms/magnetization transfer contrast medium pulse on resonance) acquisition. The MTR was calculated as: (SI-O-SI/Sm)/SI O X 100% and the ROIs were acquired as a regular circle intraleision ROI, intraleasion and extraleasion irregular ROI and on normal-appearing white matter (WM) and normal-appearing gray matter (GM).

RESULTS
The MTR mean values of cortical tubers [circle intraleision ROI (20.68 ± 6.4), irregular intraleision ROI (22.15 ± 3.6) and irregular extraleision ROI (22.66 ± 3.5)], of subependymal nodules (19.11 ± 4.09; only irregular intraleision ROI), of normal appearing white matter (33.39 ± 12.31) and of normal appearing gray matter (29.68 ± 10.92) were significantly lower than those of WM (38.27 ± 11.29) and GM (33.68 ± 12.31) MTR values of control subjects.

CONCLUSION
MT acquisition is a technique for improving image contrast in MR imaging, based on the interaction between mobile free water protons and macromolecular bound protons: chemical exchange and cross-relaxation consist of applying an off-resonance radiofrequency pulse to saturate bounds protons. MTR values give a semiquantitative analysis of focal lesions demonstrated by conventional MR imaging and information on normal-appearing WM, GM or subtle forms of the disease.

KEY WORDS: Tuberous sclerosis, magnetization transfer acquisition, children

Poster 203

Garre Osteomyelitis: Multimodality Imaging Follow Up in Pediatric Patients

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PURPOSE
Describing imaging features of mandibular Garre osteomyelitis over time with multimodality imaging.

MATERIALS & METHODS
Retrospective analysis of four patients with clinical diagnosis of Garre osteomyelitis of the mandible were observed (3 female, 1 male). The age at diagnosis was between 5-13 years. All patients had an initial mandible CT scan; follow-up periods were 2 months, 8 months, 15 months, and 9 years. Two patients had additional follow-up MR imaging, and two patients had nuclear medicine (NM) Tc-MDP bone scan. Clinical information was obtained from archived medical records.

RESULTS
One patient had severe dental problems due to congenital orofacial dysplasia, the other three patients had no history of mandibular disease prior to diagnosis. All patients underwent mandibular biopsy showing bone marrow fibrosis and new bone formation, no infectious disease detected. However, one patient had an initial biopsy in which Diphtheroides, Hemophilus species, and Veillonella were observed. All patients received antibiotic treatment. The following imaging features were observed from CT scans (Table 1): Side of involvement was unilateral in three; mandibular canal enlargement was present in all. Soft tissue findings: enlarged masseter muscle in three, enlarged lymph nodes in two, other soft tissue proliferation in one. Bone findings: lytic lesions were present in all; change of lytic lesions was observed in two; pattern of bone formation was sclerotic in four (concentric in three). MR studies showed bone enhancement in two, NM spect showed uptake of tracer in two.

Table 1

<table>
<thead>
<tr>
<th>Patient</th>
<th>Side</th>
<th>Mandible Canal Areas</th>
<th>Soft Tissues</th>
<th>Lytic Areas</th>
<th>Conclusive Bone Formation</th>
<th>Perimandibular Dysplasia Type</th>
<th>Retractor Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Left</td>
<td>Enlarged, from origin to mental foramen, loss of canal wall</td>
<td>submucosal edema of masseter muscle</td>
<td>smaller follow-up</td>
<td>concentric, the mandibular edge can be seen</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>2 Right</td>
<td>Enlarged, normal at origin, abnormal to mental foramen, loss of canal wall</td>
<td>submucosal lymph nodes</td>
<td>perimandibular swelling</td>
<td>concentric, the mandibular edge can be seen</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>3 Left</td>
<td>Enlarged, from origin to mental foramen, loss of canal wall</td>
<td>submucosal edema of masseter muscle</td>
<td>smaller follow-up</td>
<td>concentric, the mandibular edge can be seen</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>4 Bilateral</td>
<td>Enlarged bilaterally from origin to mental foramen, loss of canal wall</td>
<td>bilateral edema of masseter muscle, submandibular lymph nodes, perimandibular swelling</td>
<td>involvement of outer cortex</td>
<td>only right ramus</td>
<td>predominantly body of mandible involved</td>
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</table>

CONCLUSION
Ipsilateral mandibular canal enlargement with loss of canal wall density (Fig 1A, long arrow, first follow up), changing lytic bone lesions over time (Fig 1B, second followup same patient), and perimandibular soft tissue thickening, to our knowledge, have not been described previously in pediatric mandibular Garre osteomyelitis. Contrary to previously published cases, most of our patients did not have a history of infectious dental disease prior to diagnosis.

KEY WORDS: Garre, osteomyelitis, CT

Poster 204

Varicella Encephalitis: Still a Challenging Disease for Pediatric Population

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PURPOSE
Chickenpox is a mild disease for most people and thanks to the vaccine the number of cases and hospitalizations is down dramatically. Varicella generally affects children aged under
10 years and a CNS involvement is described in 0.1% of the cases. But the disease can be serious even in healthy children. We retrospectively evaluated neuroradiologic findings in children affected with varicella encephalitis admitted to our hospital in the last 3 years.

**Materials & Methods**

In the last 3 years 35 patients have been diagnosed with varicella encephalitis in our hospital. We have considered two different groups: Group 1: 24 patients were hospitalized in the infectious disease unit: 13 had a CT scan and/or MR imaging because of neurologic symptoms. Most of the children with a diagnosis of cerebellitis did not undergo neuroimaging. Group 2: 11 patients were hospitalized in the oncology unit: they all had CT scans and/or MR imaging.

**Results**

In group 1 only two patients showed alterations in neuroimaging. The lesions detected in these two patients were localized in basal ganglia and in subcortical white matter. They resolved in a few months. In group 2 ten out of 11 patients showed alterations and they were very variable, from meningitis to a deep and diffuse parenchymal injury with intraparenchymal hemorrhages. The variability of neuroradiologic findings correlated with the variability of patient outcome. One patient of group 2 died because of varicella complications.

**Conclusion**

Herpes Zoster (HZ) virus preferably migrates to CNS but the spreading of the infection is extremely variable according to the patient’s clinical conditions. Lesions as described in the literature in the basal ganglia have been found in healthy children. In immunodepressed children varicella encephalitis tends to be more aggressive with a chance of death even in cases of mild immunodepression. It is mandatory to monitor children with HZ infections with early and serial imaging in order to prevent serious complications. Enhanced MR and diffusion imaging are the first choice methods for a correct and exhaustive detection of CNS involvement in this pathology.

**Key Words:** Varicella, encephalitis, MR imaging

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**Poster 205**

**CMV Infection in Utero: MR Imaging and Ultrasound of the Fetal Brain**

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**Purpose**

To analyze the MR imaging findings of intracranial abnormalities in fetuses with proved CMV infection and to compare them to the ultrasound (US) findings.

**Materials & Methods**

We reviewed the brain MR imaging and UD findings of 14 fetuses that were referred to the MR unit for the evaluation due to maternal CMV infection. In 12 women the amniotic fluid was positive for CMV infection of the fetus, two were negative, but were positive for a new infection by the virus in the maternal blood. The infection occurred in the first trimester in two cases, in the second trimester of the pregnancy in six, and in the third trimester in four. In the remaining cases the time of infection was not determined. The MR and US findings were compared.

**Results**

Two of the 14 fetuses demonstrated abnormal findings on sonography: one cystic periventricular lesion and one echogenic periventricular lesion. The MR images showed abnormal signal in seven fetuses, these included hyperintensity of the subcortical white matter in five, mainly in both temporal lobes, but also in the parietal lobes. In only one fetus these findings were accompanied by temporal horns enlargement. In three fetuses periventricular cysts were demonstrated. In only one case with abnormal US an agreement between the US and the MR images was found, though the abnormality in the MR images was more severe. In one pregnancy with signal changes in the white matter the pregnancy was terminated.

**Conclusion**

MR imaging demonstrated more signal changes than reported on sonography. The abnormal hyperintense signal in the white matter was better delineated on MR imaging. The correlation between these findings and the clinical neurologic outcome should be investigated, in order to better understand their importance.

**Key Words:** CMV, fetus, brain

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**Poster 206**

**Post Streptococcal Dystonia with Bilateral Striatal Necrosis: MR Imaging and MR Spectroscopy Findings**

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**Purpose**

Dystonia with isolated bilateral striatal necrosis (IBSN) following streptococcal infection is a recently recognized condition. Although Sydenham’s chorea has been accepted as
the classical postinfectious autoimmune basal ganglial disorder, recent studies have documented a wide range of neuropsychiatric and movement disorders occurring following streptococcal infection. Swedo et al (1) have coined the term “pediatric autoimmune neuropsychiatric disorders associated with streptococcal infection” (PANDAS) to describe this group. This report describes a patient presenting with dystonia and basal ganglial imaging abnormalities following streptococcal infection. The MR imaging findings suggested a diagnosis of infantile bilateral striatal necrosis.

MATERIALS & METHODS
A 7-year-old male presented to the University of Minnesota Medical Center with progressive weakness and difficulty breathing. Two weeks before presentation, he developed high fever and abdominal distress and started to spit excessively. At that time his primary care physician made a diagnosis of streptococcal pharyngitis. However, two days later, he complained of weakness and was unable to get out of the bed. Despite treatment, his symptoms continued to worsen with increasing weakness, drooling, shortness of breath, and intermittent shaking of the hands.

RESULTS
Cranial MR imaging performed at the time of initial admission showed diffuse bilaterally symmetric abnormal T2 hyperintensity within the heads of the caudate nuclei, the putamina and the external and extreme capsules. The heads of caudate nuclei and putamina were also enlarged (Fig 1). Minimal restricted diffusion was evident bilaterally on diffusion-weighted images. Single voxel MR spectroscopy of the left lentiform nucleus demonstrated abnormal elevation of the lipid/lactate peak and a decreased NAA peak.

CONCLUSION
This communication describes a child with dystonia and basal ganglial imaging abnormalities following streptococcal pharyngitis. We found mild restriction of diffusion in the heads of the caudate nuclei, the putamina and the external and extreme capsules, suggesting the presence of intracellular edema. Single voxel MR spectroscopy of the abnormal basal ganglia showed reduction of the NAA peak (a sign of neuronal injury) and an increased lactate peak, corresponding to conversion from aerobic energy production to anaerobic glycolysis. This is the first case report with diffusion-weighted imaging and MR spectroscopy findings in a patient with poststreptococcal dystonia and presumed bilateral striatal necrosis.

REFERENCES

KEY WORDS: Basal ganglia, necrosis, MR imaging

Poster 207
Retrospective Review of CT and MR Imaging Features of Pediatric Ganglioglioma and Dysembryoplastic Neuroepithelial Tumor

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PURPOSE
Gangliogliomas (GG) and dysembryoplastic neuroepithelial tumors (DNET) are rare, cortically based, mixed glial and neuronal neoplasms that affect the pediatric population. The purpose of this study was to review CT and MR imaging characteristics of newly diagnosed GG and DNET, in order to identify radiologic features which may be used to distinguish these tumors.

MATERIALS & METHODS
We reviewed preoperative CT and MR images from 68 children (38M, 30F; mean age 8.9 yrs, range 3 months to 16 yrs) diagnosed with intracranial GG or DNET at a single institution over 25 years. Two observers independently reviewed the images blind to the pathologic diagnosis. Discrepancies were agreed upon by consensus, and the imaging findings then were correlated with the diagnosis given on the original neuropathology reports. Tumor characteristics assessed included location, morphology, MR signal, CT attenuation, and enhancement pattern. CT and MR imaging features such as scalloping of adjacent bone, calcification, triangular shape, vasogenic edema, mass effect, and presence of septations were compared. A tumor was considered cystic if > 75% appeared to be fluid on CT and/or MR imaging, solid if < 25% fluid.

RESULTS
Among the 68 subjects were 56 with GG and 12 DNET. Six of 56 GG were located in the posterior fossa and were excluded from further analysis. Gangliogliomas had a predilection for the temporal lobe; 36/50 GG were tempolar compared with 1/12 DNET. One GG was intraventricular. The remaining 13 GG and 11 DNET were distributed evenly through the frontal, parietal, and occipital lobes. Common imaging features to both GG and DNET included low T2 signal, and low attenuation on CT. On CT scan, 100% of DNET were hypodense, while 32% of GG were iso or hyperdense. There was no difference in the frequency of cystic lesions. Gangliogliomas were more likely solid (Odds Ratio; OR = 3.0) and DNET was more likely

the classical postinfectious autoimmune basal ganglial disorder, recent studies have documented a wide range of neuropsychiatric and movement disorders occurring following streptococcal infection. Swedo et al (1) have coined the term “pediatric autoimmune neuropsychiatric disorders associated with streptococcal infection” (PANDAS) to describe this group. This report describes a patient presenting with dystonia and basal ganglial imaging abnormalities following streptococcal infection. The MR imaging findings suggested a diagnosis of infantile bilateral striatal necrosis.

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REFERENCES

KEY WORDS: Basal ganglia, necrosis, MR imaging

Poster 207
Retrospective Review of CT and MR Imaging Features of Pediatric Ganglioglioma and Dysembryoplastic Neuroepithelial Tumor

Venu, V.1 · Sargent, M. A.2 · Henderson, G.2
1University of British Columbia, Vancouver, BC, CANADA, 2British Columbia’s Children’s Hospital, Vancouver, BC, CANADA

PURPOSE
Gangliogliomas (GG) and dysembryoplastic neuroepithelial tumors (DNET) are rare, cortically based, mixed glial and neuronal neoplasms that affect the pediatric population. The purpose of this study was to review CT and MR imaging characteristics of newly diagnosed GG and DNET, in order to identify radiologic features which may be used to distinguish these tumors.

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We reviewed preoperative CT and MR images from 68 children (38M, 30F; mean age 8.9 yrs, range 3 months to 16 yrs) diagnosed with intracranial GG or DNET at a single institution over 25 years. Two observers independently reviewed the images blind to the pathologic diagnosis. Discrepancies were agreed upon by consensus, and the imaging findings then were correlated with the diagnosis given on the original neuropathology reports. Tumor characteristics assessed included location, morphology, MR signal, CT attenuation, and enhancement pattern. CT and MR imaging features such as scalloping of adjacent bone, calcification, triangular shape, vasogenic edema, mass effect, and presence of septations were compared. A tumor was considered cystic if > 75% appeared to be fluid on CT and/or MR imaging, solid if < 25% fluid.

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Among the 68 subjects were 56 with GG and 12 DNET. Six of 56 GG were located in the posterior fossa and were excluded from further analysis. Gangliogliomas had a predilection for the temporal lobe; 36/50 GG were temporal compared with 1/12 DNET. One GG was intraventricular. The remaining 13 GG and 11 DNET were distributed evenly through the frontal, parietal, and occipital lobes. Common imaging features to both GG and DNET included low T2 signal, and low attenuation on CT. On CT scan, 100% of DNET were hypodense, while 32% of GG were iso or hyperdense. There was no difference in the frequency of cystic lesions. Gangliogliomas were more likely solid (Odds Ratio; OR = 3.0) and DNET was more likely
mixed (OR = 4.0). Septations were a predominant feature of DNET compared with GG (OR = 68.6), as was scalloping of the adjacent bone (OR = 2.5). While a triangular shape was more predictive of DNET (OR = 4.8), this feature was only seen in 4/62 lesions. Surrounding vasogenic edema was more common with GG (OR = 3.9). Calcifications were seen in 35% of GG but were not seen in any DNET. Gangliogliomas were more likely to enhance on both CT (OR = 7.0), and MR (OR = 8.3).

CONCLUSION
To our knowledge, this is the largest radiologic review of pediatric ganglioglioma and DNET to date. Although these tumors share many similar characteristics, we have identified several differences. Gangliogliomas are more likely to be temporal, solid, hyperdense, calcified, to enhance, and to have vasogenic edema. Dysembryoplastic neuroepithelial tumors is more likely to be mixed cystic and solid, septated, and triangular. Outside the temporal lobe, GG and DNET are distributed equally. These varying imaging characteristics may help in distinguishing radiologically between ganglioglioma and DNET.

KEY WORDS: Neoplasms, ganglioglioma, dysembryoplastic neuroepithelial

Poster 208

Cerebral Blood Flow in Childhood Autism: Comparison between ECD-TC99M SPECT and Statistical Parametric Mapping Evaluation

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Siena, ITALY

PURPOSE
The aim of this study was to establish a link between regional cerebral blood flow (rCBF) assessed with technetium-99m-ethyl cistaine dimer (Tc-99m-ECD) SPECT and the clinical manifestation of autism.

MATERIALS & METHODS
We performed the study on 11 young patients (5 females and 6 males; mean age 11.2 years) displaying autistic behavior and we compared their data with that of an age-matched reference group of eight normal children. All of them presented a detailed clinical history and were assessed using the Autism Behavior Checklist (ABC), a standardized method for assessing autistic children from 3 to 15 years of age. A quantitative analysis of rCBF was performed calculating a perfusion index (PI = cortex/cerebellum) and an asymmetry index \( AI = \frac{|r-1|}{|r+1|/2} \times 100 \) in each lobe. Images were analyzed with statistical parametric mapping software (SPM), following the spatial normalization of SPECT images for a standard brain. The Mann-Whitney U test for unpaired data was used to compare relative regional and hemispheric perfusion and asymmetry in the children with autistic disorder with the corresponding values of the controls.

RESULTS
The ABC produced a score higher than 80 for all the autistic patients and lower than eight for the controls. Neuroradiologic evaluation of brain MR imaging showed no morphologic alteration in all patients. A statistically significant \( p = .003 \) global reduction of CBF was found in the group of autistic children \((PI = 1.07 \pm 0.07)\) when compared with the reference group \((PI = 1.25 \pm 1.02)\). Moreover, a significant difference also was observed for the right-to-left asymmetry of hemispheric perfusion between the control group and autistic patients \( p = .0085 \) with a right prevalence greater in autistic \((2.90 \pm 1.68)\) with respect to normal children \((1.12 \pm 0.49)\).

CONCLUSION
Our data show a significant decrease of global cerebral perfusion in autistic children in comparison with their normal counterparts and the existence of left-hemispheric dysfunction, especially in the temporo-parietal areas devoted to language and the comprehension of music and sounds. We suggest that these abnormal areas are related to the cognitive impairment observed in autistic children, such as language deficits, impairment of cognitive development and object representation and abnormal perception and responses to sensory stimuli. It has been proposed recently that abnormal perceptions of faces and objects might account for the social impairment and restricted interest typical of autistic individuals. At the cognitive level, autistic patients present an atypical processing of complex figures, including a deficit in facial perception; in fact prosopagnosia (a recent autistic sign) is an unique syndrome in which the recognition of familiar faces is impaired. In recent research prosopagnosia has been related to a lesion of the right fusiform gyrus at the same level where we detected the most significantly hypoperfused area.

KEY WORDS: Childhood autism, regional cerebral blood flow, brain SPECT

Poster 209

Pediatric Brachial Plexus Injury: Correlating Surgical Findings with MR Imaging

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PURPOSE
To evaluate the accuracy of MR imaging of the brachial plexus reporting when compared to intraoperative findings and to demonstrate the spectrum of brachial plexus anatomy and pathology.

MATERIALS & METHODS
Retrospective analysis from 1999 to 2006 of nine patients with brachial plexus injury at birth. MR images were performed on a GE 1.5T scanner and interpreted by a pediatric neuroradiologist. Clinical information was derived from the reported operative findings. Comparison was made between findings at surgery and original MR reports; MR exams also were interpreted with knowledge of the surgical findings.
RESULTS
There were six female and three male patients; age range at imaging 20 days to 14 months. Surgery reported nerve root injury level C5/6 in six patients, level C7-T1 in one patient, intact nerve roots in two patients. However, the C7-T1 level was only explored in two patients. Brachial plexus injury was found in all nine patients: one at the level of the divisions, four at the level of the trunks. In four patients the location was not specified, but was described as “severe fibrosis with adhesions” of the brachial plexus in two out of the four. MR imaging reported nerve root injury in eight patients: C5/6 level in six patients, level C7-T1 in seven patients. MR imaging reported brachial plexus injury in one patient. There was also one reported spinal cord injury. After review of the surgical reports the original MR interpretation was augmented in seven patients. In six patients there was retrospective identification of brachial plexus signal abnormality; in one patient there was retrospective identification of C5 nerve root injury. There was no change of the remaining two MR interpretations. In one, intravenous contrast was given and demonstrated enhancement of the brachial plexus. One discrepancy remained in a patient where there was C6 nerve root avulsion on original and revised MR imaging which was reportedly intact at surgery.

CONCLUSION
1) MR imaging of the brachial plexus identifies correctly most nerve root avulsions. 2) It is important for the neuroradiologist to know the anatomy of the brachial plexus from the root to the peripheral trunks and scrutinize these regions for signal abnormalities. 3) MR imaging gives additional information of C7-T1 roots which are not explored routinely surgically, as well as spinal cord damage. 4) Intravenous contrast administration may be helpful in highlighting plexus injuries. There were two patients with intraoperative neuromas, which were excluded from our analysis, but the findings underline the possible value of intravenous contrast as part of the brachial plexus MR imaging protocol. 5) A brachial plexus MR imaging protocol needs to include the cervical spine and the upper thoracic soft tissues. Current publications suggest incorporation of high resolution imaging.

KEY WORDS: Brachial plexus, nerve root injury, surgery

Poster 210

Fast STIR T2-weighted Imaging in the Evaluation of White Matter Myelination

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PURPOSE
Conventional T1 and T2 MR images have been used widely and proved effective in the evaluation of white matter myelination. However, there are age-dependent differences between spin-echo T1 and turbo spin-echo (TSE) T2 values in the various regions of white matter. In fast STIR T2-weighted image (STIR T2), the theoretical T1 influence on T2 value may enhance the appearance of white matter myelination on T2-weighted image. In this study, therefore, we investigated the age-dependent changes of white matter in TSE T2 and STIR T2 to help elucidate the role of STIR T2 in the evaluation of white matter myelination in normal children less than 2 years of age.

MATERIALS & METHODS
Twenty-eight young infants and children (aged 1 month ~ 24 months) with initial MR imaging interpretation of brain as normal were included for analysis. All the patients underwent STIR T2 (TR/TE: 9128/60 msec, TI: 150 msec) and TSE T2 (TR/TE: 6880/120 msec) acquisitions at a 1.5T MR system (Siemens Vision+). The progression of white matter myelination was estimated by measuring normalized signal intensity (normalized to CSF) of STIR T2 and TSE T2 with three regions of interest (ROIs) located in genu, splenium of corpus callosum and posterior limb of internal capsule. Two raters compared the myelination stages of the subjects based on the STIR T2 and TSE T2 images.

RESULTS
STIR T2 and TSE T2 have similar trend of signal intensity in the quantitatively measured regions in the developing white matter in terms of myelination stage. Visual estimation of the myelination stages by the raters revealed more advanced myelination stages observed in children older than 8 months by STIR T2. Moreover, STIR T2 imaging appears to be more advantageous in the revealing of subcortical white matter myelination.

CONCLUSION
STIR T2 imaging provides better myelination contrast in the developmental white matter as compared to conventional fast T2 image due to the addition of T1 effect after 8 months of myelination.

KEY WORDS: White matter myelination, STIR, brain

Poster 211

Imaging Pediatric Back Pain

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PURPOSE
The pictorial essay will review the broad differential diagnosis of pediatric back pain and the role of imaging evaluation.

MATERIALS & METHODS
The format will be case based introducing the reader to an imaging algorithm followed by findings, diagnosis, and discussion. Images will be organized into congenital, inflammatory, neoplastic, traumatic categories.

RESULTS
Back pain is a relatively uncommon complaint in the pediatric population. While 70% of adults will experience at least one episode of back pain (lifetime incidence), only 10% of prepubescent children will (cumulative incidence). Persistent back pain in a child is not normal and significant underlying pathology such as infection or neoplasm need be excluded. Warning signs include, age, functional disability, fever, duration of pain and the presence of any neurologic
abnormality. Initial evaluation by history, physical examination, laboratory tests, and orthogonal radiographs of the painful region may be supplemented by bone scan, CT, or MRI on an individual basis. In all cases depicted, the children presented with the chief complaint of back pain. The cases are divided into the following categories: trauma, including lissostisis, apophyseal avulsion and vertebral body fracture; inflammatory, including diskitis, osteomyelitis, e.g., tuberculosis and cat scratch disease; polyarteritis nodosa, steroid induced vertebral compression; neoplastic, including not limited to osteoid osteoma, aneurysmal bone cyst, neuroblastoma, lymphoma, Langerhan cell histiocytosis, and chordoma; congenital, including scoliosis, neurofibromatosis, sickle cell disease and medullary renal cell carcinoma, as well as examples of mucopolysaccharidoses and skeletal dysplasia in children presenting with back pain.

**CONCLUSION**

Pediatric back pain is uncommon. Evaluation for significant underlying pathology is warranted. The viewer will have reviewed the radiologic evaluation as well as the spectrum of diseases in the pediatric patient presenting with back pain.

**KEY WORDS:** Pediatric back pain, pediatric spine, pediatric neoplasms

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**Poster 212**

**Utilization and Outcomes of Unenhanced CT for the Evaluation of Nontraumatic Neurologic Emergencies**

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**PURPOSE**

To determine retrospectively whether there has been any significant change in the utilization and outcomes of unenhanced CT head examinations performed for the emergency department between 2002 and 2004 for the evaluation of nontraumatic neurologic emergencies.

**MATERIALS & METHODS**

Approval from the Research Ethics Board was obtained. All CT head examinations ordered from the emergency department of a tertiary care hospital and performed in January to June 2002 and January to June 2004 were identified. Reports were reviewed and results categorized as either Category I (positive for stroke/intracranial hemorrhage); Category II (alternative diagnosis accounting for the patient’s symptoms); Category III (negative results with no significant incidental findings). Statistical comparison between the years was performed using a Chi-squared test.

**RESULTS**

During the 6-month period in 2002, 14,405 patients visited the emergency department, 436 unenhanced CT head examinations were performed for nontraumatic neurologic emergencies (30.3 CT heads/1000 visits). During the same period in 2004, 529 unenhanced CT head examinations were performed for 12,224 emergency department visits (43.3 CT heads/1000 visits). There was a relative increase of 42.9% in the number of unenhanced CT head examinations performed in 2004 as compared to 2002 (p < 0.001). A total of 39 of 436 (9.0%) unenhanced CT head studies in 2002 and 39 of 529 (7.4%) CT head studies in 2004 demonstrated a stroke/intracranial hemorrhage (Category I); 20 of 436 (4.6%) unenhanced CT head examinations in 2002 and 30 of 529 (5.6%) CT head studies in 2004 were used to identify an alternative diagnosis accounting for the patient’s symptoms (Category II); and 376 of 436 (86.4%) unenhanced CT head studies in 2002 and 460 of 529 (87%) CT head examinations in 2004 were negative with no significant incidental findings (Category III). There were no significant differences between the rates of Category I, II, or III results.

**CONCLUSION**

Despite a definite trend in increased utilization of unenhanced CT head examinations for the evaluation of nontraumatic neurologic emergencies, there was no significant difference in the diagnostic outcomes from the examination.

**KEY WORDS:** Nontraumatic, emergencies, outcomes

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**Poster 213**

**Axially Loading during MR Imaging of the Lumbar Spine Can Increase the Diagnostic Yield in Patients with Low Back Pain without Radiculopathy**

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**PURPOSE**

Upright body position often accentuates symptoms in patients with spinal stenosis. We evaluated if axial loading during MR imaging of the lumbar spine can increase the diagnostic yield by simulating upright body position in patients with low back pain without radiculopathy.

**MATERIALS & METHODS**

Twenty-nine patients had MR imaging of the lumbar spine during MR imaging of the lumbar spine can increase the diagnostic yield in patients with spinal stenosis. We evaluated if axial loading during MR imaging of the lumbar spine can increase the diagnostic yield by simulating upright body position in patients with low back pain without radiculopathy.

**RESULTS**

Mean dural sac cross-sectional area was 187 mm² without axial loading and 163 mm² with axial loading. There were statistically significant differences at all levels from L1/2 to L5/S1 (P < .01).
The cross-sectional area of the thecal sac decreased significantly with axial loading during MR imaging of the lumbar spine. This method can simulate the loading of the spine that occurs during upright body position. Axial loading increases the diagnostic yield from MR imaging of the lumbar spine in patients with low back pain without radiculopathy.

**Key Words:** MR imaging, axial loading, spinal stenosis

**Poster 214**  
**Malignant Glioneuronal Tumor in the Spinal Cord: Case Report**

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**Purpose**  
To present a case of malignant glioneuronal tumor of the cervical cord. To the best of our knowledge, there is only one previous report of this rare tumor in the spinal cord, none in radiology literature. Malignant glioneuronal tumors comprise a spectrum of neoplasms that may resemble any malignant glioma (WHO Grade III or IV) but have a distinct biologic behavior.

**Materials & Methods**  
A 19-year-old male presented with a 3-month history of progressively increasing numbness in the right hand, initially noticed after being hit in the right hand by a baseball. He also had some dyscoordination and decreased sensation in the right hand. Clinical examination was remarkable only for decreased proprioception in his right hand to passive movement and 1+ deep tendon reflexes in the right upper extremity. MRI revealed a heterogeneous mass within the cervical cord extending from C1 to C3 vertebral level. The patient underwent near gross total resection of the intramedullary tumor. Subsequently, the patient received adjuvant chemotherapy.

**Results**  
MRI of the cervical spine showed expansile lesion within the cervical cord extending from C1 to C3 level. The intramedullary mass was hypointense on T1-WI and showed heterogeneous increased signal on T2-WI and STIR. Post contrast images revealed intense, heterogeneous enhancement within the lesion. An associated syrinx was seen in the cord extending inferiorly from the mass down to the C5 level. C1 through C3 laminectomy was done for removal of the intramedullary tumor with subsequent cervical fusion. Tumor specimens on pathology showed moderate to highly differentiated glioma with neurocytic differentiation as well as “rosetted” neurophil islands. Neurofilament protein (NFP) immunostaining was strongly positive with GFAP positivity in the majority of tumor cells. Pathology was consistent with glioneuronal tumors previously described in the brain.

**Conclusion**  
We report a case of malignant glioneuronal tumor in the cervical cord showing features of both neuronal as well as glial elements. There have been recent reports of malignant glioneuronal tumors in the brain, but only one previous report in the cord. Their differentiation from malignant gliomas is clinically important because gross total resection has been reported to be curative in some cases in the brain.

**Key Words:** Malignant glioneuronal tumor, spinal cord

**Poster 215**  
**Solitary Fibrous Tumor in the Spinal Canal**

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**Purpose**  
To describe the MR imaging findings of a solitary fibrous tumor in the thoracic spinal canal. Solitary fibrous tumor is a rare spindle cell tumor deriving from mesenchymal cells that arise most commonly in the pleura. Extralobar sites of origin have been reported, including meninges and CNS parenchyma. Rarely, solitary fibrous tumors may occur in the spinal canal as intradural extramedullary masses. We will discuss the imaging appearances of this rare entity with pathological correlation. Differential diagnosis of intradural extramedullary masses will also be discussed.

**Materials & Methods**  
A 43-year-old gentleman presented with a two-month history of non-specific back pain, thoracic numbness, and right leg weakness. Neurologic examination showed loss of strength and coordination in the right leg. MRI of thoracic and lumbar spine was requested due to clinical concern for cord compression.

**Results**  
MR imaging revealed a well-circumscribed intradural, extramedullary lesion measuring approximately 2 cm in size at the T4 level in the spinal canal posteriorly. The lesion was isointense on T1-W images and low signal on T2 WI. Intense, homogeneous enhancement was seen on post contrast images. The spinal cord at this level was pushed anteriorly. The patient underwent surgical resection of this ovoid lesion. The tumor was found to be freely mobile, attached to a posterior nerve root. Gross total resection of the tumor was performed. Histologically, the tumor predominantly consisted of spindle cells separated by abundant collagen matrix fibers. The tumor cells were strongly positive for CD34 and vimentin, while negative for S-100 or SMA.

**Conclusion**  
Solitary fibrous tumors are rare benign tumors that can uncommonly arise in spinal nerve roots. These must be differentiated from other intradural, extramedullary lesions like meningioma, schwannoma and hemangiopericytoma. Confirmation of diagnosis depends on immunohistochemical results. This rare tumor should be included in the differential diagnosis of spindle cell lesions arising in the spinal canal.

**Key Words:** Solitary fibrous tumor, spinal canal, MR imaging
Poster 216

Low Grade Primary Diffuse Leptomeningeal Gliomatosis: A Case Report and Review of the Literature

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**PURPOSE**
To review the clinical, radiological, and pathological findings in a known case of low grade primary diffuse leptomeningeal gliomatosis (PDLG).

**MATERIALS & METHODS**
The clinical records of a patient with pathology-proved spinal and intracranial low grade PDLG were reviewed. The published literature on PDLG was searched on Medline and reviewed.

**RESULTS**
A 45-year-old female who presented with left lower extremity numbness and discomfort of one year’s duration. She later developed anorexia, occasional vomiting, and episodic confusion. MR imaging revealed a diffuse, enhancing leptomeningeal abnormality throughout the spine and head, filling much of the intrathecal space and the basal cisterns (Figure 1, sagittal T1-weighted post-contrast thoracic spine MR image). There was scalloping of vertebrae and of the inner table of the calvaria. No intraparenchymal brain or spinal cord tumor was evident. A suboccipital craniectomy was performed for open biopsy. Histological analysis revealed a low-grade glial tumor diffusely involving the leptomeninges. S-100 protein staining was positive, and MIB-1 labeling was limited to rare nuclei. Systemic carboplatin and etoposide was begun. A review of the literature reveals that approximately 30 cases of PDLG have been reported, and approximately 60% of these are high grade.

**CONCLUSION**
PDLG is a very rare neoplasm, which is most commonly high grade. A case of low-grade PDLG of the spine and head and a review of the literature are presented.

**KEY WORDS:** Leptomeningeal, gliomatosis

Poster 217

Hybrid Reconstruction Kernel: Optimized Spine CT

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**PURPOSE**
Develop and test a hybrid CT algorithm to simultaneously optimize bone and soft tissue characterization, potentially halving the number of images that need to be stored, transmitted, and reviewed.

**MATERIALS & METHODS**
CT images generated with separate bone and soft tissue kernels were retrospectively combined so that soft tissue algorithm pixels less than -150 HU or greater than 150 HU are substituted with corresponding bone kernel reconstructed pixels. Hybrid images were generated in Matlab (MathWorks, Inc, Natick MA) and subsequently re-imported into eFilm Workstation 2.0 (Merge Technologies Inc., Milwaukee WI) for viewing along with conventional images. Two neuroradiologists independently reviewed the
first five hybrid spine cases generated and compared them to both standard soft tissue and bone kernel reconstructed images for characterization of anatomy and pathology. For each case, corresponding image sections were simultaneously viewed in manufacturer preset settings for bone (window 2500, level 480) head and neck (window 350, level 90); an intermediate setting (window 800 level 200); as well as with independently adjusted window and level settings. The conspicuity of bone and soft tissue anatomy/pathology was separately scored for each CT reconstruction technique.

RESULTS
For the depiction of bone, in all five cases, the two neuroradiologists scored the hybrid images as being equivalent to bone kernel reconstructions but superior to the standard kernel. For depiction of soft tissues, the hybrid kernel was rated equivalent to the standard kernel but superior to that of the bone kernel. Fig 1 illustrates the dual optimized bone and soft tissue depiction afforded by the hybrid kernel technique (center) compared to the bone (left) and standard/soft tissue (right) reconstructions kernels; all images displayed at window 800, level 200 settings.

CONCLUSION
Hybrid kernel reconstruction is a promising technique affording optimized bone and soft tissue evaluation while halving the number of images needed to be transmitted, stored, and reviewed.

KEY WORDS: Computer tomography

Poster 219
Computed Tomography-guided Percutaneous Placement of Transiliosacral Rod for Sacral Insufficiency Fracture: Case Report and Operative Technique

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PURPOSE
Sacral insufficiency fractures (SIF) primarily occur in postmenopausal women with patients typically presenting in the eighth decade. Incidence in the literature ranges from 0.14 to 2.0 percent of the population. Although treatment of SIF is typically conservative, involving a combination of analgesia
and physical rehabilitation leading to resolution of symptoms by 6-12 months, refractory cases have been treated with surgical fusion or vertebroplasty. Unfortunately, surgical treatment can be associated with significant morbidity and cement may not withstand shear forces in this area, leading to pseudarthrosis. We thus propose a novel technique in which a single transiliac rod is surgically placed over a CT-guided, percutaneously-placed wire, a construct that is then further stabilized by CT-guided cement injections.

**MATERIALS & METHODS**

A 76-year-old woman with osteoporosis presented with eight months of severe low back, pelvic, and buttock pain. CT and MRI of the lumbosacral spine, demonstrated sacroiliac joint incompetence and bilateral comminuted fractures of the sacrum and pelvis. Using CT-fluoroscopic guidance, a vertebroplasty needle was passed across both sacroiliac joints and across the anterior aspect of the S1 vertebral body. A K-wire was then placed in this bony canal. The patient was taken to the operating room where a cannulated and threaded rod was passed over the wire and nuts were tightened on both ends to compress the construct. The patient was then returned to the CT scanner, where cement was injected around the construct.

**RESULTS**

There were no complications with this procedure. The patient noted immediate reduction in pain and was ambulatory on the night of the procedure. Short term follow up has shown durability of the construct integrity and of her pain relief.

**CONCLUSION**

Sacral insufficiency fractures can lead to significant disability. Although surgery and vertebroplasty may serve suboptimal roles, combining the two may lead to improved results. Our patient has been shown to have durable pain relief following CT-guided placement of a transiliac rod augmented by percutaneously-placed cement.

**KEY WORDS:** Sacrum, fracture, vertebroplasty

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CT-guided transforaminal epidural blood patch represents an effective way to treat patients with symptomatic CSF leaks.

**Poster 221**

Is Early Bladder Activity in Radionuclide Cisternography an Indirect Sign of Spontaneous Intracranial Hypotension or Sequence of Lumbar Puncture?

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**PURPOSE**

In this study, we evaluate the diagnostic reliability of early urinary bladder activity as an indirect sign of Spontaneous Intracranial Hypotension (SIH) syndrome. For this purpose, a group of patients who are clinically suspected to have normal pressure hydrocephalus (NPH) are selected to evaluate the early urinary bladder activity in Radionuclide Cisternography. We also attempted to uncover some other possible factors causing early bladder activity in these patients.

**MATERIALS & METHODS**

Between June 2004 and May 2006, twenty-one patients (10 males, 11 females; age range, 51-78 years; mean age±SD 63.6±8.4 years) with suspected NPH were referred to the Radionuclide cisternography was performed after an intralumbar injection of 185 MBq (5 mCi) Tc-99m DTPA (diethyleneetriamine-penta-acetic acid) using a 22-gauge needle. During LP we noted the number of punctures. After 5 min-
utes of resting, anterior and posterior images of abdominopelvic region were obtained to visualize bladder activity. Furthermore, delayed images of the skull were obtained at 2, 4 and 24 hours to evaluate ventricular reflux and to confirm activity of cerebral convexities. We calculated how frequent early bladder activity is observed in patients with suspected NPH. In the group of patients with detected early bladder activity, we investigated the association of presence of early bladder activity (response) with cisternographically diagnosed age, gender, presence of NPH, and number of puncture (predictors). We used logistic regression to identify the statistical significance of the association between the response and predictor variables.

**RESULTS**

Out of the 21 subjects, thirteen (62%) showed early bladder activity at varying time points. The RC revealed NPH in thirteen of the subjects in our study. Six patients (46%) showed early bladder activity in thirteen patients with NPH. Seven patients (87.5%) showed early bladder activity in eight patients without NPH. we fit a logistic regression model in which age, gender, presence of NPH variables enter as covariates and detection of the early bladder activity as the response variable. We find that only the number of punctures exert a significant effect on the probability of detecting early bladder activity (p=0.0019, \( \chi^2 \) with 1 df). That is, there is a significant association between early bladder activity and the number of punctures. The inclusion of the covariates (gender, age, NPH, and traumatic puncture factors) does not significantly improve the fit over the final logistic regression model.

**CONCLUSION**

Early bladder activity has been accepted as an indirect sign of SIH in the literature. On the contrary, we demonstrated that early bladder activity is observed in patients without CSF leakage, just as it is evaluated for patients with NPH. Multiple punctures may lead to this visualization. Multiple lumbar puncture attempts resulting additional tears are generally observed in SIH patients during RC. Besides, spontaneous dural tear and multiple iatrogenic dural punctures might also be the cause of early bladder activity.

**KEY WORDS:** Spontaneous intracranial hypotension, radionuclide cisternography, early bladder activity

**Poster 222**

CT Fluoroscopy-guided Epidural Blood Patch for Postlumbar Puncture Headache: An Effective Pain Management Technique

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**PURPOSE**

CT fluoroscopy-guided spine interventions are becoming increasingly recognized as a safe, rapid and effective alternative to "blind" or fluoroscopic-guided techniques. Our goal was to determine the efficacy and speed of CT fluoroscopy as a novel guidance tool for performing an epidural blood patch for the management of postlumbar puncture headaches.

**MATERIALS & METHODS**

We prospectively performed CT fluoroscopy-guided epidural blood patches on nine patients who presented with severe positional headaches persisting at least 72 hours following the lumbar puncture. We evaluated patient pain symptoms (scale of 0-10) prior to CT fluoroscopy-guided epidural blood patch, 1 hour postprocedure and 24 hours postprocedure. We also documented the time of procedure and all complications experienced within 24 hours postprocedure.

**RESULTS**

All 9 patients reported a decrease in pain symptoms following CT fluoroscopy-guided epidural blood patch. The patients noted a mean initial pain score of 9.44 (+/- 0.72 SD) prior to the CT fluoroscopy-guided blood patch which improved to 0.67 (+/- 0.91 SD) 1 hour postprocedure and remained unchanged at 24 hours postprocedure. Average procedure time was 17.3 (+/- 1.98 SD) minutes, and no complications were experienced.

**CONCLUSION**

CT fluoroscopy guided epidural blood patch represents a safe and effective technique for the management of postlumbar puncture headache. Patients tolerated the procedure well. Furthermore, CT fluoroscopy guided LP allows the radiologist to perform this procedure in a time-effective fashion.

**KEY WORDS:** Blood patch, CT fluoroscopy

**Poster 223**

Translational High Resolution Magnetic Resonance Imaging on a Mouse Spinal Cord Injury Model Using a Clinical 3.0 Tesla System

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**PURPOSE**

There is an increased trend to employ mouse spinal cord injury (SCI) models in preclinical experimental studies. One of the advantages is the availability of transgenic and gene knockout mice that can provide researchers a unique opportunity to investigate the impact of specific genes in the...
pathophysiology of SCI. Previous magnetic resonance imaging (MRI) studies of mouse SCI were mainly carried out on high field 9.4 Tesla(T) animal imaging systems which were equipped with specially designed implantable or surface coils (1). The accessibility to this MR system limited further application of MRI in mouse SCI. In current study, we performed translational high resolution MRI on a clinical 3.0 T MR scanner to characterize the dynamic inflammation change of mouse SCI.

MATERIALS & METHODS
Four adult female C56BL/6 mice with spinal cord contusion injuries at the T9 vertebral level were imaged at 2 hrs, 24 hrs, 72 hrs, 7 days and 28 days post-injury (dpi) on a clinical 3T MR system (Achieva, Philips Medical System), which was equipped with a 3 cm small animal solenoid coil. Two conventional high resolution sequences were employed: 3D sagittal T2 Turbo Spin Echo (TSE): TR/TE= 724/100 msecs, scan matrix 304x304, reconstruction matrix 512x512, field of view (FOV) 60 mm, voxel resolution 120x120x300 µm3, acquisition time 11 minutes 7 seconds; 2D axial T2 weighted TSE: TR/TE= 6286/77 msecs, matrix 256x256, reconstruction matrix 512x512, FOV 40 mm, slice thickness/gap 0.5/0mm, in-plane resolution 80 µm, acquisition time 6 minutes 29 seconds. To eliminate the effect of respiration and vascular pulsation, a 15 mm wide saturation band was applied in 2D axial sequence. After 28 dpi MRI, animals were intracardially perfused with 0.1 M PBS followed by 4% Paraformaldehyde. An eriochrome cyanine staining protocol was used to differentiate spared myelin at injury site. 

RESULTS
High resolution 3.0 T MRI enabled us to visualize the evolution of a mouse spinal contusion lesion over an extended post-injury interval. Specifically, both sequences succeeded in providing high resolution details of the transition from edema and hemorrhage to scar tissue at the gray/white matter interface at the injury site (Figure 1).

![Figure 1](image.png)

**Figure 1.** 3D T2-weighted sagittal high resolution MRI of SCI (focal) in one mouse. The injury site displayed as low signal lesion (arrow) with surrounding edema and hemorrhage to scar tissue at the gray/white matter interface at the injury site (Figure 1).

CONCLUSION
Clinical 3.0T MRI is a valuable translational imaging tool in identification and characterization of inflammation change in mouse SCI.
Conclusion
Line scan diffusion tensor imaging of cervical spinal cord reflects surgical therapeutic effect of compressive cervical myelopathy.

Key Words: Diffusion tensor imaging, cervical compressive myelopathy, MR imaging

Poster 225
Retrospective Comparison of Diskogram Findings with Surgical and Clinical Outcome

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Purpose
Correlate diskogram results (morphologic appearance of intervertebral disks, pain concordance) with presurgical conventional cross-sectional imaging (MR, CT) and evaluate the role of diskography in the treatment decision-making process in patients with chronic low back pain.

Materials & Methods
Fifty-nine consecutive patients with chronic low back pain underwent lumbar diskography performed by a neuroradiologist at IUMC from January 2003-January 2006. The medical records were reviewed retrospectively and information regarding symptomatology, presurgical cross-sectional examination, diskogram results, treatment and posttreatment clinical outcome was obtained. Presurgical cross-sectional findings were correlated with the diskogram morphologic appearance, including circumferential tears, radial tears, disk rupture and nonspecific degenerative changes. Surgical and nonsurgical treatment decisions were reviewed and correlated with the diskogram evaluation, including type and intensity of pain and its concordance with the initial complaint (reproducibility of the patient’s pain after lumbar intervertebral disk contrast injection). Finally, clinical follow up after treatment was reviewed.

Results
One hundred sixty-six injected disk levels were injected in 59 patients including abnormal disks on prior MR imaging and disks with normal appearance for control. Eighty-four (51%) studied disks were considered morphologically abnormal by the performing neuroradiologist, with 29 circumferential tears (34.5%), 46 radial tears (54.75%), eight nonspecific degenerative changes (9.5%) and one disk protrusion with annular tear (1.2%). Twenty-eight of 59 patients had prior MR or CT imaging before the diskogram and in 10 patients (35.8%) there was correlation between the diskogram morphologic appearance and the cross-sectional imaging findings. Concordant pain was noted in 68 disk injections (74%) in 52 patients (88%). Concordant pain was demonstrated in 21 (75%) patients with abnormal findings in cross-sectional images. Twenty-one (40.3%) patients from the 52 whom had concordant pain during the diskogram had surgical treatment while 31 (59.7%) received nonsurgical treatment including epidural injections, facet injections, selective nerve blockage and medical pharmacologic treatment. Posttreatment follow up was documented on 16 patients after their procedures with significant improvement experienced by nine (56.2%) while seven patients (43.8%) still complained of back pain (43.8%).

Conclusion
Pain concordance during diskography correlated better than morphologic disk appearance with cross-sectional imaging findings in patients with low back pain in our series. Most of the patients with concordant pain in lumbar diskography in our series did not have surgery as definite treatment.

Key Words: Diskogram, concordant pain, spine surgery

Poster 226
MR Imaging in Tuberculous Spondylitis: A Study in an Indian Population

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Purpose
To study the patterns of disease spread in tuberculous spondylitis on noncontrast-enhanced MR imaging and compare them with global data.

Materials & Methods
MR spine images of 20 patients with histologically confirmed tuberculous spondylitis were reviewed retrospectively.

Results
1) The thoracic spine was the most commonly involved region, with involvement occurring in thoracic spine alone in 12 cases (60%), and with other areas of the spine in an additional three cases (15%). 2) Contiguous spread of the disease to a minimum of two vertebrae was seen in all our patients, with a maximum of seven vertebrae showing contiguous disease spread in one patient. Single vertebral involvement was seen only in patients with multifocal disease. 3) Multifocal disease was seen in four patients (20%). 4) Posterior elements were involved in 12 patients (60%). 5) Intervertebral disk involvement was seen in 11 cases (55%). 6) Partial vertebral involvement was seen in 10 cases (50%). 7) Paravertebral soft tissue/abscess was seen in 18 patients (90%). 8) Epidural soft tissue/abscess was seen in 17 patients (85%). 9) On T2-weighted sequences, a mixed signal intensity pattern was seen in 14 patients (70%), isoointense signal with predominant hypointensity in two patients (10%), and hyperintense signal in four patients (20%).

Conclusion
1) Thoracic spine is the most commonly involved region in tuberculous spondylitis. 2) Unlike the conventional teaching, involvement of the intervertebral disks and posterior elements was commonly seen in tuberculous spondylitis in our study. 3) Noncontrast MR imaging clearly depicts the entire spectrum of disease spread in tuberculous spondylitis, thus obviating the need of contrast study. 4) A fairly advanced pattern of disease, especially with paravertebral and epidural spread was seen in a large number of patients in our study. This may be attributed to a delayed presentation and delayed diagnosis in a developing country like India.

Key Words: Tuberculous spondylitis, MR imaging
Lumbar Pedicle Marrow STIR Hyperintensity in Patients with Low Back Pain: Prospective Longitudinal Correlation with Patient Symptoms

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PURPOSE
Previous work demonstrated a 1.5% prevalence of lumbar pedicle hyperintensity on STIR sequences in patients presenting with low back pain. Associated findings included degenerative facet changes (more common >30 years and pedicle or pars fractures, more common <30 years) As part of this study, 85 patients with T2/STIR hyperintensity in the lumbar pedicles (type I marrow changes) and without a diagnosis of malignancy, trauma, or infection were entered into a study. Imaging was graded for extent and degree of signal abnormalities and interval change (same, better, worse). All of these patients had one or more follow-up examinations and sufficient clinical documentation (including modified Roland scores and independent chart review) to determine the clinical course. End points were 16 months of clinical follow up (16/30) or resolution of marrow hyperintensity (9/30). Duration of follow up was 1-19 months (mean 9.5, median 11). Eleven of the 30 patients had more than one follow-up examination. Imaging was graded for extent and degree of signal abnormalities and interval change (same, better, worse). The patient’s pain level (0-10) and functional limitation (modified Roland score) were evaluated independently and graded for interval change (same, better, worse).

MATERIALS & METHODS
Working diagnosis was degenerative spondylosis (17 patients, mean age 57 years, range 42-72 years), spondylosis and fractures of the pars interarticularis and pedicles (2 and 1 patients, respectively, mean age 60 years, range 50-66 years); and youth/young adults (mean age 17 years, range 13-23 years) with fractures of the pars interarticularis and pedicles (7 and 2, respectively), and one in which no definite diagnosis was established. Three of the youth/young adults showed early degenerative change.

RESULTS
Pedicle marrow edema improved or resolved in 17 study patients, with concordant improvement of clinical symptoms in 13. 4 patients with improved imaging had persistent low back pain. In the 13 patients with persistent signal hyperintensity three improved clinically, nine patients had stable persistent back pain and one patient had worsening clinical symptoms. Thirteen of 18 patients who had a more acute presentation had concordant MR signal and clinical improvement on follow up.

CONCLUSION
Marrow signal intensity improvement correlated with clinical improvement in patients with low back pain. This concordant improvement was more common in patients who presented with a more acute course.

KEY WORDS: Pedicle, marrow
**Materials & Methods**

Study of cervical spine in 4 healthy volunteers was carried out on a 3T Philips Achieva MR system. Seventy-five axial diffusion-weighted (DW) images (1.3 x 1.3 x 2 mm³, b = 700 s/mm², 15 directions) were acquired using a single-shot spin-echo EPI sequence in 7.3 minutes and covered the entire cervical spine. The DW images were coregistered to the b = 0 s/mm² image using nonrigid method (1-2) and the results were visually inspected. For fiber tracking, regions of interest (ROIs) were placed at the level of C1 and C6 (block arrows in Fig 1A) and fibers passing through the ROIs were reconstructed, if their local fractional anisotropy (FA) > 0.25 and deflection < 50°. The FA, trace (Trace) and eigenvectors along the tracked fibers, and the number of the reconstructed fibers, respectively, were compared before and after the registration.

**Results**

Visual inspection of the images after coregistration was satisfactory in all four subjects. Figure 1 demonstrates the results of tractography, where apparently more fibers were reconstructed from the realigned (Fig. 1B) than from nonrealigned (Fig. 1A) images, respectively. Mean FA (0.739), Trace (2.9 x 10⁻³ mm²/s) and eigenvectors (2.0, 0.6, 0.3 x 10⁻³ mm²/s) of the diffusion tensor averaged over the subjects did not change after image registration. We found, however, more than three-fold average increase (from 1.2 to 8.6) in the number of reconstructed fibers after coregistration.

**Fig 1.** Sagital reconstructions of DW image of cervical spine overlayed by the fibers tracked before (A) and after (B) the nonrigid registration.

**Conclusion**

In this study, intrasubject nonrigid image registration was carried out using well tested parameters (2), which did not alter diffusion tensor indices. Based on the presented results it seems that nonrigid image realignment could improve spinal cord tractography.

**References**


**Key Words:** Spinal cord, diffusion tensor tractography, image registration

*This work was supported by a grant from the “To Walk Again” foundation.*

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**Poster 230**

**MR Neurography of Peripheral Entrapment Neuropathies: Evaluation of Nerve and Muscle Injuries**

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**Purpose**

Conventional evaluation of neuromuscular disorders usually involves clinical exam and history, as well as obtaining electrodiagnostic information. Although this information is useful in assessing the disease, MR imaging has the potential to provide additional specific anatomical and functional information. We evaluated the utility of MR neurography to identify abnormalities in a number of patients with peripheral entrapment neuropathies.

**Materials & Methods**

Patients with neuropathies (n = 18) were evaluated by using a standard MR imaging protocol, including fat saturated T2 and postcontrast T1 images of the extremities. Each of these patients had clinical examination and neurologic testing that indicated the presence of peripheral neuropathy. Images were evaluated for any structural abnormalities in the nerves, muscles and adjacent anatomical structures, and results were correlated with clinical and laboratory findings. The areas evaluated included sciatic (n = 4), brachial plexus (n = 4), wrist (n = 2), knee (n = 3), ulna (n = 1), ankle (n = 2), and shoulder girdle (n = 2).

**Results**

MR imaging abnormalities included: 1) abnormally increased T2-weighted signal in the nerves such as the sciatic, ulnar, peroneal and suprascapular nerves compatible with edema; 2) abnormally increased T2 signal and contrast enhancement in adjacent innervated muscles indicating corresponding edema and denervation injury of muscles, and 3) focal cystic lesions such as ganglion cysts in the region of the knee, wrist, ankle and shoulder girdle. In the hip and shoulder regions, some findings were compatible with conditions such as piriformis (sciatica), infraspinatus, and anterior tarsal tunnel syndromes.

**Conclusion**

MR neurography helps to identify the specific cause of a neuropathy as well as the extent of nerve abnormalities and muscle denervation injury, and provides information that is useful in the preoperative evaluation and surgical planning of patients with peripheral entrapment neuropathies.

**Key Words:** Neurography, neuropathies
Poster 231

Imaging Findings of Bilateral Bifid Median Nerves

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PURPOSE
The role of MR imaging and ultrasonography is well established in the diagnosis of carpal tunnel syndrome (CTS). Especially MR imaging with advanced multichannel specific wrist coils and ultrasonography with high frequency transducers (over 10 MHz) provide excellent resolution. Imaging modalities have become a complimentary tool to clinical examination and electroneuromyography in the diagnosis of this entrapment neuropathy. Anatomical variations regarding the median nerve in the carpal tunnel are important for surgical planning, and if missed, may represent a number of failed surgeries or complications. One of the most common variations of median nerve in the wrist is the bifid median nerve, which is high division of the nerve. Presurgical diagnosis of bifid median nerve in a patient with carpal tunnel syndrome was first published by Propeck et al in 2000. We present imaging findings of bilateral bifid median nerves.

MATERIALS & METHODS
Forty-three-year-old female patient presented with the signs and symptoms of carpal tunnel syndrome bilaterally. She had the disease on the right side for 2 years and recently developed similar symptoms on the left. Ultrasonographic examination was performed using GE LOGIQ 9 (GE Medical Systems, Milwaukee, WI, USA) equipped with 12 MHz linear transducer. Transverse sections of the wrists depicted bilateral bifid median nerves. The echogenicity of both trunks of both nerves were within normal limits and also sonographic isotropy were preserved. Cross-sectional areas measured were as follows: Right nerve radial trunk:0.12 cm², ulnar trunk:0.11 cm², left wrist radial trunk:0.08 cm² ulnar trunk:0.09 cm². Patient underwent MR examinations in a 1.5T suite (GE Signa Excite HD, GE Medical Systems, Milwaukee, WI, USA) using a specific wrist coil of 8 parallel channels. Imaging parameters included T1-weighted axial images for anatomical delineation (TR:520 TE:15 FOV:10x10 cm matrix: 288 x258 NEX:2), fat saturated T2-weighted axial images (TR:5820 TE: 5.8 FOV:10x10 cm matrix: 288x224 NEX: 4) and a T2-weighted 3D gradient-echo sequence (3D FIESTA) (TR:6.9 TE:2.1 flip angle:55 FOV:12x12 cm matrix:320x288 NEX:2). Fat saturated T2-weighted images demonstrated increased signal intensity of radial and ulnar trunks of both nerves. 3D sequence was valuable for reformatted views. Cross-sectional areas measured, were in concordance with the values obtained by sonography.

RESULTS
Another interesting finding was demonstration of bilateral persistent median arteries.

CONCLUSION
Bifid median nerve is one of the four types of variations regarding the median nerve anatomy in the wrist. In an anatomical dissection study by Lanz it was found to be around 2.8%. However there is no published study exactly describing incidence in CTS patients and normal population, as well as its relation to gender and ethnicity. Also incidence of the bilaterality of this variation is unclear. Szabo and Pettey reported a bilateral case with bilateral accessory compartments. In a recent case report by Jones, the author emphasized on bilateral bifid median nerves associated with bilateral palmaris profundus tendons as a cause of failed surgery. In contrast to those surgical papers, our case is the first presentation of bilateral bifid median nerves in a bilateral CTS patient with preoperative imaging findings.

KEY WORDS: Bifid median nerve

Poster 232

Translaminar Cervical Epidural Steroid Injection: Is the Procedure Right for Your Patient?

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PURPOSE
To assess the efficacy of translaminar cervical epidural steroid injection in the management of neck pain and assess for any categorical factors that can help predict the clinical outcome.

MATERIALS & METHODS
A 22-gauge epidural spinal needle is advanced into the epidural space and 3.0-3.5 ml of a solution containing 2.0 mL of Kenalog (40 mg/ml) and 1.0-1.5 mL of preservative-free normal saline is injected. Injections were performed by five different interventional radiologists at three separate institutions. A total of 312 injections were performed on 172 patients (78 male and 94 females) with an average age of 54 years. The average duration of symptoms until the time the procedure was performed was 18.2 months. All patients are assessed by telephone 1 week after the procedure to determine the efficacy.

RESULTS
Patients presenting with multilevel degenerative changes had a greater percentage of pain relief compared to those who presented with degenerative changes localized to a single level (p-value 0.0112). Fifty percent of patients that ultimately required surgery for their symptoms did not report any pain relief from the injection (p-value 0.0053). Patients who required narcotics for pain relief prior to the procedure had a greater chance of having no pain relief from the injection. Patients who had their injections performed at a level other than C7-T1 also had a greater chance of not having any pain relief. There was no statistically significant difference with regards to relief from pain and how it related to the number of procedures performed, age of the patient, and duration of symptoms. Five patients reported side effects from the steroids. The procedure could not be completed in two patients due to increased patient anxiety and the patients unwillingness to continue the procedure after the first attempt at injection.
CONCLUSION
Translaminar cervical epidural steroid injection is a safe and effective procedure that should be considered in the management of neck pain. Clinical results are optimized when the injection is performed at C7-T1 in patients who have multilevel degenerative changes and do not require narcotics for pain relief.

KEY WORDS: Cervical, translaminar, epidural

Poster 234
Use of a Curved Bone Catheter in the Performance of Percutaneous Vertebroplasty and Sacroplasty: Preliminary Results

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PURPOSE
To evaluate the safety and efficacy of a new device, the curved nitinol bone catheter in the performance of percutaneous vertebroplasty and sacroplasty.

MATERIALS & METHODS
Vertebroplasty was performed in three patients and sacroplasty in one. The indications were osteoporosis in the three vertebroplasty patients, and metastatic disease in the sacroplasty patient.

RESULTS
All procedures were performed with a single pedicle approach, or in the sacroplasty, a single entry point. It was possible to place the curved bone trocar across the midline and adjacent to the superior and inferior endplates in the vertebroplasty patients, and along the long axis of the sacral alae in the sacroplasty patient. Excellent filling of the vertebral bodies and the sacrum was achieved from this single entry point in each patient. There were no complications and no significant leakage of cement.

CONCLUSION
In this preliminary, preclinical study, the curved nitinol bone catheter is a useful and safe tool for the performance of percutaneous vertebroplasty and kyphoplasty. Good filling of the vertebral bodies and the sacrum was achieved from a single entry point in each patient.

KEY WORDS: Vertebroplasty, sacroplasty, nitinol catheters

Poster 235
Evaluation of Osteoporosis with Quantitative Diffusion Weighted Imaging

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PURPOSE
Osteoporosis is characterized by low bone mass and microarchitectural deterioration of bone tissue. The World Health Organization (WHO) uses Dual energy x-ray absorptiometry (DEXA) to provide a quantitative definition of osteoporosis. Our purpose in this study was to determine the role of quantitative diffusion weighted imaging in the diagnosis of osteoporosis compared to DEXA. We compared diffusion signal intensity and apparent diffusion coefficient (ADC) values of each vertebrae with the bone mineral density (BMD) calculated by DEXA.

METHODS & MATERIALS
Fifty-one subjects (F/M:41/10; mean age: 52; age range 20-86) underwent both DEXA and conventional MRI with diffusion weighted imaging (DWI) and ADC map. Results were obtained from L1-4 of each patient with a total of 204 lumbar vertebrae. Diffusion signal intensity and ADC of each vertebrae were calculated and compared to bone mineral density. All examinations were performed on a 1.5 T whole body MRI system (Excite, General Electric, Milwaukee, Wisconsin) with a 33 mT/m maximum gradient capacity. Sagittal diffusion weighted images were acquired by using a spin-echo single shot echo-planar imaging sequence (repetition time (TR), 10000 msec; echo time (TE), 68 msec; section thickness, 5 mm; field of view, 28 mm; matrix, 128X128). Two diffusion weighted images were obtained with b values of 0 and 500 seconds/mm² in three planes (x,y,z). ADC values were calculated automatically. The mean and standard deviation of the signal intensity values were measured from operator defined regions of interest (ROI) on diffusion weighted images and ADC maps. The ROI area was 242 mm². Bone mineral density data was obtained on a DEXA scanner (Hologic QDR4500W; Hologic, Waltham, Mass). The L1 through L4 vertebrae were scanned and measured in the anteroposterior direction. After completion of DEXA scanning, BMD (g/cm²) as well as T and Z scores for individual lumbar vertebrae (L1-L4) were calculated using online software. WHO considers a T score of less than -2.5 as indicative of osteoporosis. Osteopenia denotes bone loss in the range of -1 to -2.5. Subjects with an average T score above -1 are considered normal.

RESULTS
A total of 204 vertebrae were grouped into three according to T score values: 68 (normal), 70 (osteopenia), 66 (osteoporosis). The difference between ADC and diffusion signal values of normal, osteopenic and osteoporotic vertebrae were statistically significant. ADC and diffusion values tended to decrease with reduced BMD. The decrease was statistically significant.

CONCLUSION
As a conclusion, water marrow diffusion is restricted secondary to accumulation of fatty marrow as a result of reduction in bone density. By adding DWI and ADC map to a rou-
tine lumbar spine MRI study and quantitatively assessing diffusion weighted images and ADC map, it might be possible to predict the risk of osteoporosis.

REFERENCES

KEY WORDS: Osteoporosis, diffusion, quantitative

Poster 236
Adjacent Compression Fracture Soon after Vertebroplasty: The Influence of Fluid Existence in the Treated Vertebral Body

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PURPOSE
We reviewed six patients with fluid at the bone-cement interface in the treated vertebral body and adjacent new compression fracture soon after vertebroplasty.

MATERIALS & METHODS
Conducted a retrospective analysis of 24 patients treated with 42 levels of percutaneous vertebroplasty. The follow-up MRI studies were performed due to persistent or recurrent pain after vertebroplasty. Reviewing the follow-up MRI, six patients with fluid existence in the bone-cement interface of the treated vertebral body showed adjacent new compression fracture. The interval between the vertebroplasty and the follow-up MRI which showed adjacent compression fracture in the six patients was 32-166 days. The upper or lower disk of the treated vertebral body showed displacement toward the adjacent new compression fracture on MRI.

RESULTS
The treated levels of the six patients were 1 at T9, 4 at T12 and 1 at L1. Two of the six treated vertebral bodies with fluid were retreated with cement injection. The fluid was obtained before the 2nd cement injection. The cytology showed few inflammatory cells and necrotic bony fragment in the fluid. The two patients had partial pain relieve after the 2nd vertebroplasty. In the MRI study one month after the 2nd vertebroplasty, fluid in the retreated vertebral bodies was still found.

CONCLUSION
The mechanism of fluid in the vacuum clefts or bone-cement interface was still unknown. The treated vertebral bodies with fluid in the bone-cement interfaces were at the midthoracic spine and thoracolumbar junction where the flexion and extension was most dynamic. Though retreatment of the patients had partial pain improvement, the fluid in the bone-cement interface was persisted or recurrence in the follow-up MRI study.

KEY WORDS: Vertebroplasty, fluid, adjacent compression fracture
### Scientific Exhibits 1–87

**Riverside Center East**

**Monday, June 11**

*12:00 PM – 9:00 PM*

**Tuesday, June 12 – Wednesday, June 13**

*6:30 AM – 9:00 PM*

**Thursday, June 14**

*6:30 AM – 6:00 PM*

**Note:** A missing Scientific Exhibit number indicates an abstract has been withdrawn.

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### Scientific Exhibit 1

**MR Imaging Appearance of Thalamic Infarcts Related to Different Vascular Territories and Their Associated Clinical Syndromes**

Mangla, R. · Srinath, G. · Kathuria, S. · Malhotra, A. · Ekholm, S.

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**Purpose**

Thalamic infarcts traditionally have been classified into four territories and these different lesions can be identified on MR imaging. A few variations in the vascular supply have been demonstrated which will result in some variability in the MR appearance of these lesions. There are characteristic syndromes which are associated with these lesions. The purpose of this exhibit is to describe classical and variant distribution in patients with thalamic stroke. A brief description on characteristic clinical syndrome also will be described.

**Materials & Methods**

The clinical records and MR imaging studies of patients with thalamic infarcts in classical and variant territories which were diagnosed and/or treated at our institution were reviewed. All patients had MR imaging performed on a 1.5T system. Various appearances of thalamic infarcts in different territories will be shown in detail and the characteristic vascular syndromes associated with these lesions will be described.

### Scientific Exhibit 2

**Global Hypoxic Ischemic Damage of the Brain: Imaging Spectrum and Underlying Factors**

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**Purpose**

Global hypoxic ischemic injury of the brain varies considerably in severity, distribution, and outcome. The neuroradiologist often is confronted with imaging patients who have suffered such injury. We investigated the factors involved in global hypoxic ischemic injury and illustrate typical and unusual imaging patterns, focusing on CT and MR imaging.

**Materials & Methods**

Global hypoxic ischemic injury can be approached from several aspects. Causative or mediating factors include hypoxia, hypoperfusion, anemic ischemia or toxins, blood glucose status, maturity of the brain, availability of collateral supply, and selective tissue vulnerability. A set of different imaging patterns results, with occasional unusual variations.

**Results**

We present illustrations of the variety of injury patterns to the brain resulting from global hypoxic ischemic injury as well as discussion of the factors involved in pathogenesis. Classic patterns include borderzone infarctions and more

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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/2007.
extensive gray matter damage. However the location of tissue damage can be quite variable. There also is considerable variation in actual outcome, and some patients demonstrate unusual patterns such as severe white matter damage. Timing of CT and MR imaging also has great impact on the appearance.

**CONCLUSION**
Recognition of underlying factors can help one understand the imaging appearance of global hypoxic ischemic injury. It is important to be aware of the variety of findings that may occur and to search for such variations. A range of such findings will be illustrated.

**KEY WORDS:** Stroke, global ischemia

**Scientific Exhibit 3**

**Subacute Infarct: A Great Pretender**

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**PURPOSE**
To present examples of various manifestations of subacute infarcts and discuss the underlying pathophysiology.

**MATERIALS & METHODS**
The subacute phase of infarct begins by the third day. It is a period of great upheavals in the natural course of an ischemic infarct; it is a time for regenerating, remodeling, and repair. This is the stage when cytotoxic edema slowly changes into vasogenic edema with maximum mass effect. Frequently, there is a breakdown in blood-brain barrier and proliferation of new vessels. Mass effect, bleeding, and enhancement are common.

**RESULTS**
During the early and mid stages of subacute infarct (SAI), the apparent diffusion coefficient (ADC) trace maps may be normal due to a combination of cytotoxic and vasogenic edema. Subacute infarcts can mimic a primary brain tumor due to the presence of mass effect, edema, and enhancement. MR perfusion and spectroscopy may be required to differentiate SAI from tumor. Subacute infarcts also have been mistaken for lymphoma. A focal SAI may enhance and be mistaken for a metastasis. Not infrequently, SAI also can be misinterpreted as encephalitis. Bleeding is common due to fragile vessels and reperfusion.

**CONCLUSION**
Neuroradiologists need to be aware of the various presentations of the subacute infarct to avoid wrong diagnosis.

**KEY WORDS:** Subacute, infarction

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**Scientific Exhibit 4**

**Role of the Neuroradiologist in the Evaluation of Alzheimer Disease: Anatomical, Physiologic, and Functional Imaging: A Teaching Exhibit**

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**PURPOSE**
Alzheimer disease (AD) is a well known neurodegenerative process related to aging, affecting cortical and deep basal neurons, which is progressive starting first with impaired memory and proceeding to more severe cognitive dysfunction and eventually death, while preserving motor function until late in the disease. Due to probable Wallerian degeneration there also is loss of tissue in the white matter (also affected by ischemia) and T2 changes of leukoariosis with overall resulting atrophy of the brain. Alzheimer disease has predilection for the medial temporal lobe, especially the hippocampal region, as well as temporal and parietal regions, and forebrain deep nuclei. The hallmark pathologically is the presence of β-amyloid plaques and neurofibrillary tangles with the tau protein. There has been an explosion in the field of genetic, metabolic, and neuroimaging with functional imaging coming to the forefront especially with development of amyloid binding protein such as the Pittsburgh B protein, and [18F]FDGDP in PET scanning. MR imaging has assumed a leading role not only in automated volumetric assessment of atrophy, but also in evaluation of infarct by perfusion imaging (along with SPECT and PET), white matter loss (DWI, DTI), and functional paradigms (BOLD). Although the only definitive diagnosis is brain necropsy, the most important role of neuroimaging is not in establishing the diagnosis of full blown AD, but in detecting the early changes so that the current neuroprotective therapies may be started early hoping to delay disease progression. Petrella (1) provided a thorough discussion of neuroimaging in AD. It is the purpose of this exhibit to update this discussion with the current state of art in the evaluation of AD.

**MATERIALS & METHODS**
Key anatomical regions will be illustrated including the entorrhinal cortex, amygdyla, perihippocampal fissure, substantia innominata and basal nucleus of Meynert, thalamus and its radiations, as well as the hippocampus, emphasizing the memory/association complex and rhinencephalon. Examples of neuroimaging assessing volume, and function (MR, PET, SPECT) will be provided emphasizing the role of the neuroradiologist. The Pittsburgh B protein (PIB) will be discussed. Alzheimer disease will be contrasted with frontal-temporal dementia, vascular dementia, and Lewy body dementia. Voxel based morphometry, Talaraich coordinate, Colin brain, and statistical methods also will be discussed.

**RESULTS**
Neuroimaging is better defining the pathology of AD with advances in PET and MR imaging, but still does not provide the definitive diagnosis. But when coupled with neuropsychiatric testing and other clinical parameters, becomes highly specific, and clearly paves the way for future evaluation.
CONCLUSION
With estimates of AD at 18 million worldwide and expected to double by 2025 and annual health related costs at 80-100 billion dollars, the role of the neuroradiologist becomes increasingly key particularly when some of that cost is due to expensive medical imaging. It behooves the neuroradiologist to remain at the cutting edge of neuroimaging and diagnosis to meet this challenge. This teaching exhibit will provide illustrative examples of key diagnostic findings in the various imaging modalities, as well as pertinent neuroanatomy.

REFERENCES

KEY WORDS: Alzheimer, neuroimaging, functional imaging

Scientific Exhibit 5
Manganese Accumulation in the Brain: MR Imaging

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Manganese (Mn) accumulation in the brain is detected as symmetrical high signal intensity in the globus pallidi on T1-weighted MR images (Fig. 1) without abnormal signals on T2-weighted images. In this education exhibit, we present several cases of Mn accumulation in the brain due to hepatic cirrhosis with a portosystemic shunt, congenital biliary atresia, primary biliary cirrhosis, congenital intrahepatic portosystemic shunt without liver dysfunction, Rendu-Osler-Weber syndrome with a diffuse intrahepatic portosystemic shunt, patent ductus venosus, long-term total parenteral nutrition and welding-related Mn intoxication. The most severely affected site was the globus pallidus, followed by the anterior pituitary gland, midbrain, pontine tegmentum and corpus callosum (Fig. 2). These MR abnormalities are reversible in the majority of patients after adequate treatment within 6 months. Examination of the upper abdomen by computed tomography, evaluation of blood chemistry to check liver function and evaluation of the blood Mn level are necessary for accurate diagnosis. If no cause of Mn accumulation is found, medical and occupational histories should be checked.

KEY WORDS: Manganese, globus pallidus, MR imaging

Scientific Exhibit 6
MR Imaging of Malformations of Cortical Development: A Pictorial Review Based on the Recent Classification Schemes

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PURPOSE
To describe and illustrate the MR imaging findings of malformations of cortical development on 1.5T and 3T according to the recent classification of malformations of cortical development (MCDs) (1) and the classification of focal cortical dysplasias (FCDs) (2).

MATERIALS & METHODS
Cortical malformations are being recognized increasingly as a significant cause of developmental delay, focal neurologic deficit, refractory epilepsy, and mental retardation. Many of these malformations present in the neonatal period or infancy. Proper diagnosis and rational classification of these disorders is essential for prognosis, genetic testing and counselling, and investigation of the underlying molecular causes.

RESULTS
The classification scheme of MCD by Barkovich is based on whether these disorders are the result of 1) abnormal neuronal and glial proliferation or apoptosis, 2) abnormal neuronal migration, or 3) abnormal cortical organization. Characteristics that correlate with and enforce this system of classification can be identified by MR imaging. We present a pictorial review of the MR imaging features of MCDs with 1.5 and 3T MR imaging, including 3T MR virtopsy imaging and 3T dedicated surface coil imaging.

CONCLUSION
Current MR imaging techniques can clearly demonstrate the morphology, distribution and extent of malformations of cortical development. When in doubt, high resolution multi
array surface coil MR imaging at 3T can better delineate the cortical anatomy and has higher gray matter/white matter contrast to reveal subtle migration anomalies. The understanding of the classification and the MR imaging findings are essential for proper diagnosis, prognosis, therapy, and genetic counseling.

REFERENCES
2. Palmini et al. Neurology 2004

KEY WORDS: Development, brain, epilepsy

Scientific Exhibit 7
MR Spectroscopy in Patients with Epilepsy: Mapping Brain Seizure Activity

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PURPOSE
MR imaging of the brain plays a key role in evaluation of anatomical abnormalities involved in epilepsy, but localization of seizure activity is sometimes difficult. Recently, MR spectroscopy has been shown to provide potentially useful additional functional information regarding brain metabolites that are affected by seizures, in particular lactate and lipids. In order to improve detection and localization of seizure activity, we evaluated the utility of MR spectroscopy in patients with epilepsy.

MATERIALS & METHODS
Patients with epilepsy (n = 9) were evaluated by using standard MR imaging of the brain, including high-resolution coronal images through the temporal lobes. All patients had spot EEG evaluation followed by long-term EEG monitoring or subdural grids. MR spectroscopy images were acquired after each patient had recent seizures using multivoxel PRESS MRSI. Images then were evaluated for any structural abnormalities, in particular, those involving the temporal lobes. MR spectroscopy maps also were analyzed for changes of conventional metabolites such as NAA, creatine, choline, and specifically for abnormalities involving lactate and lipids. These patterns were compared to clinical presentation, EEG, and subdural electrode findings.

RESULTS
In all patients, MR spectroscopy demonstrated abnormally elevated lactate and lipid levels in the brain. Corresponding anatomical abnormalities were not always detectable on conventional MR imaging. Color maps of brain lactate and lipids were useful in displaying the topographical distribution and propagation of seizure activity in the brain. Regions of abnormal brain lactate and lipids correlated with localization patterns obtained by clinical, EEG, and subdural grid findings.

CONCLUSION
Although MR imaging of the brain is necessary for evaluation of brain lesions and anatomy in patients with epilepsy, these results suggest that MR spectroscopy can provide useful additional information regarding postictal changes in brain metabolism activity. Changes in lipids and lactate levels may be used for the evaluation and mapping of seizure activity in the brain of patients with epilepsy.

KEY WORDS: Epilepsy, spectroscopy, lactate

Scientific Exhibit 8
Neuroimaging Tools for Evaluating Patients with Refractory Epilepsy: Presurgical and Postsurgical Approach

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PURPOSE
The aim of this educational exhibit is to show different neuroimaging tools such as MR imaging, SISCOM, and functional MR imaging used in the evaluation of patients with refractory epilepsy.

MATERIALS & METHODS
We reviewed several diagnostic neuroimaging tools for the evaluation of patients with refractory epilepsy used in our epilepsy clinical unit. We divided the patients into two groups: temporal lobe epilepsy and extratemporal lobe epilepsy and we propose a clinical and radiologic algorithm for the study of these patients. We also describe surgical and postsurgical evaluation.

RESULTS
Last year we studied 86 patients in our institution with refractory epilepsy. MR imaging demonstrated the epileptogenic lesion in 86% of cases. The most frequent lesion was temporal mesial sclerosis followed by cortical dysplasia. SISCOM studies helped to demonstrate the epileptogenic zone in patients with extratemporal lobe epilepsy. Functional MR imaging also was useful for language lateralization and for surgery planning. Neurosurgical procedures such as neuronavigation or esterotactic intracranial implantation of deep electrodes also are described. Postsurgery evaluation of several neurosurgery approaches also will be discussed.

CONCLUSION
The appropriate knowledge of different neuroimaging tools in the study of refractory epilepsy is essential to improve the diagnosis and prognosis of these patients.

KEY WORDS: Refractory epilepsy, neuroimage, surgical evaluation
Scientific Exhibit 9

Functional MR Imaging and Tractography for Eloquent Cortex and White Matter Tract Mapping at 3T: Methodology, Applications, and Intraoperative Integration in Neurosurgical Patients

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PURPOSE
1) Provide a review of functional MR imaging (fMRI) and diffusion tensor imaging (DTI) techniques useful for assessment of neurosurgical patients. 2) Demonstrate a reproducible method for obtaining fMRI data on clinically based MR scanners. 3) Present our experience with combining fMRI and DTI obtained at 3T to outline eloquent cortex and associated white matter tracts for preoperative planning as well as intraoperative neuronavigation.

MATERIALS & METHODS
Standard language (presented noun - verb generation, presented letter - word generation, and passive listening), motor (sequential finger tapping, foot flexion), and visual stimulation fMRI paradigms were performed. Twenty-five direction DTI was performed for tractography with subsequent outlining of the corticospinal and geniculocalcarine tracts, and arcuate fasciculus. BOLD and DTI data were processed and fused with a subsequent fiducial scan for surgery, and objects created for intraoperative use outlining important white matter tracts and fMRI activation areas in relationship to pathology (Fig 1). In selected cases, results of intraoperative cortical stimulation were correlated with fMRI data.

RESULTS
A clinically based review of fMRI and DTI techniques for use in neurosurgical patients is provided with an emphasis on neoplastic disease utilizing case material from a large academic medical center. Multiple case examples outlining the utility, performance, interpretation, and limitations of these techniques are presented.

CONCLUSION
Functional MR imaging and DTI are highly useful as preoperative planning tools in neurosurgical patients. Utilization of this data intraoperatively is a rapidly emerging technique with significant potential for improving resection results, diminishing the time of surgery, and reducing postoperative deficits. Neuroradiologist involvement in this process is highly beneficial.

KEY WORDS: Tractography, functional MR imaging, brain tumor

Scientific Exhibit 10

How to Design a Functional MR Imaging Study Focused on Language and Vocalization Mapping for Parkinson’s Disease Patients

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PURPOSE
Regarding clinical applications, some of the classical paradigms of functional MR imaging (fMRI) must be adapted. When investigating cerebral areas related to language, there is no ideal task to map all of its components: phonetic, semantic (lexical), morphologic (grammar), syntax (lexical in phases), and pragmatic (verbal and nonverbal contexts). According to the disease physiopathology there must be prioritized tasks which better exam this dysfunction. However, for some particular exams, there are no previous designed tasks.

MATERIALS & METHODS
Patients with Parkinson’s disease (PD) have dysarthria, with monotony of pitch, monotony of loudness, reduced stress, short phrases, variable rate, short rushes of speech, and imprecise consonants. Only in more severe stages they show cognitive impairment. The authors propose a battery of fMRI tasks to evaluate language impairment in patients with mild PD. The chosen tests were: spontaneous word generation from letters, to access verbal fluency; semantic decision from categories and rhymes, for the cognitive contribution; and the most demanding work to exam the phonation through sustained vowel vocalization. All paradigms were in ABC block design, with different degrees of difficulty, aiming correlation with the disease grade.

RESULTS
Recording behavior response is fundamental not only to correlate cerebral activity to errors percentage, but also to relate it with neurologic and phonoaudiologic exams outside the scanner.

CONCLUSION
We discuss how far we can adapt paradigms and still correlate date obtained to previous knowledge, with no much reproducibility compromise, and its limitations, when concerning multidisciplinary approach.

KEY WORDS: Functional MR imaging, Parkinson’s disease, language
Diffusion Abnormality in Alzheimer Disease: Tract-Specific Analysis

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PURPOSE
MR diffusion tensor imaging (DTI) is a noninvasive technique that can identify white matter tracts by evaluating bulk diffusion of water in three dimensions and thus can describe the microarchitectural characteristics of local brain tissue. Several recent reports have shown that mapping of diffusion parameters is potentially useful in speculating the pathology of Alzheimer disease (AD). However, most of the previous reports used manually drawn regions of interest (ROIs) for DTI abnormalities in AD patients. Tract-specific analysis is now highlighted to evaluate diffusion parameters of the specific white matter tract. The purpose of this poster is to assess changes of diffusion properties in AD using tract-specific analysis.

MATERIALS & METHODS
We studied the posterior cingulate fiber tracts (PCFT) and uncinate fasciculus (UF) in AD patients and controls. Mean diffusivity (MD) and fractional anisotropy (FA) were measured using tract-specific analysis. For PCFT, 25 AD patients and 16 age-matched normal controls were measured, for UF, 19 AD and 19 age-matched controls were measured. To reduce partial volume effect and incidental fiber contamination, we used shape processing technique to measure core of the tract.

RESULTS
For measured FA and MD in PCFT, FA in patients with AD was significantly lower than that in normal controls (p < 0.006). Mean diffusivity in PCFT in patients with AD was significantly higher than that in normal controls (p < 0.012). For measured FA and MD in UF, FA in patients with AD was significantly lower than that in normal controls (p < 0.0001). However, MD in UF in patients with AD was not significantly higher than that in normal controls (p = 0.65).

CONCLUSION
Our results suggested that FA and MD in the PCFT and FA in the UF reflects progression of AD-related histopathologic changes and may be useful biological indices to monitor AD.

KEY WORDS: Alzheimer disease, diffusion tensor tractography, tract-specific analysis

Diffusion Tensor Imaging of White Matter Tracts at 3T

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PURPOSE
Diffusion tensor imaging can be utilized to create a virtual dissection of the white matter tracts in the brain and brainstem. It is now important for neuroradiologist to understand this anatomy. The diffusion tensor imaging data can be displayed in multiple ways in order to demonstrate the otherwise “hidden” white matter anatomy. A powerful and quick method to display the position of white matter tracts is to utilize tricolored directionally encoded fractional anisotropy maps. Eigenvector maps demonstrate a finer degree of the fiber trajectories using a color-coded method. In addition, tractography can be used to visualize the white matter tracts and pathways in three dimensions. The purpose of this exhibit is to review and demonstrate white matter tract systems by using diffusion-tensor imaging at 3T.

MATERIALS & METHODS
Six healthy subjects without any history of neurologic disorders were included in this study. The images in this exhibit were all obtained with a HDx GE 3.0T MR imager. Twenty-five directions of water motion encoding were acquired in the axial, coronal, and sagittal planes. A single-shot echoplanar technique was used with TR = 6000-10000 ms, TE = minimum (79-95 ms), B-value = 1000, 128 x 128 or 256 x 256 matrix, 22 x 22 cm field of view, 2.4 mm to 3 mm slice
thickness, 0 to 0.5 mm slice gap, acceleration factor = 2. The GE Functool ADW 3.1.23 workstation was utilized to process the DTI data.

**RESULTS**

White matter fiber tracts are demonstrated by using eigenvector maps, tricolored fractional anisotropy maps, and tractography. In addition, high-resolution maps of the lateral geniculate nuclei and Meyer’s loop are displayed. These demonstrate how to localize Meyer’s loop on the tricolored maps and the tractograms of Meyer’s loop further demonstrate the relationship of Meyer’s loop to the lateral ventricle and uncinate fasciculus. The appearance of the thalamus by eigenvector mapping and the three major projections from the thalamus are shown. Brainstem maps with attention to the midbrain are created from high resolution DTI data.

**CONCLUSION**

This exhibition demonstrates the anatomical location of various white matter fiber tracts and the anatomical relationship between different tracts. Understanding this anatomy is important for neuroradiologists. Familiarization with these tracts should be beneficial in the clinical application of diffusion-tensor imaging.

**KEY WORDS:** Diffusion tensor imaging, white matter tracts

**Scientific Exhibit 13**

**Clinical Features and MR Imaging Findings of Hashimoto’s Encephalopathy**

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**PURPOSE**

Hashimoto’s encephalopathy (HE) recently has come to be regarded as a new autoimmune encephalopathy that is acute or subacute, and steroid-responsive disorder with various neuropsychiatric symptoms. We investigate the clinical features and MR imaging of patients with HE to obtain any useful information to suspect and precede specific autoantibody analysis.

**MATERIALS & METHODS**

Eleven patients of Hashimoto’s encephalopathy (Table 1) diagnosed with clinical symptoms and antithyroid antibodies and/or specific autoantibodies against the NH2-terminal region of α-enolase (NAE) were evaluated on MRI (either 1.5T or 3.0T; GE). Follow-up MR images were available in seven patients with periods of two weeks to three years.

**RESULTS**

Eight cases showed high intensity spots on T2-WI and FLAIR with or without associating deep white matter hyperintensity, with subcortical predominance in five cases. One particular case, high intensity abnormalities were demonstrated symmetrically in swollen deep temporal lobes, representing limbic encephalitis. After steroid therapy, follow-up MRI showed the decreased number of high-intensity spots in four of seven cases (Fig 1, Case 5, two-week interval) and resolving limbic change in the limbic encephalitis case (Fig 2, Case 4, a year interval).
CONCLUSION
Although the MR findings were rather nonspecific, in clinically acute or subacute encephalopathy affecting relatively young patients, subcortical distribution of high intensity spots on T2-WI and FLAIR with sparing the deep white matter and basal ganglia might be useful to cast suspicion of Hashimoto’s encephalopathy, which can be diagnosed with specific anti-NAE antibodies and be well treatable with steroid therapy.

KEY WORDS: Hashimoto’s encephalopathy, Hashimoto’s thyroiditis, MR imaging

Scientific Exhibit 14
Imaging Findings of Central Nervous System Infections
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PURPOSE
1) To describe and depict central nervous system (CNS) infections within the different compartments of the brain. 2) To illustrate characteristic imaging findings attributable to specific pathogens. 3) To demonstrate infectious etiologies specific to immunocompromised and HIV patients. 4) Discuss the role of MR spectroscopy in diagnosis of certain CNS infections.

MATERIALS & METHODS
Localizing a lesion within the intracranial compartment is the first critical step in constructing a differential diagnosis. Furthermore, certain types of infections have certain propensities for different anatomical regions within the brain and can possess certain imaging characteristics. Of course, the imaging findings must be placed in the context of the clinical setting particularly in immunocompromised and HIV patients.

RESULTS
We present a pictorial review of infections within different compartments of the brain. Pathology-proved infectious cases will be presented in both immunocompetent and immunocompromised patients with discussion of the characteristic findings of each pathogen and differential diagnosis.

CONCLUSION
The radiologist plays a crucial role in identifying and narrowing the differential diagnosis of CNS infections. A thorough understanding of the intracranial compartment anatomy and characteristic imaging findings of specific pathogens as well as incorporating the clinical information is essential to help the clinicians arrive at the correct diagnosis in a timely manner.

KEY WORDS: Infection, HIV, immunocompromised

Scientific Exhibit 15
MR Imaging Features of Histopathology Proved Cerebral Radiation Necrosis
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PURPOSE
Cerebral radiation necrosis (CRN) is an undesired effect of brain radiation. It is imperative to distinguish CRN from recurrent tumor in order to administer appropriate therapy. To date, however, there is no definitive imaging method to distinguish these conditions.

MATERIALS & METHODS
We retrospectively reviewed all clinical cases of CRN identified histologically at surgery from HFH in the past 15 years. All cases of CRN mixed with significant amounts of viable tumor were excluded from study. We included only cases with CRN without tumor or with microscopic foci of tumor cells.

RESULTS
Forty-one cases were identified. Treated tumors included 34 gliomas, 5 metastases, 1 PNET and 1 ependymoma. Central necrosis (37) and cysts (24) were common. T1 hyperintensity without contrast administration was seen in 17 cases. Contrast enhancement on T1-weighted images was most common in the frontoparietal lobes. The most common pattern of enhancement seen in 35 patients (85%) included ill-defined borders, lack of a nodular component, and a central “swiss cheese” appearance (striations within the enhancing area). Subependymal enhancement was present in 25 cases and corpus callosum enhancement was seen in 16. The brain stem was involved in only one patient. There were no lesions in the cerebellum. A pattern of enhancement in two adjacent lobes separated by the dura and without evidence of dural thickening or intervening parenchymal or dural enhancement was seen in three cases. Brain atrophy was present in 29 patients and leukoencephalopathy in 19.

CONCLUSION
This is the largest report of MR findings in histologically proved CRN. A “swiss-cheese” and ill-defined, nonnodular pattern of enhancement was most common (85%). The high frequency of involvement of the corpus callosum and subependyma was unexpected, as these findings are traditionally reported with tumor infiltration. A pattern of enhancement in adjacent lobes separated by the dura may be pathognomonic of CRN when the imaging changes are consistent with the radiation field dosimetry.

KEY WORDS: Cerebral, radiation necrosis, MR imaging
Scientific Exhibit 16

“Silencing of the Genes:” Central Role of Tumor Suppressor Genes in the Pathogenesis of Central Nervous System Neoplasms

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PURPOSE
1) To review current concepts elucidating the seminal role of tumor suppressor genes in the development of select central nervous system (CNS) neoplasms. 2) To describe cytogenetics, oncologic pathways and geno-phenotype correlation of CNS tumors. 3) To discuss the therapeutic and prognostic implications of recent advances in the molecular biology of CNS tumors.

MATERIALS & METHODS
There is a wide spectrum of CNS neoplasms with characteristic histopathology, tumor biology, and imaging findings. Recent advances have offered new insights into the ontogeny, biology, and pathogenesis of CNS tumors. Several CNS tumors now are thought to be a byproduct of suppression of tumor suppressor genes. The suppressor genes, their locations and functions recently have been clarified.

RESULTS
Several hereditary and sporadic CNS neoplasms occur due to suppression of tumor suppressor genes or their functions. While inactivating mutations involving the APC, SUFU and PTC1 genes result in the development of medulloblastomas, lack of TSC1/TSC2 genes cause giant-cell astrocytomas. Neurofibromatosis types 1 and 2 are two disparate entities characterized by abnormalities of NF1 and NF2 genes and their protein products, neurofibromin and merlin. PTEN suppression may partly explain the highly infiltrative nature of glioblastomas. INI1 and RB suppressor dysfunction result in development of rhabdoid/choroid plexus tumors and retinoblastoma, respectively. Several drugs have been developed against molecular targets in an effort to treat some CNS tumors.

CONCLUSION
Silencing of the tumors suppressor genes is a key mechanism of CNS oncogenesis. Knowledge of the cytogenetics and molecular biology of CNS tumors not only permits better understanding of geno-phenotype expression but also allows development of molecular therapeutics.

KEY WORDS: Neoplasms

Scientific Exhibit 17

Influence of Imaging Conditions on the Enhancement Effect of MR Contrast Agents

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PURPOSE
Multiple factors determine both longitudinal and transverse relaxation rates (R1 & R2) associated with the presence of exogenous contrast media. As the choice of available MR contrast agents and the range of possible MR field strength increases, knowledge of the interaction of MR contrast agents with imaging variables becomes critical. Herein, we review the variables that affect MR contrast agent relaxivity, and thus the enhancement effect in vivo.

MATERIALS & METHODS
Several recently published studies on the relaxivity and enhancement mechanism of gadolinium-based contrast agents were reviewed. Three contrast agents were studied: a nonprotein interacting 0.5 M agent (Gd-DTPA), a nonprotein interacting 1 M agent (Gd-DO3A-butrol), and a 0.5 M agent that interacts weakly and transiently with serum albumin (Gd-BOPTA). Studies were conducted to determine the relaxivity and accurate relaxation rates of these agents in human plasma and to compare their relaxation times at various field strengths.

RESULTS
Overall, the relaxivity of a given gadolinium agent depends on the conditions under which relaxivity is assessed. Proton relaxation times shorten (and thus enhancement increases) with higher field strengths. Higher field strengths resulted in lower values of R1, R2, and r1 for all contrast agents tested and of r2 for Gd-DTPA and Gd-DO3A-butrol. For Gd-DTPA and Gd-BOPTA the R1 decreased by 10% and 20% respectively at 3T compared to 1.5T. While the relaxivity of gadolinium agents tends to be comparable when measured in water, some agents (such as Gd-BOPTA) show increased relaxivity (i.e., shorter transverse and longitudinal relaxation times) in the presence of serum proteins. Theoretical calculations showed that Gd-BOPTA provides the highest signal increase at any given TR and benefits from the use of short TE sequences.

CONCLUSION
The use of an agent with increased relaxivity can compensate the reduced signal intensity enhancement and signal loss that are characteristic of sequences with short TE imaging both in structural MR imaging and MR angiography. The advantage of a higher relaxivity agent over conventional gadolinium agents is evident at all magnetic field strengths. A better understanding of the factors influencing the contrast enhancement provided by gadolinium-based agents under various imaging conditions will enable neuroradiologists to maximize contrast enhancement, and thus diagnostic efficacy, while minimizing dose and cost related to the imaging study.

KEY WORDS: MR contrast agents, relaxivity, gadobenate dimeglumine
Scientific Exhibit 18

Pineocytoma Mimicking a Simple Pineal Cyst on Imaging: Urban Legend or True Diagnostic Dilemma?

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**PURPOSE**

It has been stated that a pineocytoma can mimic a simple pineal cyst in imaging appearance, yet the majority of the reports of the appearance of this uncommon tumor state that it is at least a partially enhancing lesion. In fact, only one series describes similar postcontrast MR imaging findings of pineal cysts and pineocytomas with only one case possibly having an imaging appearance identical to a simple cyst. We attempt to determine if the truly cystic pineocytoma exists when imaged using CT and multisequence MR imaging with and without contrast, or if it is a myth which concerns radiologists and causes the recommendation of possibly unnecessary follow-up studies or even biopsy.

**MATERIALS & METHODS**

Radiology reports from a large academic tertiary care medical center and associated Children’s Hospital were reviewed for any pathologically proved pineocytomas with available imaging studies or reports. We also reviewed the radiology literature for case reports and case series describing the imaging appearance of pineocytomas on MR imaging. We noted the imaging findings of the tumors, and for any lesion described as cystic, we tried to elucidate the exact extent of imaging that was performed (i.e., CT, MR sequences, contrast utilization) and lesion size, shape, enhancement pattern, and wall characteristics were noted when available.

**RESULTS**

Eleven case reports or case series which included MR imaging of pineocytomas were found and yielded 42 pathologically proved cases of pineocytomas. The records of our institution yielded seven pathologically proved cases of pineocytomas with available imaging studies or reports. Of these 23 were solid masses, seven were partially solid and cystic, while 13 tumors could not be characterized completely due to incomplete evaluation, lacking either T1- and T2-weighted MR imaging or lacking postcontrast T1-weighted imaging. Six of the evaluated pineocytomas were primarily cystic. One was septated, eccentric with a thick wall, one had a dorsal nodule, three had walls that were thicker than two millimeters (more precise measurements were not provided), while one may have been a simple cyst with a thin wall (it is difficult to determine this from the published data).

Importantly, several tumors appeared cystic on initial imaging with noncontrast MR and CT; however when further imaging with multisequence postcontrast MR was performed, the solid nature of these tumors were evident. From this review, the imaging findings of a pineocytoma mimicking a thin (< 2 mm) walled simple cyst without any associated nodularity to the wall is extremely rare.

**CONCLUSION**

Although one series described a single pineocytoma that was possibly indistinguishable from a thin-walled pineal cyst on imaging, this seems to be a very rare presentation of a very rare tumor. Therefore while we cannot say this never occurs, it would be very unlikely that when a pineal lesion appears as a simple cyst on both CT and postcontrast MR imaging that this would represent a pineocytoma, given the rarity of pineocytomas overall.

**KEY WORDS:** Pineocytoma, pineal cyst

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Scientific Exhibit 19

Retrospective Study of 201Thallium SPECT in the Diagnosis of Recurrent Primary Brain Tumors

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**PURPOSE**

In patients with primary brain tumors the diagnosis of progressive disease is important in planning further debulking surgery, chemotherapy and/or radiotherapy. 201Thallium scanning may be used to distinguish increased intracellular metabolism occurring in tumor progression from postsurgical change, radiation fibrosis, or normal brain which exhibit little or no 201thallium uptake. The aims of this study are: 1) to determine the relationship between MR imaging and 201thallium scans in patients with primary brain tumors. 2) to compare outcomes in patients with negative and positive 201thallium scans with reference to the MR appearances.

**MATERIALS & METHODS**

A retrospective study of 72 patients with primary brain tumors who underwent 201thallium SPECT scanning between January 2000 and October 2006, where MR findings were equivocal or there was discordance between the MR findings and the patient’s clinical status. Nine patients were WHO grade II and 63 grade III or IV.

**RESULTS**

Outcome data were available from 54 patients. Twenty-three patients had a positive and 31 patients had a negative 201thallium scan. In those patients with a negative scan, the mean progression-free survival was 24 months: only one patient subsequently had early progression diagnosed on brain biopsy. Of 23 patients with a positive 201thallium scan, 12 subsequently had chemotherapy, one had radiotherapy and four underwent debulking surgery. The negative predictive value was 97%.

**CONCLUSION**

A positive correlation between MR imaging and 201thallium scans reliably predicted outcome indicating that 201thallium scans may be of value in routine follow up of patients with primary brain tumors. In patients with a negative thallium scan, lack of tumor progression was associated with a long disease-free survival. In our study a negative thallium scan indicated inactive disease. A positive thallium scan, though suggestive of recurrence, was histologically confirmed in only four patients who underwent surgery. A positive thallium scan therefore should be correlated with further MR imaging.

**KEY WORDS:** Thallium, brain tumor
Efficacy of Two Commonly Used MR Contrast Agents for Evaluation of Brain Metastases

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PURPOSE
To compare enhancement and conspicuity of intraaxial metastases after application of two MR contrast agents, the high relaxivity agent gadobenate dimeglumine (Gd-BOPTA) and the conventional agent gadopentetate dimeglumine (Gd-DTPA).

MATERIALS & METHODS
Thirty-seven patients with confirmed intraaxial brain metastases underwent two complete MR examinations at 1.5T. One examination was performed with 0.1 mmol/kg body-weight Gd-BOPTA and the other with an identical dose of Gd-DTPA. The contrast agents were given at 2 mL/sec in randomized order with an interval between examinations of 2-7 days. Acquisition parameters and postdose acquisition times were identical for the two examinations. Three fully blinded readers independently evaluated images for lesion border delineation, definition of disease extent, visualization of lesion internal morphology, lesion contrast enhancement and global preference. Differences were evaluated with the Wilcoxon signed rank test. Reader agreement was assessed using weighted kappa (κ) statistics. Quantitative lesion enhancement (% enhancement, lesion-to-brain ratio [LBR] and contrast-to-noise ratio [CNR]) was determined.

RESULTS
Quantitative enhancement was significantly greater after Gd-BOPTA (% enhancement: p ≤ 0.013; LBR: p ≤ 0.002; CNR: p ≤ 0.04). Contrast enhancement of metastatic lesions was preferred in 49%, 57%, and 68% of subjects after Gd-BOPTA compared with 5%, 8%, and 10% of subjects after Gd-DTPA (readers 1, 2, 3, respectively). Similar improvements were noted for global preference (49%, 54%, and 70% of the subjects after receiving Gd-BOPTA compared with 5%, 8%, 14% of the subjects after receiving Gd-DTPA), and for all other qualitative parameters. Reader agreement was good for all evaluations (up to κ = 0.55; 67.6%).

CONCLUSION
Visualization of brain metastases is significantly improved with the high relaxivity contrast agent Gd-BOPTA. Improved enhancement may translate into better surgical decision-making based on improved depiction of the number, size, and location of brain metastases.

KEY WORDS: Metastases, contrast media, gadolinium
Scientific Exhibit 21

Imaging Evaluation of the Cerebrovascular Complications in Tumors

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PURPOSE

Cerebrovascular disease is the second most common cause of central nervous system disease in cancer patients at autopsy. Imaging features of the cerebrovascular complications associated with tumors, either directly related to the tumor or related to therapy, will be reviewed in this exhibit, with an emphasis on various imaging techniques.

MATERIALS & METHODS

Initial imaging evaluation involves CT for assessment of ischemic or hemorrhagic stroke, followed by further evaluation with MR imaging. However, management depends on the cause of the stroke, which requires evaluation of the cerebral vasculature. With recent advances in CT and MR angiography/venography, role of catheter angiography in diagnosing cerebrovascular disease has become limited. We will incorporate images from our teaching files to demonstrate various causes of strokes associated with tumors or with tumor-related therapy.

RESULTS

Tumor-related infarction or hemorrhage could be related directly to the tumor mass invading or compressing the cerebral vasculature such as arterial or more commonly dural sinus occlusion caused by meningiomas or metastases. Tumor-emboli such as seen in lung carcinoma or atrial myxomas causing stroke are a rare but known phenomenon. Indirect causes of stroke in cancer patients could be due to thrombosis caused by hypercoagulable states which can cause sinus thrombosis or thromboembolic events. Stroke related to therapy such as radiation injury to vessels, inadvertent stroke during endovascular therapy such as during meningioma embolization or even related to antineoplastic chemotherapy has increased in incidence due to more aggressive treatment approaches used nowadays.

CONCLUSION

Causes of stroke in cancer patients are different as compared to the general population. Aggressive treatment approaches can lead to unusual or accelerated cerebral vasculature disorders. Neuroimaging evaluation of a patient with known cancer, presenting with stroke or encephalopathy, can help diagnose the cause of stroke. However, cerebrovascular disease also can be the presenting feature frequently, which in effect will diagnose or lead to an unsuspected malignancy.

KEY WORDS: Cerebrovascular, complications, tumors

Scientific Exhibit 22

Protean Manifestations of Pituitary Adenoma

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PURPOSE

To illustrate protean clinical and imaging manifestations of pituitary adenoma.

MATERIALS & METHODS

One hundred and ninety-three pathologically proved pituitary adenomas in our institution (male to female; 80:113, mean age; 40.7 years old) from April 1993 to November 2006 were reviewed retrospectively and analyzed clinically and radiologically from a multifactorial perspective. All cases were preoperatively evaluated by 1.5T MR scanner (slice thickness 3 mm, gap 1 mm). Coronal T1- and T2-weighted images, fat-saturated sagittal T1-weighted images, and postcontrast fat-saturated T1-weighted images were obtained.

RESULTS

Among 193 cases, 107 hormonally functioning adenoma (PRL;49 GH; 43, ACTH;12, TSH;2, FSH;1) and 86 hormonally nonfunctioning adenomas were observed. Six pituitary adenomas were ectopically located in the extrasellar regions: 3 in the sphenoid sinus (Fig 1), 2 in the clivus, and 1 in the suprasellar region. The intact sellar floor, the dura, or the diaphragm was noted in these cases during surgery. Eight pituitary adenomas were bizarrely located in the sella turcica: 3 protruded to the sphenoid sinus, 3 displayed empty sella, 2 almost surrounded the normal pituitary gland. Seven out of these 8 were GH producing adenomas. Six pituitary adenomas displayed calcification: 3 in a peripheral, 2 in a diffuse, and 1 (Fig 2) in a multifocal scattered manner. Diabetes insipidus was noted preoperatively in 3 pituitary adenomas and 2 of these 3 cases presented with pituitary apoplexy. Five male prolactinomas apparently tended to be larger in size than those of the females. An ACTH producing tumor was invisible on MR imaging however, and tumor cells had diffusely invaded the histopathologic specimen. One prolactinoma displayed massive siderosis. A giant nonfunctioning adenoma massively extended to the left temporal lobe with a slight enlargement of the sella turcica.
CONCLUSION
Awareness of these findings would be beneficial to radiologists.

KEY WORDS: Pituitary adenoma, ectopic, pituitary gland

Scientific Exhibit 23
Color-Encoded Thresholding of Diffusion-weighted Imaging: Technical Feasibility and Application in the Assessment of Acute Stroke and Other Neurologic Conditions

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PURPOSE
The current method of interpretation of diffusion-weighted imaging (DWI) and apparent diffusion coefficient (ADC) maps relies on detection of pathology on a grayscale image. To enhance the conspicuity of the lesions and appreciate the intralesional pixel-by-pixel variation, a software program was written to convert these grayscale images into color-encoded images.

MATERIALS & METHODS
Our software program was implemented as a plugin based on ImageJ, an open source Java-based image processing and analysis program (http://rsb.info.nih.gov/ij/). Our program utilizes: 1) fundamental image processing techniques (e.g., thresholding, image calculation, and binary operations), and 2) a previously published algorithm (1) to automatically extract the midsagittal plane from MR images obtained from the same scan. The program supports color thresholding of ADC images via 4 modes: 1) Absolute thresholding: Each pixel of the grayscale ADC image is transformed to its corresponding color on the color-encoded map. 2) Absolute thresholding with DW image as a filter: To reduce the noise seen on the color-encoded map, this mode utilizes absolute thresholding as described above, with the additional use of the corresponding DW imaging as a filter since the DW image provides better contrast between a pathologic lesion and normal brain parenchyma. 3) Symmetry thresholding: Based on the midsagittal plane extraction algorithm, the value of a pixel on the grayscale ADC image is compared to the value of the contralateral pixel to generate a ratio. Color thresholding then is applied based on this ratio. A smoothing algorithm also is applied to correct for intrinsic variability from one pixel to another pixel, allowing a more representative topography of the pathologic lesion. 4) Symmetry thresholding with DW image as a filter: This mode utilizes symmetry thresholding after applying the DW imaging as a filter (as described in 2).

RESULTS
Apparent diffusion coefficient and DW images with lesions from acute stroke and abscess cases were obtained from the Vancouver General Hospital PACS system. Color-encoded maps were generated from these images, which demonstrates our program’s ability to perform midline extraction, enhance lesions conspicuity, and allow appreciation of intralosomal topography.

CONCLUSION
We have developed a program capable of performing color-encoded thresholding of diffusion-weight imaging. Our next step is: 1) to correct for case-by-case variation of gray values among DW images to enable batch processing, 2) to handle contralateral pixels that are not part of the brain parenchyma during symmetry thresholding, and 3) once the program is validated with the current set of retrospective cases, it will be applied to a prospective population to validate the program’s ability to aid diagnosis of acute stroke and other neurologic conditions.

REFERENCES

KEY WORDS: Diffusion, stroke, thresholding
it is well known that the number of MR artifacts increases too. Therefore we think that it is important to know about them and be able to recognize them.

**MATERIALS & METHODS**
Our group has now worked with our 3T system (Siemens Trio) for approximately eight months, with 50% of the time devoted to clinical work and 50% of the time dedicated to research, with 60% of the clinical time dedicated to neuroradiology and the remaining time to whole body MR imaging. We have detected these artifacts during our case readings and we hereby illustrate the most representative of each series.

**RESULTS**
3T MR systems are becoming an increasingly popular choice for clinical neuroimaging at many institutions throughout the world. High-field imaging offers the benefit of higher signal-to-noise ratio, thus making possible the options of higher imaging matrix, thinner slices, and finally a reduction in time. In this scientific exhibit each one of the artifacts will be illustrated as well as the pathologies that they can simulate. We found several artifacts due to chemical shift, susceptibility, homogeneity, and motion (the motion artifact is fortunately limited to the brain relative to the other areas of the body), blurring artifact and flow artifact.

**CONCLUSION**
It is vital for the daily practice to learn to recognize these artifacts that can simulate pathologies thus causing diagnostic errors and which might induce unnecessary treatment.

**KEY WORDS:** MR imaging, artifacts, 3T

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**Scientific Exhibit 25**

**MR Artifacts at 3T in Neuroradiology**

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**PURPOSE**
With this article we would like to illustrate the most common MR artifacts at 3T that we have found in clinical routine and which simulate a pathology and interfere with diagnosis. Even if it is commonly accepted that there is a substantial improvement in the quality of the MR images obtained at 3T and we hereby illustrate the most representative of each series.

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**Scientific Exhibit 24**

**Implanted Devices: Safe and Effective MR Imaging of Patients with Vagal Nerve Stimulators**

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**PURPOSE**
Vagal nerve stimulators (VNS) are being used increasingly to treat patients with seizure and depression disorders refractory to medical therapy. The increased number of patients with VNS poses a safety problem for MR imaging due to heating and possible altered function of the implanted device or leads. In this exhibit, we review the indications and methods for VNS implantation, summarize the literature of MR in vitro VNS testing, and provide our experience with in vivo safety and image quality.

**MATERIALS & METHODS**
The VNS indications, implantation method, and function are presented. The MR protocols for brain imaging were established at our institution from published guidelines and according to the VNS manufacturer (Cyberonics, Houston, TX, USA) MR safety recommendations, keeping the whole body specific absorption rate and time-varying gradient intensity (dB/dt) below recommended levels.

**RESULTS**
Safety issues are addressed. Imaging protocols for the 1.5T Philips MR Achieva scanner (Best, The Netherlands) are presented. Diagnostic, representative images are exhibited.

**CONCLUSION**
MR imaging of the head is safe and effective at 1.5T using a transmit/receive radiofrequency head coil if strict compliance with imaging parameters and patient selection is achieved. MR imaging of VNS should be avoided with a 3T scanner, with a transmit radiofrequency body coil, in the patient with altered mental status, and in anatomical regions containing the generators or leads (cervical spine/neck, chest). The VNS device should be programmed before and interrogated after scanning.

**KEY WORDS:** Vagal nerve stimulators, MR imaging, safety

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**Scientific Exhibit 26**

**MR Cisternography in Intracranial Nonneoplastic Lesions: Pre and Postsurgical Evaluation**

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**PURPOSE**
MR cisternography (MRC) is a heavily T2-weighted pulse sequence with high spacial resolution, which contributes to the evaluation of not only intracranial neoplasms but also nonneoplastic lesions. This study demonstrated the efficacy of MRC in the latter entity, focusing on pre and postsurgical evaluation.

**MATERIALS & METHODS**
We retrospectively reviewed the MRC in patients with intracranial nonneoplastic lesions (arachnoid cyst, aqueductal stenosis, neurovascular compression), and compared with the pre and postsurgical images. Surgical procedure includes cyst-cisternostomy, endoscopic third ventriculostomy (ETV), aqueductal plasty, and microvascular decompression. MR imaging was performed on 1.5T imagers (Magnetom Visions, Siemens; Signa Horizon EchoSpeed, General Electric).
Electric), using constructive interference in steady state (CISS) imaging, and fast imaging employing steady state acquisition (FIESTA), respectively.

**RESULTS**
In the case of arachnoid cyst, MRC was useful in detecting membranous structure between the cyst and cerebrospinal fluid (CSF) space. In addition, after cyst-cisternostomy MRC also showed a hole in the membrane and flow-related signal loss through the hole. In the case of aqueductal stenosis, MRC was useful in detecting the causal lesion. In some postmeningitis cases, MRC clearly showed membranous structures in the aqueduct, which probably caused the non-communicating hydrocephalus. In the case in the post-ETV state, MRC was useful in detecting the hole in the third ventricular floor and flow-related signal loss through the hole. Ventriculostomy and flow-related signal loss were visualized differently between CISS and FIESTA. The cases after aqueductal plasty clearly showed the patency of the aqueduct. In the case of neurovascular compression, MRC was useful in showing the compression (and/or deviation) of trigeminal or facial nerves, and the improvement after microvascular decompression.

**CONCLUSION**
MR cisternography is very useful in detecting tiny structure in the CSF space, which contributes to the detailed pre and postsurgical evaluation of the nonneoplastic lesions.

**KEY WORDS:** MR cisternography, nonneoplastic lesion, postsurgical

### Scientific Exhibit 28

**MR Imaging in the Diagnosis and Management of Trigeminal Neuralgia**

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**PURPOSE**
Trigeminal neuralgia (TN), the most frequent cranial neuralgia, can be idiopathic or caused by pathologic conditions such as mass lesions or multiple sclerosis. The purpose of this exhibit is to discuss the current and evolving role of MR imaging in the diagnosis and management of TN.

**MATERIALS & METHODS**
This exhibit is based on a retrospective analysis of TN patients referred for MR imaging at our institution for diagnostic or pretherapeutic evaluation.
**RESULTS**
The following will be discussed: 1) An overview of clinical findings, types, and causes of TN; 2) Normal anatomy of the trigeminal nerve and trigeminal nucleus; 3) Imaging techniques used in the evaluation of TN; 4) Role of MR imaging in the diagnosis of TN. (a) Tumors and inflammatory conditions causing TN. (b) Multiple sclerosis related TN. (c) Idiopathic TN due to neurovascular contact or compression at the root entry zone of the trigeminal nerve; 5) Role of MR imaging in the localization and evaluation of the trigeminal nerve, before and after gamma knife radiosurgery or neurovascular decompression surgery for TN. Prognostic value of pretherapeutic detection of neurovascular compression by MR imaging also will be discussed; 6) Evolving imaging techniques like estimation of nerve and cerebello-pontine angle cistern size in the diagnosis of TN will be discussed.

**CONCLUSION**
MR imaging plays an important role in the diagnosis and management of TN. The role of MR imaging in TN is evolving.

**KEY WORDS:** Trigeminal neuralgia, MR imaging

**Scientific Exhibit 29**

**Pachymeningeal and Leptomeningeal Enhancement: MR Characteristics and Differential Diagnostic Considerations**

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**PURPOSE**
Meningeal enhancement postgadolinium contrast is secondary to meningeal irritation from a variety of pathologic processes. The purpose of this exhibit is to demonstrate the various MR patterns of cranial and spinal cord meningeal enhancement and discuss the spectrum of disease entities comprising the differential considerations.

**MATERIALS & METHODS**
A retrospective search is performed of our institutional clinical database for patients with the clinical or pathologic diagnoses of a variety of disease entities that may present with meningeal enhancement, including meningitis, meningioma, sarcoidosis, metastatic disease, melanoma, lymphoma, subarachnoid/subdural hemorrhage, intracranial hypotension, and vasculidities. Those patients who have had MR imaging of the brain performed with gadolinium contrast are chosen and their MR studies are reviewed systematically.

**RESULTS**
In MR imaging, the meninges normally enhance slightly postgadolinium contrast administration. However, enhancement pattern changes with meningeal irritation due to inflammatory, neoplastic, infectious, or postsurgical processes. This pictorial review provides a brief discussion of the normal anatomy and MR enhancement characteristics of the meninges. It then focuses on the various patterns of meningeal enhancement detect on MR imaging: leptomeningeal versus pachymeningeal, diffuse versus focal, nodular versus smooth. Differential considerations and their imaging characteristics are discussed in relation to their enhancement patterns. Pathologic or clinical proved disease entities to be illustrated with leptomeningeal enhancement may include infectious meningitis, meningeal carcinomatosis, primary leptomeningeal melanoma, diffuse leptomeningeal gliomatosis, lymphoma, vasculidities such as moyamoya and Sturge-Weber, neurosarcoïdosis, and siderosis from recurrent subarachnoid hemorrhage with diffuse enhancement. Disease entities with pachymeningeal enhancement to be displayed may include pachymeningitis secondary to infections such as TB and syphilis, spontaneous or secondary intracranial hypotension with secondary Arnold-Chiari 1 malformation, postsurgical/subacute to chronic subdural hematoma/hygroma, enhancement adjacent to calvarial metastasis, autoimmune pachymeningitis secondary to rheumatoid arthritis, and idiopathic hypertrophic pachymeningitis.

**CONCLUSION**
This pictorial review presents an overview of a variety of disease entities with meningeal enhancement. Understanding and recognizing the different locations and distributions of meningeal enhancement facilitates formation of a differential diagnosis.

**KEY WORDS:** Meningeal enhancement, leptomeninges, pachymeninges

**Scientific Exhibit 30**

**Advantages of FLAIR Sequence in the Diagnosis of Brain Diseases, and the Normal Findings and Pitfalls of FLAIR Images: Review Articles**

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**PURPOSE**
The purpose of the study is to present the advantages of the FLAIR sequence in interpretation of brain diseases, and the normal findings and pitfalls of FLAIR images.

**MATERIALS & METHODS**
We reviewed the articles for the clinical usefulness of FLAIR sequence in the diagnosis of neurologic diseases, the normal findings and the artifacts commonly found in FLAIR images with our case illustrations.

**RESULTS**
FLAIR had well known clinical advantage in the detection of parenchymal lesions that are periventricular in location or near the convexity. FLAIR images allowed the differentiation between tumor and edema, small white matter lesions and dilated perivascular spaces, and the identification of cystic or necrotic areas in the lesions (1, 2). Many subarachnoid space diseases including subarachnoid hemorrhage (3), meningitis, slow-flowed vessels in ischemic stroke, and even ependymal seeding and ventriculitis (4) were well picked up on FLAIR images. However, some regions of the normal brain may be mildly hypersignal on FLAIR (e.g., the hippocampus (5)), the middle cerebellar peduncles and the pitu-
Encountering bilateral thalamic lesions in clinical practice is a diagnostic challenge. The broad differential diagnosis can be difficult to sort out unless careful attention is paid to the specific clinical and imaging characteristics. The neuroradiologist then can provide critical information that can be useful in guiding clinical management.

**Materials & Methods**
We review the categories of bilateral thalamic disease including tumors (primary and secondary), ischemic injuries (arterial, venous, global hypoxia), infections (viral, postviral, prion disease), disorders of myelination, and metabolic conditions (acute and inborn), with appropriate illustrative cases. Imaging findings of deep venous system thrombosis are emphasized to help recognize this “mimicker.”

**Results**
Encountering bilateral thalamic lesions can be a diagnostic challenge.

**Conclusion**
This review will illustrate the diverse conditions that may affect the thalami simultaneously, providing the radiologist with the essential imaging findings to aid in the diagnosis and treatment.

**Key Words:** Thalamus, bilateral, differential

**Scientific Exhibit 32**
Thinking Outside the Box: Extracranial Lesions Not to Be Missed on Routine Brain MR Imaging
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**Purpose**
Brain MR scanning is commonly performed for the follow up of known neoplasms or for the evaluation of new symptoms. Radiologists interpreting these studies always discuss the intracranial findings. However, extracranial extent or recurrence of intracranial lesions, or new extracranial lesions are often unsuspected and may be overlooked. The purpose of this exhibit is to show representative cases that emphasize the importance of always carefully evaluating the skull base and searching for extracranial lesions when interpreting MR scans of the brain. These lesions are often subtle and can be overlooked on routine MR scans of the brain, but often alter patient management, surgical approach, prognosis or staging.

**Materials & Methods**
Representative cases were collected from patients referred to a large tertiary care academic medical center for either initial diagnostic imaging or follow-up imaging for a known pathologic process that warranted MR scanning of the brain. All patients had either lesions detected at or below the skull base, or primary intracranial lesions with extracranial extent or recurrence. We retrospectively reviewed the sequential radiologic examinations, clinical course, and management of these patients, and the final pathology of the lesions. The literature was reviewed to assess the clinical significance of these lesions and the most common lesions to present in this fashion are discussed.

**Results**
Representative lesions include metastatic disease, lymphoma, perineural spread of tumor, nasopharyngeal carcinoma, pleomorphic adenoma, cranial base meningioma and chondrosarcoma of the skull base. The detection of these lesions either altered staging, surgical planning, or prognosis.

**Conclusion**
It is important for the radiologist to carefully look “outside the box” in order to detect lesions of the skull base or below, as these lesions can have a significant effect on patient management.

**Key Words:** Extracranial, skull base
Tumor-like Mimics of the Brain

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Purpose
The objective of this exhibit is to demonstrate a variety of nonneoplastic pathologies that may present with mass effect and/or abnormal enhancement, thus simulating neoplasia.

Materials & Methods
We collected 77 cases of various tumor mimics from teaching files of three institutions. All patients presented with intra and/or extraaxial lesions and imaging findings that could, potentially, mimic brain neoplasia.

Results
Assessment of central nervous system pathology can be very challenging. The usual description of mass effect and abnormal enhancement, typical of brain neoplasia, also can be shared by a variety of nonneoplastic etiologies. The radiologist should be familiar with these tumor mimics, such that he/she includes them as differential diagnoses. We categorized and divided these nonneoplastic lesions, which could potentially mimic extra and/or intraaxial brain tumors, into the following groups: 1) Normal variant (giant tumefactive perivascular spaces); 2) Infection (tuberculosis, cysticercosis, and fungal lesions); 3) Syndromes (NF1, Rosai-Dorfman syndrome, Lhermitte-Duclos disease, Krabbe disease [adult type]); 4) Vascular lesions (vascular malformations, aneurysms and cerebral venous sinus thrombosis [CVST]); 5) Autoimmune and inflammatory processes (MS, ADEM, encephalitis, sarcoidosis and PML); 6) Idiopathic (idiopathic hypertrophic pachymeningitis); 7) Congenital brain lesions (cortical dysgenesis and heterotopias); 8) Miscellaneous (postictal brain lesions).

Conclusion
In this educational exhibit, we present a large collection of nonneoplastic tumor mimics. Awareness, understanding, and recognition of these mimics may permit the radiologist to play a significant role in the prevention of unwanted surgical interventions or extensive diagnostic evaluation procedures.

Key Words: Tumor-like lesions, MR imaging, CT

Dissection Imaging in the Era of Multidetector CT: A Review of the Complementary Roles of CT and MR Imaging

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Purpose
The advent of multidetector CT adds a new weapon to the arsenal of noninvasive imaging strategies to evaluate cerebral artery dissection. Technological improvements, including soft-copy viewing stations and rapid acquisition of high-resolution CT data, make CT competitive with MR imaging and catheter angiography. This scientific exhibit reviews imaging findings in dissection, comparing and contrasting the use of CTA and MR imaging/MR angiography (MRI/MRA) in diagnosis and follow up of cervical artery dissection.

Materials & Methods
Patients in the Stanford database (since 2000) with cervical dissection imaged at presentation with both CTA and MR imaging as well as from patients with CTA or MR imaging at diagnosis and follow up were reviewed retrospectively. Images were evaluated for signs of dissection, including luminal narrowing, vessel irregularity, wall thickening/hematoma, pseudoaneurysm, and dissection flap. Follow-up images were assessed for vessel recanalization and resolution of vessel wall abnormalities. Ancillary findings of stroke and underlying vascular disease were assessed and confidence of findings and diagnosis based on each modality were assessed subjectively.

Results
Fifteen patients with 22 dissected vessels had both MR imaging and CTA performed at diagnosis. CTA was considered superior for diagnosis in five patients (3 vertebral artery, 1 ICA, 1 multivessel). MR imaging was superior in two patients (2 ICA), which demonstrated bright methemoglobin signal on T1 fat-saturated images. The remaining eight patients were equivalent for diagnosis with CTA and MR imaging, but the two modalities provided complementary information in many cases. Twelve patients had acute infarcts on MR imaging of which four were subtle or not visible on CT. Seven patients demonstrated bright methemoglobin rims on T1 fat-saturation images, increasing diagnostic confidence. Six patients had dissection flaps and five had pseudoaneurysms easily detected only on CTA. Catheter angiography, performed in only two patients, did not change management. Twenty-four patients had both initial and follow-up noninvasive studies. Mean follow up was 32 weeks (range: 6 weeks to 3 years). All patients were treated with anticoagulation. Twelve patients were followed with MR imaging only, eight with CTA only and four received both MR imaging and CTA. Seventeen patients showed at least partial recanalization, but this was not always accompanied by resolution of luminal and vessel wall abnormalities. Five vessels were occluded at diagnosis (4 imaged with MR only and 1 assessed with both CTA and MRA); two additional patients had occluded vessels on MR imaging but either narrowing or string signs on CTA. Of these seven patients, four showed recanalization on follow-up imaging.
**CONCLUSION**

CTA and MRI/MRA provided complementary information in assessment of cervical artery dissection. Detection of stroke with diffusion-weighted imaging was helpful in identifying the vascular territory involved. A methemoglobin crescent on MR imaging around the dissected vessel was extremely helpful when present. MR imaging in follow up is advantageous given lack of radiation. CTA provides better spatial resolution that was helpful to identify dissection flaps, pseudoaneurysms, and may more accurately assess luminal patency.

**KEY WORDS:** Dissection, multidetector CT, MR angiography

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**Scientific Exhibit 35**

**Role of MR Perfusion in Evaluation of Cerebral Hemodynamics in Moyamoya Syndrome**

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**PURPOSE**

Moyamoya syndrome is an angiographically defined cerebrovascular disorder with terminal internal carotid artery (ICA) occlusion and basal collateral vessels that may be idiopathic or may occur secondary to many disorders. Nonetheless, digital subtraction angiography remains an important component; however, further investigation to observe the extent and severity of ischemic compromise is also essential, and several authors have documented the role of positron emission tomography (PET) and single photon emission CT (SPECT) in assessing perfusion defects. Both these techniques have potential disadvantages. PET is limited by availability, and SPECT has a relatively low spatial resolution. Both incur exposure to ionizing radiation. We present the radiologic features including the MR perfusion findings which illustrates the homodynamic changes of cerebral ischemia in moyamoya syndrome.

**MATERIALS & METHODS**

The MR examinations were conducted by using a 1.5T system with a quadrature head coil. Perfusion-weighted, dynamic susceptibility contrast MR imaging was performed by using a single-shot gradient-echo echo-planar imaging sequence during an intravenous bolus injection of gadolinium-based contrast. For each pixel, the time-concentration or R2* curve was obtained, which was calculated from the equation $R2^* (t) = \frac{\ln(SI_0/SI(t))}{t}$, where SI0 is the average precontrast signal intensity and SI(t) is the signal intensity at time t. The cerebral blood flow (CBF) ratio, cerebral blood volume (CBV) ratio, transit time (MTT) and time interval to peak enhancement (TTP) maps were calculated using the cerebellum as a control region.

**RESULTS**

This exhibit will discuss the role of various perfusion parameters (CBF, CBV, MTT, and TTP) in depicting the extent and severity of ischemic compromise in various areas of brain and their correlation with the angiography findings. Homodynamic changes after ICA-to-ECA bypass surgery also are described.

**CONCLUSION**

Perfusion MR imaging is a useful tool for quantitative evaluations of homodynamic status of patients with moyamoya syndrome. By this technique, the presence and degree of misery perfusion can be detected which can be helpful in making treatment decisions. Perfusion-weighted MR imaging can be applied for evaluating the postoperative changes in the cerebral blood flow in moyamoya syndrome.

**KEY WORDS:** Moyamoya, MR perfusion, TTP

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**Scientific Exhibit 36**

**Cerebral Amyloid Disease**

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**PURPOSE**

To review the imaging findings, clinical presentations, and histopathologic features of cerebral amyloidosis. Cerebral amyloid angiopathy (CAA) is an important cause of cerebral hemorrhages, although it may also lead to ischemic infarction and dementia. It is an under-recognized cause of cerebrovascular disorders affecting elderly patients. Imaging findings are important in guiding clinical decision making.

**MATERIALS & METHODS**

This exhibit is based on retrospective review of imaging findings in patients with cerebral amyloidosis. CT and MR imaging findings will be discussed. Computed tomography is the imaging study of choice to evaluate acute cortical hemorrhage, which may be accompanied by extraxial hemorrhage. Magnetic resonance imaging is the optimal study for identification of small or chronic cortical-subcortical hemorrhages and ischemic sequelae of this disease as well as exclusion of other causes of acute hemorrhage.

**RESULTS**

Amyloidosis is caused by extracellular deposition of beta-amyloid in tissues. Cerebral amyloid deposition may occur in three morphologic patterns: cerebral amyloid angiopathy, amyloidoma, and diffuse white matter involvement. Cerebral amyloid angiopathy is not associated with presence of systemic amyloidosis. Although commonly seen at autopsy, cerebral amyloid angiopathy remains an under-recognized cause of cerebrovascular disease. Diagnosis often requires a combination of clinical and imaging evaluation.

**CONCLUSION**

Cerebral amyloid angiopathy is an important but under-recognized cause of cerebrovascular disorders, mostly in elderly patients. Many patients are asymptomatic and clinical presentations can be varied. Early recognition of neuroimaging findings, especially multiple cortical hemorrhages helps to identify this condition. This exhibit should help the practicing radiologist understand this important clinical condition and its accurate neuroimaging interpretation.

**KEY WORDS:** Amyloid angiopathy, cerebral, imaging
Scientific Exhibit 37

Growth of Unruptured Cerebral Aneurysms: Follow-up Evaluation Using Helical CT Angiography

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PURPOSE
Early detection of aneurysm growth is mandatory to prevent rupture of unruptured aneurysm. We conducted measurement of aneurysm growth using helical CT angiography.

MATERIALS & METHODS
Two hundred seventeen patients harboring 250 intracranial aneurysms were enrolled. Patients ranged in age between 26-82 years. Patients with intracranial unruptured aneurysms underwent scanning with multidetector helical CTA using timing injection, and a high-resolution protocol. All aneurysm sac and neck measurements were performed using 2D MIP images. When distances are measured on cross-sections, values at the window center influence aneurysm measurements. Follow-up interval ranged from 76 to 1408 days, with a mean interval of 1.3 years. Aneurysm frequency per location was: MCA = 76, ICA = 92, ACA = 60, VABA = 22. Aneurysm sac sizes were: S < 5 mm (n = 174), M/S 5 ≤ ≤10 mm neck size < 4 (n = 27), M/W 5 ≤ ≤10 mm neck size 4 ≤ ≤10 mm neck size 4 ≤ (n = 44), L 10 mm > (n = 5). Neck sizes ranged from 1.1 to 13.8 mm. Aneurysm growth was defined as increase in diameter above error margin for ≥1.0 mm. The 3D images were reviewed for change in aneurysm shape.

RESULTS
Two hundred eighteen of the 250 aneurysms (87%) showed no change in size, whereas 32/250 (13%) grew in size. Although 18 of 32 (56%) were ≤ 5 mm in maximal diameter, risk of aneurysm growth was significantly enhanced in larger size at initial diagnosis: M/L: HR: 2.3; 95%CI: 1.0-5.1; L: HR: 5.7; 95%CI: 1.3-25. Locations and multiple/single aneurysm as well as history of subarachnoid hemorrhage, gender and age were not significant risk factors of aneurysm growth. Ten in 32 (31%) aneurysms with growth underwent treatment. No aneurysm ruptured in this series.

CONCLUSION
The data suggests that larger size of aneurysm may have higher risk of growth.

KEY WORDS: Unruptured aneurysms, CT angiography, natural history

Scientific Exhibit 38

Navigating the Deep Brain Nuclei for Deep Brain Stimulation: A Teaching Exhibit

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PURPOSE
Deep brain stimulation, although the mechanism is not known, is fast becoming the treatment of choice for Parkinson’s, as well as for other disease processes. Although deep brain stimulation (DBS) has the potential for both excitatory and inhibitory mechanisms, it appears to function mainly by inhibition, similar to what surgical ablation does, except that when the stimulator is turned off, the results are reversible. What is common to DBS is the targeting of specific nuclei in the brain involving the anatomical skills of the neuroradiologist. This teaching exhibit will highlight the specific anatomy which the neuroradiologist must become familiar with emphasizing treatment of tremors, the best established use to date.

MATERIALS & METHODS
Examples from 49 thalamic, 23 subthalamic, and six globus pallidi targets will illustrate the major portion. Other nuclei for obsessive compulsive disorder (OCD), Tourette’s, depression, epilepsy, and chronic pain will be featured.

RESULTS
With tremors reliance on brain map atlases such as Schaltenbrand and Wahren with formulas are the mainstay for targeting. However, direct identification of the nuclei is much better, since the maps are based on nonatrophic brains. In fact identification of the supramammillary commissure may prove to be more reliable for targeting the subthalamic nuclei. Other methods such as optic tract, red nucleus, and mustache method of targeting based on direct visualization of the anatomy will be featured as well for control of tremors.

CONCLUSION
For essential tremors and Parkinson’s the globus pallidus interna (GPi), ventromedial nucleus of the thalamus (VIM), and subthalamic nucleus (STN) are targeted. For dystonia the nuclei is the GPi, for chronic pain the periventricular gray, sensory nucleus of the thalamus, and anterior limb of internal capsule, for OCD bilateral anterior limb of IC, thalamus for Tourette’s, and centromedian and anterior thalamic nucleus and STN for epilepsy. In fact many of the nuclei also are relevant to understanding the pathology of Alzheimer’s, including the medial temporal lobe, amygdyla, peri- and entorhinal cortex, basal nucleus of Meynert, cingulate gyrus, and substantia innominata. Surgical ablation of the substantia innominata also is used to treat refractory depression and OCD. Despite the obvious benefits of DBS in Parkinson’s patients there are complications of depression, memory dis-
orders, and cognitive decline, areas that need further exploration. No doubt this is due to the proximity of these targetted nuclei to others involved with memory and cognitive functions. The role of the neuroradiologist is in the preciseness of targeting, because there is little room for error after the leads are placed. Microelectrode recordings confirm the location of the DBS tips, but cannot be used to guide the placement. Therefore knowledge of the anatomy is the single most important quality control issue. This exhibit will highlight the key anatomy of the basal nuclei for these major disease entities.

**Key Words:** Deep brain nuclei, deep brain stimulation, deep brain stimulation targeting

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**Scientific Exhibit 39**

**Oculomotor Nerve: Anatomy and Pathology**

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**Purpose**
The oculomotor nerve (CN III) plays a major role in controlling the extraocular muscles responsible for the precise movement of the eyes as well as intrinsic ocular muscles for pupillary light reflex and accommodation. The purpose of this exhibit is to review the pathway of CN III from its nucleus to the extraocular muscles on MR imaging and to demonstrate the spectrum of CN III pathology.

**Materials & Methods**
The lengthy course of CN III can be divided into four segments: brainstem including both somatic and visceral nuclei, interpeduncular subarchnoid cistern, cavernous sinus, and orbit from the superior orbital fissure to distal branches. We present a variety of CN III abnormalities evaluated by MR imaging, identified from a retrospective review of our case logs according to their location on the CN III pathway.

**Results**
Oculomotor nerve pathology is categorized as follows: 1) brainstem segment- midbrain stroke, Behcet’s disease, demyelinating disease, trauma, cavernous angioma; 2) cisternal segment - posterior communicating artery aneurysm, temporal lobe/uncal herniation, neurofibromatosis type 2, ophthalmoplegic migraine, sarcoidosis, demyelinating disease, tuberculosis; 3) cavernous sinus segment - internal carotid artery aneurysm, cavernous sinus syndrome including perineural extension, large perineural space of CN III; 4) orbital segment - orbital cellulitis, orbital metastases, schwannoma and denervation atrophy.

**Conclusion**
High resolution MR images permit superb depiction of the CN III pathway. Knowledge of CN III normal anatomy and pathology significantly aids in detection and evaluation of CN III pathology.

**Key Words:** Anatomy, cranial nerve, MR imaging

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**Scientific Exhibit 40**

**Anatomy of the Lateral Sellar Compartment (Cavernous Sinus): Demonstration Utilizing 3T MR Imaging with Microdissection and Histologic Correlation**

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**Purpose**
1) To demonstrate detailed soft tissue and vascular anatomy of the lateral sellar compartment (LSC) visible on high-resolution 3T MR imaging. 2) Provide correlation of imaging findings and gross anatomy (from microdissection) and histology to clarify anatomical relationships. 3) Provide clinical examples of LSC pathology and how it relates to the anatomy of this region.

**Materials & Methods**
Detailed soft tissue and vascular anatomy of the LSC is provided by performing high resolution MR imaging at 3T. Postcontrast 3D FSPGR, volumetric 3D FIESTA, and high-resolution FSE T2-weighted images, are utilized to demonstrate the soft tissue anatomy of the LSC. Elliptic centric encoded contrast-enhanced MR venography is utilized to demonstrate the venous connections and relationships of the LSC, with angiographic and anatomical venous cast correlation. Gross anatomical correlation is performed utilizing silicone-injected specimens evaluated and photographed utilizing microdissection techniques. Histologic correlation is provided by sagittal and coronal sections of anatomical specimens (using Masson’s trichrome staining). Clinical examples of pathology in the LSC are provided including neoplastic, vascular, and inflammatory disorders.

**Results**
Example image from the presentation is shown.

**Conclusion**
Knowledge of the anatomy of the LSC is important for proper diagnosis and therapy. Detailed anatomical assessment is possible with high-resolution 3T MR imaging and MR venography. Correlation with anatomical dissections and histology is helpful to demonstrate the imaging anatomy in this region.

**Key Words:** Cavernous sinus, anatomy, 3T MR imaging
Scientific Exhibit 41

A Spectrum of Carotid Artery Variants

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PURPOSE
To demonstrate the spectrum of developmental carotid artery anomalies as seen on arteriography and cross-sectional imaging and to discuss their clinical relevance.

MATERIALS & METHODS
This exhibit is based on a retrospective search for clinically relevant frequent and unusual developmental carotid artery anomalies. Characteristic arteriography and cross-sectional imaging of each anomaly, the pertinent clinical sequelae, and the pitfalls secondary to lack of recognition will be shown and discussed.

RESULTS
The following major categories of anomalous development will be discussed: 1) Carotid agenesis; 2) Carotid hypoplasia; 3) Carotid occlusion; 4) The aberrant carotid. Multiple examples in each major category will be shown using arteriography, CTA, MRA, and conventional cross-sectional imaging when available. Diagnostic pearls and clinical sequelae will be discussed for each example.

CONCLUSION
Carotid anomalies frequently are seen today with the increased utilization of CTA and MRA. Recognition of the anomaly and its clinical significance is essential for appropriate patient management. We present a pictorial essay to facilitate identification and management of the frequently encountered carotid artery anomalies.

KEY WORDS: Carotid, variant, developmental

Scientific Exhibit 42

Muscular Anatomy of the Neck: A PET/CT Review

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PURPOSE
The neck contains an intricate array of small muscles used for motion of the head and neck, for speech, and for support of the upper thorax and shoulder girdle. Most radiologists are familiar with the larger muscles, such as the sternocleidomastoid and trapezius muscles, but the names of the smaller muscles traditionally are not used in everyday clinical practice. The rapid advent of PET/CT has changed this. Small muscles frequently take up FDG in a focal fashion, and thus can mimic malignancy. This is particularly troublesome in the setting of head and neck cancer, because the neck is at high risk for metastatic disease and because the physiology of the neck musculature is often disrupted by surgery or radiation. The fused modality of PET/CT usually can demonstrate when focal uptake is attributable to muscle, and thus avoid false positive interpretations, but only if the radiologist is aware of the normal locations and attachment points of the neck musculature.

MATERIALS & METHODS
PET/CT scans performed on patients with head and neck cancer were reviewed retrospectively for areas of focal FDG uptake that were attributed to muscles of the neck. The origins, insertions, and course of each muscle were used to confirm the identity of the muscle.

RESULTS
Along with the large muscles such as the sternocleidomastoid and trapezius, many of the smaller neck muscles can demonstrate focal FDG uptake. An organized approach to the muscles of the neck, with examples of focal FDG uptake on PET/CT, is provided.

CONCLUSION
There are many muscles in the neck that do not garner attention on conventional cross-sectional imaging, but can create confusion on PET/CT scans of the head and neck. Radiologists should be familiar with these muscles to avoid false positive interpretations of focal FDG uptake, and to provide more credible, precise radiology reports.

KEY WORDS: Neck muscles, PET/CT

Scientific Exhibit 43

Craniocervical Junction: A Review of the Congenital Anomalies Encountered in Imaging

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Henry Ford Hospital
Detroit, MI

PURPOSE
The craniocervical junction is a complex group of interconnecting bones and ligaments that forms the articulation of the skull base and upper cervical spine. Due to its multiple components and numerous primary and secondary ossification centers, congenital anomalies of the craniocervical junction are numerous and vary greatly in their radiographic appearance. Understanding the embryologic development and recognizing developmental anomalies is crucial in appropriately assessing this region radiographically. Since many of these lesions can mimic subacute or chronic fractures, failure to recognize these anomalies as congenital, and not traumatic, can result in misappropriation of health care resources in the form of further testing, consultations, or examinations. We will review the embryology, normal anatomy, and radiographic findings of the developmental anomalies of the craniocervical junction.

MATERIALS & METHODS
A retrospective review of our institutions imaging studies encompassing the craniocervical junction was performed including conventional radiographs, CT, including CT 3D reconstructions, and MR imaging. These examinations were performed using our institutions routine protocols for MR imaging and CT examinations of the head and cervical spine and standard radiographic plain film views. Many of these anomalies were discovered in patients presenting for reasons
not related to cranio cervical junction anomalies. The various anomalies of the cranio cervical junction were studied and were grouped into anomalies of the skull base, anomalies of the atlas, and anomalies of the axis.

RESULTS
Multiple anomalies of the cranio cervical junction were found in our retrospective review or our institutions imaging studies. These anomalies were grouped into those involving the skull base and those involving the upper cervical spine. The pattern of osseous development within the cranio cervical junction will be discussed to help facilitate full understanding of the developmental patterns and anomalies of this region and will help equip the radiologist with the proper fundamental understanding to correctly assess abnormalities within this region. Anomalies that will be discussed include: fusion and nonunion anomalies of the atlas and axis, assimilation of the C1 vertebral body, basilar invagination, odontium and condylus tertius.

CONCLUSION
The cranio cervical junction is a developmentally complex region with the potential for a multitude of different developmental anomalies. An understanding of the anatomical pattern of development of the ossified structures within this complex framework is the cornerstone to correctly assessing radiographic abnormalities within this region and correctly separating developmental anomalies from potential traumatic lesions.

KEY WORDS: Cranio cervical junction, cervical anomalies, anatomical variant

Scientific Exhibit 44
Embryology of the Neural Crest
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PURPOSE
The neural crest is an embryologic cell group which gives rise to many critically important structures in the mature vertebrate. Arising adjacent to the cells which will eventually form the central nervous system, neural crest cells display varying degrees of similarity with neuroectoderm and often play a role interfacing between central nervous system and the body. This is true both functionally and morphologically. Recent advances in molecular biology and embryology have provided new insights into how the neural crest evolves and contributes to the mature organism. It is our goal to review, analyze, and present the current state of our understanding of normal neural crest embryology in humans.

MATERIALS & METHODS
Our presentation is based upon extensive review of the published literature over the last 10-30 years in fields concerned with the neural crest, including molecular biology, embryology, teratology, evolutionary theory, and others. After reading and studying widely, we have attempted a more concise and understandable synthesis of information which is currently available. Our information will be presented graphically and in text. Due to the large amount of subject material, we will focus more on certain developmental pathways than others in order to provide more detailed information.

RESULTS
Study of the neural crest has contributed to significant changes and consideration of new hypotheses in embryology. Neural crest cells challenge the trilaminar cell layer theory of vertebrate embryology and their study has led to a deepening understanding of the interplay between intrinsic and inductive aspects of embryologic development, as well as of the underlying genes and gene products which govern it.

CONCLUSION
The neural crest is a fascinating and complex embryologic cell group, whose development and functioning is not yet fully understood. Nevertheless recent advances allow us to begin to see some of the ways in which these cells contribute to the rich complexity of normal mature vertebrate and human functioning. In a subsequent work, we will focus on pathologic derivatives of neural crest origin in humans including both syndromal and sporadic cristopathies.

KEY WORDS: Neural crest, embryology

Scientific Exhibit 45
MR Imaging in Bisphosphonate-induced Osteonecrosis of the Jaw
Krishnan, A. · Silbergleit, R. · Vyas, A. · Werner, E.
William Beaumont Hospital
Royal Oak, MI

PURPOSE
To display and discuss the MR imaging findings of osteonecrosis of the jaw in patients receiving bisphosphonate therapy particularly for osseous metastatic disease. A review of this peculiar condition and postulated etiology and reason for the particular site of involvement are discussed.

MATERIALS & METHODS
MR images of the head/neck and brain from a small group of patients who had been diagnosed clinically with bisphosphate-induced osteonecrosis were reviewed. Imaging findings were assessed. A particular attempt was made to identify the presence of the lesion on previous serial brain MR scans performed for other reasons. Corroboration with other modalities where available, including bone scintigraphy, was performed.

RESULTS
Common findings seen were edema (both in the marrow of the mandible and in the adjacent soft tissues extending into the pterygoid musculature) and enhancement. Enhancement often involved the adjacent mucosal surfaces and soft tissues, thus making it difficult without the history to distin-
guish it from metastatic disease. A T1 hypointensity was identified in the posterior mandible on brain MR imaging in at least one case on multiple prior studies at a site that subsequently developed osteonecrosis.

**CONCLUSION**

Bisphosphonates have been used in the therapy of both benign and less aggressive conditions such as osteoporosis and Paget’s disease but are increasingly used in patients suffering from osseous metastatic disease or multiple myeloma. These patients often receive high doses of the more potent aminobisphosphonates, particularly pamidronate and zolendronic acid, which have been associated with the majority of the reported cases. It is pertinent therefore to be aware of the existence of this condition. While dentists and oral surgeons are increasingly aware of this condition, the majority of literature has focused on plain radiography and CT. A number of these patients have concurrent disease in the brain or are imaged with MR to exclude intracranial disease. This gives us an opportunity to evaluate the included mandible on the sagittal T1-weighted images that are part of most protocols of the brain. This is particularly important as patients may first present with this condition after minor trauma such as from dentures, or after tooth extraction. Thus understanding the basis for the condition and its imaging findings is of importance to the practicing neuroradiologist dealing with oncologic patients.

**KEY WORDS:** Bisphosphonate, osteonecrosis, mandible

**Scientific Exhibit 46**

**Orbital Wegener’s Granulomatosis: CT Appearances**

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**PURPOSE**
To demonstrate the varied CT appearances of Wegener’s Granulomatosis (WG) of the orbit.

**MATERIALS & METHODS**
A pictorial review of orbital WG features on the presenting CT-orbits examinations from a large series of 20 patients presenting initially with orbital mass or inflammation and without a previous diagnosis. All cases presented have clinical, c-ANCA, and biopsy correlation. The literature is reviewed and discussed.

**RESULTS**
Both limited and systemic WG can present as an orbital mass which is usually unilateral. A significant minority of cases will not show paranasal sinus disease on CT. Most cases will show extraconal or mixed lesions, with intraconal or apex-only lesions being uncommon. The lacrimal gland may be primarily involved. Multiplanar reformatting helps delineate the pattern of orbital involvement. Mass lesions have similar attenuation to extraocular muscle on noncontrast and enhance moderately and slightly heterogeneously postcontrast. CT is sensitive to bony orbital wall erosion.

**CONCLUSION**
Wegener’s Granulomatosis usually responds well to treatment but has a high morbidity and mortality if the diagnosis is delayed. Primary orbital involvement without sinus disease on CT presents a diagnostic challenge requiring clinical, histopathologic and serologic consensus. The diagnostic neuroradiologist should consider WG in the differential of a newly presenting orbital mass.

**KEY WORDS:** Wegener’s, orbit, CT
Scientific Exhibit 47

PET/CT of the Head and Neck: When Is It Useful, and When Is It Overused?

Branstetter, B. F. · Johnson, J. T.
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Pittsburgh, PA

PURPOSE
PET/CT has revolutionized the staging and surveillance of patients with head and neck cancer. In some clinical scenarios, PET/CT is clearly useful, and in others, the cost may not be warranted. Areas of particular confusion include: which patients deserve staging PET/CT, how soon after therapy is PET/CT useful, and how frequently should PET/CT be used for surveillance. The purpose of this research was to summarize the existing radiology and otolaryngology literature on PET/CT and provide recommendations on the appropriate utilization of PET/CT in the setting of head and neck cancer.

MATERIALS & METHODS
The English-language literature was reviewed for scientific exhibits focusing on utilization of PET/CT in head and neck cancer. Areas of controversy were identified, and the existing literature was summarized.

RESULTS
Several important questions about the application of PET/CT can be preliminarily answered with existing literature, including: Is PET/CT superior to PET? Which patients require PET/CT for staging? Is PET/CT useful to identify unknown primary lesions? Is PET/CT needed in the setting of an N0 neck? Is PET/CT needed for restaging recurrences? How soon after treatment should a patient undergo PET/CT? How frequently are surveillance PET/CTs needed? When can radiographic surveillance end? How useful is PET/CT for nonsquamous cell cancers?

CONCLUSION
Although the literature on the utility of PET/CT is incomplete, and many results are preliminary, several outcome-driven recommendations can be made with regard to PET/CT for staging, postoperative evaluation, and surveillance of patients with head and neck cancer.

KEY WORDS: PET/CT, head and neck cancer, review

Scientific Exhibit 48

Speed Bumps: Diagnostic Risks with 64-slice Speed

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Nashville, TN

PURPOSE
The purpose of this exhibit is to maximize scanning parameters for nonvascular neuroimaging with 64-slice CT scanning in the head and neck.

Materials & Methods
Patients were imaged using 64-slice CT scanners with multidimensional reformatted images of the head and neck. We discuss the technical imaging parameters currently in place for our standard CT protocols of the head and neck. We provide multiple cases where 64-slice CT studies do not provide adequate detail of underlying lesions, related to technical pitfalls.

RESULTS
The advances of 64-slice CT imaging come at a price, and the diagnostic risks must be accounted for. We worship speed, but we must have an exam that remains accurate. We will have beautiful vessel enhancement in patients with squamous cell carcinomas, but tumors will pass unnoticed. We see cases of adenitis, but never clearly identify an abscess wall. The technical advances in multislice scanning have outpaced the rigorous scientific studies required to maximize their potential. Establishing the ideal scanning parameters for 64-slice scanning is a work in progress. Vascular clarity must be weighed against tumor visualization; patient throughput countered by permeability changes of the blood-brain barrier. Variable (biphasic, triphasic) injection rates and appropriate scanning delays must be considered.

CONCLUSION
We present the clinical experience at our institution since the inception of 64-slice CT scanning of the head and neck, along with a review of the current literature.

KEY WORDS: 64 Slice CT

Scientific Exhibit 49

Pitfalls of PET/CT in the Head and Neck

Branstetter, B. F. · Escott, E.
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Pittsburgh, PA

PURPOSE
PET/CT has rapidly become a critical modality in the assessment of head and neck cancer. Unfortunately, there are many potential sources of abnormal FDG uptake other than malignancy, and some malignancies do not accumulate FDG. Although PET/CT is potentially extremely accurate for head and neck cancer, a clear understanding of interpretive pitfalls is needed to provide optimal patient care recommendations.

MATERIALS & METHODS
PET/CT performed for the staging or surveillance of patients with head and neck cancer were reviewed for potential sources of false-positive and false-negative interpretations. Sources of inaccurate interpretations were classified, and examples are shown from each category.

RESULTS
Potential false-positive results on PET/CT can be classified as physiologic, inflammatory, or benign neoplastic. Physiologic increased uptake most frequently results from brown fat, glands, and muscle, and appears in predictable patterns. Inflammatory false-positives are associated most frequently with dental and sinonasal disease. Benign neo-
plasms with increased FDG uptake usually arise from the salivary or thyroid glands. The most frequent cause of confusing false-positive interpretations, however, are the effects of prior cancer therapy. These can include physiologic asymmetry from prior surgery or radiation, inflammation in healing tissues, new pathology induced by therapy, and the effect of implanted foreign bodies. False-negative results can occur with certain histologic cell types, with small tumors, with necrotic tumors, in the setting of superficial tumor spread, and shortly after therapy. Various acquisition artifacts may contribute to either false-positive or false-negative results.

**CONCLUSION**

There are many pitfalls in the interpretation of PET/CT in the head and neck, especially in patients who have undergone therapy for head and neck cancer. This exhibit demonstrates the most commonly encountered errors, with an emphasis on distinguishing recurrent cancer from the effects of cancer therapy.

**KEY WORDS:** PET/CT, head and neck cancer

**Scientific Exhibit 50**

**Buttress Concept and Le Fort Classification: The Plot Thickens**


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London, UNITED KINGDOM

**PURPOSE**

To illustrate the imaging findings of facial and orbital fractures, correlating the Le Fort classification with the facial buttress concept. To outline the relevance of the facial buttress concept of facial and orbital fractures.

**MATERIALS & METHODS**

A comprehensive pictorial review of imaging findings of facial and orbital fractures using 2D and 3D image display.

**RESULTS**

Facial and orbital fractures frequently occur during motor vehicle accidents and assaults. They are easily suspected clinically, but full assessment of the extent of the fractures requires detailed plain radiography and computed tomography. The classification of facial and orbit fractures is important in the determination of whether maxillofacial surgery is required and the nature of the surgery needed. However, applying the Le Fort classification is a source of frustration to radiologists. The importance of the information obtained from the classification often is not appreciated. The reasons behind the Le Fort classification of facial fractures is poorly understood outside the maxillofacial surgery/radiology fields. Now there is a new concept of the facial buttress that is used to describe areas of relatively thicker bone that can be utilized in surgical treatment of facial fractures.

**CONCLUSION**

We will describe the CT findings in facial fractures correlating the Le Fort classification with the facial buttress concept using 2D and 3D image display.

We will highlight the ways in which utilizing both the buttress concept and Le Fort classification provides more accurate information for communication between the clinician and radiologist.

**KEY WORDS:** Facial, fractures

**Scientific Exhibit 51**

**Neoplastic Disease of the Orbit: Pictorial Review**

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West Virginia University
Morgantown, WV

**PURPOSE**

To provide an educational exhibit illustrating major neoplastic entities that affect the orbit. Approach is based on anatomical localization of the latter with an emphasis on differential diagnosis and clinical context. Histopathologic correlation is provided for select cases.

**MATERIALS & METHODS**

Retrospective case review of a broad range of pathological and clinically proved cases of neoplastic orbital disease accumulated from 1996-2006 at a tertiary referral eye center. These represent a broad spectrum of orbital neoplastic diseases. These are organized by location to Skullbase and Bony Orbit, Orbital Contents, and Ocular Globe. Major neoplastic diagnostic entities for each location are reviewed with appropriate differential diagnostic points and recommended imaging approaches for common clinical presentations. High quality images illustrate the findings and complement the succinct review of this category of disease. Examples of cases discussed include but are not limited to the following: fibrous dysplasia, osteosarcoma, chondrosarcoma, neuroblastoma, esthesioneuroblastoma, meningioma, optic sheath meningioma, melanoma, lacrimal gland tumors, optic nerve gliomas, lymphoma, and metastatic lesions. Some of the cases will be accompanied by histopathologic correlation.

**RESULTS**

The viewer of this exhibit will gain or refresh information about neoplastic diseases of the eye, orbit, and adjacent skullbase for clinical practice and for preparation for certifying examinations. The images provided aid recognition of neoplastic lesions of the orbit with an emphasis on clinical context and differential diagnosis.

**CONCLUSION**

Neoplastic lesions of the orbit can present a diagnostic challenge. Extensive illustrations of the different entities and a solid understanding of the clinical presentations can aid the radiologist in arriving at the appropriate diagnosis.

**KEY WORDS:** Orbital neoplasm, orbit lesion, orbit
**Scientific Exhibit 52**

Nonneoplastic Orbital Region Imaging: Pictorial Review

Hogg, J. P. · Guzman Perez-Carrillo, G. J.
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Morgantown, WV

**PURPOSE**
To provide an educational exhibit illustrating major nonneoplastic masses and other entities affecting the orbital region. Approach is based on anatomical localization of the latter with an emphasis on differential diagnosis and clinical context. Histopathologic correlation is provided for select cases.

**MATERIALS & METHODS**
Retrospective case review of a broad range of pathological and clinically proved cases of nonneoplastic orbital region disease accumulated from 1996-2006 at a tertiary referral eye center. These are organized by location to: Skullbase and Bony Orbit, Orbital Contents, and Ocular Globe. Major nonneoplastic diagnostic entities for each location are reviewed with appropriate differential diagnostic points and recommended imaging approaches for common clinical presentations. High quality images illustrate the findings and complement the succinct review of this category of disease. Examples of cases discussed include but are not limited to the following: dermoid, epidermoid, neurofibromatosis I lesions, infections, myositis, pseudotumors, thyroid ophthalmopathy, cavernous hemangioma, capillary hemangioma, orbital varix, lymphangioma, carotid cavernous sinus fistula, dural arterial venous fistula, traumatic lesions, foreign bodies, and congenital malformations such as coloboma. Some of the cases will be accompanied by histopathologic correlation.

**RESULTS**
The viewer of this exhibit will gain or refresh information about nonneoplastic diseases of the eye, orbit, and adjacent skullbase for clinical practice and for preparation for certifying examinations. The images provided aid recognition of nonneoplastic lesions of the orbit with an emphasis on clinical context and differential diagnosis.

**CONCLUSION**
Nonneoplastic lesions of the orbit can present a diagnostic challenge. Extensive illustrations of the different entities and a solid understanding of the clinical presentations can aid the radiologist in arriving at the appropriate diagnosis.

**KEY WORDS:** Nonneoplastic orbital lesion, orbit lesion, orbit

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**Scientific Exhibit 53**

Complex Cranial Neuropathies: The Intersection of Anatomy, Pathology, and Function

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University of California San Francisco
San Francisco, CA

**PURPOSE**
1) To create a better understanding of cranial nerve (CN) anatomy and function. 2) To emphasize the importance of dedicated techniques for CN imaging. 3) To illustrate the complexity of clinical neurologic syndromes involving the CN and how the radiologist can participate best in finding a pathologic cause.

**MATERIALS & METHODS**
1) We will discuss the anatomical intersection of CN pathways and how this can help in localizing pathology and allowing a more tailored approach to CN imaging. 2) We will present cases of multiple cranial neuropathies, neuropathies in association with other neurologic signs and specific named clinical syndromes to familiarize the radiologist with important concepts of cranial nerve imaging.

**RESULTS**
The key to better imaging and interpretation of cranial neuropathies is a thorough understanding of the normal anatomy of each CN. Frequently however cranial neuropathies do present as an isolated CN abnormality but as multiple cranial neuropathies. An understanding of the anatomical “intersection” points of the CN is therefore very important for further tailoring an examination and focusing the radiologist’s attention on the regions of highest probability of pathology. For example CN6 plus CN7 neuropathy suggests pontine pathology, CN7 plus CN8 suggests IAC/CPA pathology, and neuropathy of CN3 to 6 suggests cavernous sinus pathology. There are specific named CN clinical syndromes including Vernet syndrome (CN9-11), Collet-Sicard syndrome (CN9-12) and the Orbital Apex syndrome. There are also syndromes where cranial neuropathy is part of the clinical symptom complex such as Wallenberg syndrome (includes CN5 sensation) for lateral medullary infarction and Gradenigo’s syndrome (CN5 and CN6) with petrous apicitis. Multiple cranial neuropathies also may be found in association with systemic disease such as sarcoidosis, syphilis, and solid tumors. There are imaging and clinical distinguishing features in these cases that can help determine the pathologic cause.

**CONCLUSION**
A clinical history of complex cranial neuropathy calls for a more detailed understanding of the anatomical intersection of the CN and of the nerves with other important CNS structures. This allows the radiologist to pinpoint the main region of concern within the brain and extracranial head and neck to allow a more focused imaging exam and more accurate case interpretation.

**KEY WORDS:** Cranial nerves, neuropathy
Complications of Autogenous Bone Cranioplasty after Decompressive Craniectomy

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Purpose
Decompression craniectomy for the treatment of refractory-increased intracranial pressure has a long history, dating back to the early 1900s (Cushing 1905) (1). The primary objective of the procedure is to prevent secondary injuries, such as infarct, or even death from herniation and brainstem compression. Over the last 20 years literature has emerged suggesting that craniectomy could be a life-saving technique, and the technique has become increasingly common. Patients who survive their injury eventually need cranioplasty. Autogenous bone graft using the removed bone fragment is the most frequently used material. The purpose of this exhibit is to demonstrate common complications of craniectomy with subsequent autogenous bone cranioplasty.

Materials & Methods
Dictated reports of CT scans of 2005 and 2006 were searched for the words “craniectomy” or “cranioplasty”. A total of 89 dictations were found, 45 of which were unique cases of craniectomy. These were reviewed for images demonstrating complications of cranioplasty. Representative images then were collected from their clinical imaging. Research protocol was approved by our institutional review board.

Results
The most common complications in this series of patients included resorption of bone graft, infection, and subdural hygroma. Representative series of images of each of these entities will be displayed (3 cases of resorption, 2 cases of infection, and 1 case of subdural hygroma) with discussion of key points in differentiating between complications, especially differentiating bone resorption from infection. The patient’s relevant clinical history will be described.

Conclusion
Decompressive craniectomy with subsequent cranioplasty is a technique that is often used as a life-saving measure in patients with otherwise uncontrollable cerebral edema. Potential complications of cranioplasty are important for neuroradiologists to recognize since surgical revision of the cranioplasty may be required.

Key Words: Cranioplasty, infection, resorption

Imaging of Tumors and Tumor Mimics of the Temporomandibular Joint

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2 University of Oslo, Oslo, NORWAY

Purpose
The purpose of this exhibit is to illustrate the imaging findings of various benign and malignant lesions involving the temporomandibular joint and discuss the tumor-like conditions at this site.

Materials & Methods
This exhibit is based on high quality CT and MR imaging studies of tumors of the temporomandibular joint with clinical and pathologic correlation. We retrospectively reviewed these images and we will illustrate the pertinent imaging findings. We will review briefly the normal anatomy of the temporomandibular joint, discuss the common tumors found in this location with a systematic approach to analyzing tumor characteristics and extension. Thus, synovial chondromatosis, osteochondroma, osteoma, sphenoid meningioma, osteosarcoma, local extension of neoplastic lesions and
metastasis will be illustrated. We will also discuss tumor-like conditions of pseudo gout, pigmented villonodular synovitis, traumatic bone cyst, and normal variants.

RESULTS
CT and MR imaging have been used widely for imaging the temporomandibular joint, helping to provide differential diagnosis and accurately determine the extent of lesions. CT improves the diagnostic information and serves as the standard diagnostic instrument for cartilaginous or osseous neoplastic lesions. MR imaging is especially useful in evaluating soft tissue extent with multiplanar techniques and has high spatial resolution. Marrow infiltration also is evaluated best on MR imaging. CT and MR imaging are often complimentary in the diagnosis and characterization of temporomandibular lesions.

CONCLUSION
Radiologic diagnostic procedures are essential for the diagnosis and treatment planning of neoplastic lesions of the temporomandibular joint. Neoplastic lesions of the temporomandibular joint are often incidental findings and radiologists need to be confident about interpretation of these lesions. This exhibit will provide the practicing radiologists an opportunity to become familiar with their imaging characteristics.

KEY WORDS: Temporomandibular joint, tumors, imaging

Scientific Exhibit 56
Anatomy and Pathology of Common and Uncommon Pathways of Perineural Tumor Spread

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PURPOSE
After viewing this exhibit, the reviewer will be able to describe the normal anatomy of nerves and neural foramina commonly involved in perineural tumor spread (PNTS) and know the common CT and MR appearances of PNTS.

MATERIALS & METHODS
Representative CT and MR examples of PNTS are reviewed, involving major divisions (V1, V2, V3) and branches of the trigeminal nerve, facial nerve (VII), and Vidian nerve.

RESULTS
Perineural tumor spread of primary head and neck malignancies involves metastatic extension of tumor along perineural or endoneural tissues of the neural sheath. Perineural tumor spread most commonly involves the trigeminal and facial nerves. CT and MR imaging have complementary roles for diagnosis of PNTS. Thin-cut bone algorithm CT shows widening and/or destruction of skull base foramina. Obliteration of fat planes, particularly in and around the pterygopalatine fossa, is well demonstrated on soft-tissue algorithm CT and can suggest the diagnosis of PNTS. However, MR imaging is superior for showing abnormal nerve enhancement. In this exhibit, examples of PNTS from a wide range of pathologies, including squamous cell carcinoma, adenoid cystic carcinoma, olfactory neuroblastoma, lymphoma, and chondrosarcoma are presented. An example of cervicofacial actinomycosis of the masticator space with perineural involvement of the mandibular and inferior alveolar nerves also is presented, underscoring the need to include benign disease processes in the differential for PNTS.

CONCLUSION
Detection of PNTS is crucial because its presence can alter surgical resection or radiation therapy, or may render a tumor unresectable. Perineural tumor spread is associated with a higher incidence of tumor metastasis and recurrence.

KEY WORDS: Perineural, malignancy, cranial nerve

Scientific Exhibit 57
Imaging Appearance of Basal Cephaloceles in Twelve Cases: Review of the Literature and Classification Update

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PURPOSE
Basal cephaloceles are rare entities. Most previous publications discussing basal cephaloceles are in the form of case reports or small series. There has been an abundance of inconsistency and inaccuracy in the choice of terms used for the various types of cephaloceles. The classification list commonly used so far is incomplete as it does not include some of the previously described types.

MATERIALS & METHODS
We, therefore, undertook a comprehensive review of our experience with this rare entity. We retrospectively looked at clinical and radiologic findings in 12 cases of spontaneous basal cephaloceles that were diagnosed and/or treated in our institution during the years 1999-2005 and reviewed the literature.

RESULTS
The 12 cases in our files included most of the types of basal cephaloceles that have been described previously. New characteristic features are described for some of these types, mainly considering the association of mass lesions and basal cephaloceles, as well as additional observations on cephaloceles in NF1. Ancillary radiologic findings considering the associated morphologic changes in intracranial content that may aid in the exact anatomical diagnosis of basal cephaloceles are provided in detail.

CONCLUSION
Based on these cases, and the added informative value of modern imaging, a modification to the classification system previously defined is presented as new types are added to the previous lists, including the trans-alar, petrous apex, ethmoid roof, and frontal sinus cephaloceles.

KEY WORDS: Cephalocele, congenital
**Scientific Exhibit 58**

**Imaging of Transpatial Involvement in Head and Neck Neoplastic Disease**

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Morgantown, WV

**PURPOSE**

Purpose is to provide education regarding neoplastic disease of the head and neck region. The exhibit approaches this purpose by: 1) Describing routes of spread of neoplastic entities affecting the head and neck region; 2) Illustrating these routes of spread with case examples; and 3) Providing commentary on formulation of image-based differential diagnosis using CT, MR imaging, and PET-CT imaging.

**MATERIALS & METHODS**

Pathologically proved cases were accumulated over a 10-year period at a tertiary referral cancer center. These represent a broad spectrum of head and neck neoplastic diseases. Both common and less usual patterns of spread of head and neck neoplasms from one space to another are shown by case examples. Cases include but are not limited to squamous cell carcinoma, basal cell carcinoma, adenoid cystic carcinoma, sinonasal undifferentiated carcinoma, esthesioneuroblastoma, meningioma, osteosarcoma, chondrosarcoma, chordoma, nasopharyngeal carcinoma, juvenile nasopharyngeal angiofibroma, and metastases. Clinical findings that herald disease progression and spread to additional structures are emphasized. Major neoplastic diagnostic entities for each location are reviewed with appropriate differential diagnostic points and recommended imaging approaches for common clinical presentations. High quality images illustrate the findings and complement the review of this disease behavior.

**RESULTS**

The viewer of this exhibit will gain or refresh information about patterns of spread of neoplastic diseases of the head and neck region for clinical practice and for preparation for certifying examinations. The images provide aids to recognition of varying patterns of neoplastic spread beyond the location of primary involvement.

**CONCLUSION**

The attendees of this exhibit will have the opportunity to review many case examples of head and neck neoplasms with descriptions of findings and patterns of disease progression.

**KEY WORDS:** Neoplasm, spread, perineural

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**Scientific Exhibit 59**

**Imaging Perspective on the Cranial Nerves: Normal Anatomy and Pathology**

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West Virginia University
Morgantown, WV

**PURPOSE**

1) Describe and illustrate the anatomical course of each cranial nerve using MR imaging and CT. 2) Review both common and rare lesions associated with the cranial nerves and their associated imaging appearances. 3) Discuss the clinical presentation of patients with cranial nerve lesions.

**MATERIALS & METHODS**

1) Utilizing MR imaging and CT, the anatomical course of each cranial nerve will be reviewed with reinforcement provided through description of common and unusual lesions involving the cranial nerves and their associated clinical presentation.

**RESULTS**

1) A thorough discussion of the anatomical course of the cranial nerves and associated pathology utilizing imaging.

**CONCLUSION**

1) By understanding the course and function of the cranial nerves together with the clinical presentation, identification of cranial nerve lesions and narrowing of the differential diagnosis can be achieved.

**KEY WORDS:** Cranial nerve, anatomy, pathology

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**Scientific Exhibit 60**

**Imaging of the Postradiation Neck: Tips for Evaluation of Response to Treatment, Recognizing Complications, and Detection of Recurrent Disease**

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**PURPOSE**

1) To illustrate expected imaging findings of radiation therapy to the neck and their typical evolution over time. 2) To facilitate recognition of complications of radiotherapy. 3) To suggest techniques for detecting residual and recurrent tumor in the setting of postradiation changes. 4) To emphasize what findings are important to the radiation oncologist.

**MATERIALS & METHODS**

1) A brief overview of rationale and physiology of radiotherapy for head and neck cancer will be presented. 2) The expected imaging findings and clinical manifestations of radiation to the neck will be reviewed. 3) Recognition of common, as well as less common but important, complications will be emphasized. 4) Tips for detection of residual and/or recurrent tumor will be provided, in the context of “what the radiation oncologist wants to know.”
RESULTS
Radiation, alone or in combination with chemotherapy and/or surgery, is a mainstay for treatment of head and neck cancer. The expected imaging changes of radiation in the neck include skin thickening, edema and reticulation of the subcutaneous and deeper tissues, retropharyngeal edema, gliotic and supraglottic edema, increased salivary gland enhancement followed by atrophy, mucosal enhancement, pooling of secretions, and bone marrow fatty replacement. These changes may be striking and confusing, especially as they evolve over time, and may be mistaken for residual or recurrent tumor. These changes may also decrease conspicuity of residual tumor. Complications of radiation treatment include fibrosis (which may result in airway compromise), osteonecrosis, chondronecrosis, myopathy, myelopathy, brachial plexopathy, arteritis, and radiation-accelerated atherosclerosis.

CONCLUSION
Detection of residual or recurrent tumor in the setting of postradiation change may be difficult. Understanding the evolution of the appearance of the irradiated neck facilitates evaluation of response to treatment, recognition of complications, and detection of persistent and/or recurrent tumor.

KEY WORDS: Radiation, head and neck cancer, complications

Scientific Exhibit 61
Congenital Cystic Neck Masses: Review of Common and Unusual Presentations

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PURPOSE
Congenital cystic neck masses include lesions such as branchial cleft cysts, thyroglossal duct cysts, cystic hygromas, laryngoceles, ranulas, and dermoid cysts. We will present the common radiologic appearances of these cystic lesions, as well as unusual presentations or complications associated with these lesions (e.g., superimposed infection, carcinoma).

MATERIALS & METHODS
The embryological origins of the cystic neck lesions are discussed, along with illustrative examples of the common radiologic appearances. Potential complicating features (e.g., infection, neoplasm) associated with the lesions are reviewed, along with discussion of the imaging characteristics key to their diagnosis.

RESULTS
While a palpable mass is the most common presentation of a congenital cystic neck mass, superimposed infection of the lesion is also a common occurrence. In addition to infected branchial cleft and dermoid cysts, we will present an example of an infected laryngcele (laryngopyocele). Carcinoma associated with the cystic neck lesions is an uncommon occurrence, but the imaging features suggestive of a concur-
Scientific Exhibit 63

Laryngoceles: Symptomatic or Incidental, Multidetector CT Findings

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Purpose
Laryngocele is an abnormal dilatation of laryngeal saccule arising between the false cord, base of epiglottis, and inner surface of the thyroid cartilage. The etiopathogenesis of these structures is unknown. They can be congenital or acquired and in acquired cases malignancy as the cause of underlying etiology should be carefully ruled out.

Materials & Methods
Retrospective review of 241 neck CT cases between August 2005 and August 2006 yielded a total of five laryngoceles. Of the five patients, all were male with ages ranging between 27 and 56 years. Three of them presented with hoarseness, one with neck mass, and in the last patient it was diagnosed incidentally. All CT examinations were performed in an eight-channel multidetector CT suite (GE Healthcare, Milwaukee, WI, USA) and multiplanar reconstructions were carried out in the workstation (adw 4.2, GE Medical Systems, Milwaukee, WI, USA).

Results
Three of the laryngoceles were internal, one was combined and one was external in type. The maximum diameter of the lesions changed between 17 mm and 33 mm, the largest being internal. The incidentally diagnosed one was smallest in diameter and all others were symptomatic and bigger than 2 cm in size. In two patients the lesions were suspected during direct laryngoscopy examination as well.

Conclusion
Laryngoceles may remain silent but if not, the most common presenting symptom is hoarseness. They may go undiagnosed during clinical examination, so the role of the radiologist is to define the presence, type, and underlying malignancy or other accompanying pathology if present.

Key Words: Laryngocele, computed tomography

Scientific Exhibit 64

Head and Neck Manifestations of Maffucci’s Syndrome

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Purpose
Maffucci’s syndrome is a rare congenital disease due to neuroectodermal dysplasia and is characterized by multiple enchondromas and subcutaneous hemangiomas. It was first described in 1881 by Angelo Maffucci and since then fewer than 200 cases have been published in the English literature. The purpose of this pictorial exhibit is to demonstrate the spectrum of head and neck imaging findings of such a rare condition including unusual associations, some of them only recently reported.

Materials & Methods
The authors illustrate some of the head and neck manifestations of this syndrome using a multimodality approach (conventional radiograph, ultrasound, scintigraphy, computed tomography, magnetic resonance imaging, including magnetic resonance angiography) and discuss the typical and atypical associated features. They also comment on the differential diagnosis with other similar diseases.

Results
Bone lesions as well as the appearance of the soft tissue hemangiomas are demonstrated with different imaging modalities. Skull base lesions (enchondromas, chondrosarcomas), involvement of the thyroid, parathyroid, orbits, oral cavity, pharynx, larynx, and sinonasal cavities are discussed and illustrated in this review.

Conclusion
The authors recommend the careful evaluation of any patient diagnosed with Maffucci’s syndrome with various imaging modalities in order to diagnose associated conditions that will alter the prognosis and future follow up.

Key Words: Maffucci’s syndrome, congenital, enchondromatosis

Scientific Exhibit 65

Sinonasal Diseases from Inflammatory to Neoplastic: What Do Our Otorhinolaryngology Colleagues Want to Know?

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Purpose
Sinonasal diseases cause significant public health afflictions and sinonasal surgeries often are performed to alleviate patient discomfort and to treat underlying disease. The purpose of this exhibit is two-fold: 1) to present the normal radiologic anatomy of the sinonasal cavity, to emphasize the sites of obstruction and anatomical variants that are most likely to result in symptoms, to highlight the potential sites for surgical disaster which are of interest to the otorhinolaryngologists and must be mentioned in reports, and to demonstrate the CT and MR characteristics of postoperative changes, and 2) to review the cross-sectional imaging appearances of clinically or pathologically proved cases of inflammatory, infectious, and neoplastic sinonasal diseases.

Materials & Methods
Approximately 400 cases of sinus CT and 40 cases of MR imaging of the head and neck performed over the past two years for sinonasal complaints at our institution are reviewed, with emphasis on detection of anatomical variants
which may have contributed to symptoms or created difficulty during surgery. Pathologic and surgical reports of the patients with significant disease who underwent surgical interventions are obtained, and correlations are made with the radiographic appearances. The CT and MR imaging characteristics of these disease entities, including inflammatory, infection, and neoplastic processes, are reviewed and summarized.

RESULTS
Representative CT images of normal anatomy and anatomical variants with specific focus on sites of obstruction such as the osteomeatal units, sphenoidostomal and frontoethmoidal recesses, deviated nasal septum, ethmoidal bulla, Haller and Onodi cells, and hypoplastic maxillary antrum are presented. Potential sites for surgical complications are highlighted. These include apposed uncinate process and medial orbital wall, dehiscence in the cribiform plate, posterior ethmoid sinus and sphenoid sinus walls, and intersinus septum in the sphenoid sinus that attaches to the carotid canal. CT and MR imaging characteristics and pitfalls of postsurgical changes are presented with reference to the types of surgery performed. A pictorial review of the CT and MR imaging characteristics of various clinically or pathologically proved disease entities from our institution is offered. Differential diagnoses and specific imaging characteristics are highlighted. Sinonasal disease entities to be displayed and differentiated may include both acute and chronic sinusitis, fungal sinusitis, bacterial sinusitis complicated by meningitis, abscess/empyema, and dural sinus thrombosis, mucocele, retention cyst/polyposis, granulomatous diseases such as sarcoidosis and Wegener’s, benign neoplasms such as papillomas, osteomas, and enchondromas, and malignant neoplasms such as squamous cell carcinoma, melanoma, olfactory neuroblastoma, and lymphoma.

CONCLUSION
We present a thorough evaluation of anatomical concerns of the paranasal sinuses that are important to the surgeons and offer a pictorial review of our CT and MR experiences in diagnosis and treatment of sinonasal diseases with emphasis on their imaging characteristics and differential diagnosis.

KEY WORDS: Anatomy, sinonasal disease, paranasal sinus

Scientific Exhibit 66
Distinguishing Features of Sinonasal Neoplasms

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PURPOSE
To offer an approach for the evaluation of sinonasal neoplasms based upon imaging characteristics, tumor location, and clinical factors.

MATERIALS & METHODS
There are some features that may suggest certain tumors among the host of diagnostic possibilities. These include imaging features, tumor location, and clinical factors. Imaging features to assess and consider include density, calcification, hemorrhage, matrix, and tumor margins. Tumor location is important, whether it be paranasal sinus mucosa, cribiform plate, lateral nasal wall, nasal septum, or adjacent bone. Lastly, clinical factors, such as age, sex, presence of epistaxis and ethnicity, also are essential in arriving at a limited differential diagnosis.

RESULTS
Imaging of sinonasal tumors may be confusing as these tumors are rare and not encountered on a routine basis. Additionally, benign and malignant tumors may overlap in imaging characteristics with each other and with aggressive infections, such as fungal sinusitis. Tissue specificity is generally not possible with CT or MR imaging for the majority of sinonasal neoplasms.

CONCLUSION
Tumors of the sinonasal tract may be classified as 1) benign or malignant; 2) carcinomas, sarcomas, or lymphomas; 3) according to the tissue of origin (epithelial, osseous, lymphoid, etc.); or 4) a combination of the above. Tumors specifically reviewed in this educational exhibit include squamous cell carcinomas, papillomas, esthesioneuroblastoma, melanoma, JNA, lymphoma, various benign and malignant bone tumors and glandular tumors including adenocarcinoma and minor salivary gland tumors.

KEY WORDS: Sinonasal, neoplasms

Scientific Exhibit 67
Navigating the Labyrinth: A Pictorial Essay of the MR Appearance of Inner Ear Anatomy and Pathology

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PURPOSE
MR findings within the membranous labyrinth are often subtle and easily overlooked. It is our goal to elucidate the normal appearance of the inner ear and to describe a variety of inner ear pathologies using a tailored MR imaging approach.

MATERIALS & METHODS
High-resolution MR imaging of the labyrinth requires a specialized examination designed to maximize resolution and SNR in order to detect subtle changes in fluid signal and pathologic intralabyrinthine enhancement. These techniques should employ small fields of view (10-12 cm) and take advantage of the higher resolution available with 3D acquisitions (3D FSE, FIESTA or CISS and 3D FLAIR). This is easier to accomplish with higher SNR at 3T. Fat saturation on postcontrast sequences is useful in accentuating the conspicuity of labyrinthine enhancement.
RESULTS
This pictorial essay will focus on the normal morphology of the labyrinth with emphasis on 3T. The normal appearance will be compared to the characteristic dysmorphic features seen in a few congenital labyrinthine anomalies. It also will underscore the normal signal intensity of labyrinthine fluid in comparison to signal alterations seen in various disease states (inflammatory to include autoimmune and infection, primary and secondary neoplastic, iatrogenic and hereditary conditions). Patterns of pathologic enhancement will be reviewed.

CONCLUSION
A working knowledge of state of the art MR techniques and familiarity with the normal and abnormal appearance of the labyrinth on high-resolution imaging will sharpen the diagnostic acumen of the neuroradiologist and should improve patient care in the setting of otologic disease.

KEY WORDS: Labyrinth, MR imaging, temporal bone

Scientific Exhibit 68
CT and MR Findings of Rare Temporal Bone Tumors and Tumor-mimicking Lesions

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PURPOSE
We have identified, on CT and MR imaging, several cases of rare tumors and tumor-mimicking lesions developing from the temporal bone. Our aim is to catalogue the imaging findings in this exhibit to help radiologists, who come across CT and MR imaging of such rare temporal bone lesions, make a diagnosis.

MATERIALS & METHODS
Nine cases are presented including a case of chordoma of the petrous pyramid apex (n = 1), endolymphatic sac tumor (n = 1), giant cell tumor of the temporal bone (n = 1), paraganglioma of facial canal origin (n = 1), perineural invasion of the temporal bone facial nerve by a submandibular gland adenoid cystic carcinoma (n = 1), petrositis (n = 1), myeloma (n = 1), and giant cell reparative granuloma (n = 2).

RESULTS
We were able to correlate imaging findings with histopathologic diagnoses after retrospectively reviewing our CT and MR findings of rare temporal bone tumors and tumor-mimicking lesions.

CONCLUSION
We expect that we will be able to use images of such cases to confirm histopathologic diagnoses.

KEY WORDS: Temporal bone, tumor, tumor-mimicking lesion

Scientific Exhibit 69
Management of Intraprocedural Adverse Events during Coil Embolization of Cerebral Aneurysms

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PURPOSE
The overall complication rate for endovascular coil embolization of cerebral aneurysms is 5%. A synopsis of adverse events related endovascular coil embolization is presented.

MATERIALS & METHODS
This is an illustrative case series that describes management aspects and probable precipitants of adverse events during coil embolization and related imaging and clinical outcomes.

RESULTS
Major intraprocedural intracranial adverse events during endovascular coil embolization of cerebral aneurysms can be divided into three categories. 1) Thromboembolic: This is the most frequent complication and cause of morbidity and mortality. Thromboemboli may occur consequent to failure of sustained and or sufficient systemic anticoagulation. Prevention of localized platelet and clotting cascade activation in the context of thrombogenic device introduction for coil embolization is vital in preventing partial or complete parent, branch, or distal vessel occlusion. Embolic propagation of thrombus may arise from native vessel disease and/or consequent to mechanical device manipulation during coil delivery and deployment, as well as with the use of adjuncts such as balloon assist. Frequent monitoring of activated clotting time (ACT) values for systemic anticoagulation with heparin to confirm twice the baseline value is the primary preventative method. Intraprocedural pharmacologic platelet thrombus dissolution with short- and long-acting glycoprotein IIb/IIIa inhibitors are effective when administered locally or systemically. Raising cerebral perfusion pressure may augment collateral flow with consequent reduction in the risk of ischemic sequelae. 2) Device related: Coil unraveling and migration with or without fracture occurs in less than 2% of cases. This often occurs with placement of the finishing series of coils. Early or delayed coil loop herniations into the parent vessel are precipitants of extraaneurysmal thrombogenesis and may be influenced by the type of coil configuration deployed and aneurysm aspect ratios. Coil loop unraveling and migration is managed with mechanical or surgical coil retrieval. Coil loop herniations can be approached conservatively or treated with loop incarceration by stent implantation. 3) Perforations and ruptures: Intraprocedural aneurysm rupture occurs in approximately 2-3% of cases with an overall periprocedural mortality of 25-50%. They are more likely to occur in small aneurysms and aneurysms that have already ruptured. Aneurysm rupture caused by coil or microcatheter perforation may result in less morbidity and mortality than perforation from a microguide wire.
Intracranial vessel injury such as dissection or microguide wire distal branch vessel perforation are also other events included in this category. Reversal of systemic anticoagulation and expedient continued coil embolization with measures to control raised intracranial pressure that includes preprocedural or timely placement of ventricular drainage catheters are important in managing intraprocedural aneurysm rupture. Judicious monitoring of distal microguidewire tip location is critical in preventing inadvertent distal vessel perforation.

CONCLUSION
Each of the adverse events described result in or may progress to either hemorrhagic or ischemic consequence to the brain with or without resultant clinical neurologic sequelae. Anticipation, early recognition, and appropriate management of adverse events during cerebral aneurysm coil embolization are the most crucial determinants of patient morbidity and mortality.

KEY WORDS: Cerebral aneurysms

Scientific Exhibit 70
Endovascular Treatment of Giant Intracranial Aneurysms: Review of a Single-center Experience

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PURPOSE
Giant aneurysms are rare lesions, associated with high mortality and morbidity, with survival rates as low as 20% at two years in untreated cases. There has been growing use of endovascular techniques in the treatment of these aneurysms and development of innovative therapeutic modalities. The purpose of this study is to present the experience of our institution in the treatment of intracranial giant aneurysms with intradural expression, analyzing their presentation form, localization, therapeutic method, and clinical outcome.

MATERIALS & METHODS
In this retrospective study we review the clinical data and neuroimaging exams of adult patients submitted to endovascular treatment of giant aneurysms in our hospital between 1996 and 2006.

RESULTS
During the considered 10 years, 12 patients with giant aneurysms were referred to endovascular treatment in our institution (9M: 3F; mean age 44.4 years, range 22-64 years). Around 8% of patients presented with rupture of the aneurysm and 83% with headache and/or focal signs. Ten aneurysms were located in the anterior circulation (five in the cavernous segment of the internal carotid artery and five in the supraclinoid segment) and two in the vertebrobasilar system. A deconstructive technique was used in 10 patients (proximal arterial occlusion with either coils or balloons), stent placement and embolization with coils was done in one patient and a covered stent was placed in one patient. In two cases there were immediate transient deficits that resolved within the first 24 hours and all of the 10 cases in which there is long term follow up (mean duration 26.8 months) are independent in their daily life activities (scores of 0 or 1 in the modified Rankin scale).

CONCLUSION
A careful choice of cases and adequate therapeutic modalities allows the treatment of this challenging type of aneurysms with low morbidity and mortality. Further development of endovascular techniques will yield safer, more effective, and longer lasting treatment of a growing number of patients.

KEY WORDS: Giant aneurysms, endovascular treatment

Scientific Exhibit 71
Can Ethanol Sclerotherapy be the First-line Treatment in the Management of Craniofacial Venous Malformations?

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PURPOSE
To evaluate the safety and the feasibility of ethanol sclerotherapy in the treatment of craniofacial venous malformations (VMs).

MATERIALS & METHODS
From May 1998 to July 2006, 85 patients (38 men, 47 women; age range, 2-68 years) with craniofacial VMs underwent staged ethanol sclerotherapy (range, 1-21; median, 2). Ethanol sclerotherapy (50%-100% ethanol mixed with nonionic contrast material) was performed by direct puncture techniques. Twelve patients underwent additional glue or microfoam or ethanolamine oleate sclerotherapy. Clinical follow up (range, 1-99 months; mean, 29 months; median, 20 months) was performed in all patients. Therapeutic outcomes were established by evaluating the clinical outcome of symptoms and signs in all patients, as well as the degree of devascularization at follow-up imaging in 32 patients.

RESULTS
Two hundred sixty-three procedures with use of ethanol were performed in 85 patients. One (1.2%) of 85 patients was cured, 74 (87.1%) had partial remission, 5 (5.9%) patients had no response and 5 (5.9%) patients experienced aggravation. Ethanol sclerotherapy was considered effective (cure, 1 patient; partial remission, 74 patients) in 75/85 patients (88.3%). All minor complications were healed with wound dressing and observation. Major complication such as skin necrosis did not developed.

CONCLUSION
Percutaneous sclerotherapy with use of ethanol is an effective and safe treatment for craniofacial VMs.

KEY WORDS: Venous malformation, ethanol sclerotherapy
Scientific Exhibit 72

Perfusion CT Imaging Utilizing Intraarterial Contrast Injection in Balloon Occlusion Test

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PURPOSE
Therapeutic occlusion of the unilateral internal carotid artery (ICA) is still inevitable in some situations such as giant cerebral aneurysms or skull base tumors although intracranial stents are available recently. Balloon occlusion test (BOT) is performed to evaluate the collateral flow in case of the occlusion of the affected ICA; however, BOT with neurologic evaluation alone has a rather high false-negative rate. In order to improve the sensitivity and evaluate the necessity of the bypass surgery, several modalities such as xenon-enhanced computed tomography (CT) or single photon emission CT (SPECT) have been combined with BOT. Perfusion CT (PCT) is another modality that is capable of measuring cerebral blood flow (CBF). Our institute has an angio suite equipped with a multidetector CT. To take advantage of this angio/CT combination suite, we perform BOT with PCT without transferring the patient. We also administer the contrast material for PCT via the catheter in the aortic arch. This is a study to evaluate the efficacy and the safety of PCT during BOT utilizing intraarterial contrast injection.

MATERIALS & METHODS
From July 2003 to December 2006, 21 patients underwent BOT in our institution. Nineteen of them had large or giant aneurysms. One patient had dissecting aneurysm and the other had cervical tumor invading the left ICA. All the procedures were performed in the angio/CT comb suite (Miyabi; Siemens, Erlangen, Germany). Bilateral femoral arteries were punctured and femoral sheaths were placed. Balloon occlusion test was performed in the usual fashion, inflating the balloon in the cervical ICA for 30 minutes with neurologic examination every 5 minutes. When the patient passed the 30 minutes’ BOT clinically, PCT was performed subsequently. The balloon was kept inflated, and contrast material was injected from a Pig Tail catheter, which tip was placed in the ascending aorta. The obtained data were transferred to a workstation and perfusion maps were generated. Sixteen of the 21 patients underwent SPECT study simultaneously, with administering 99mTc-ethyl cysteinate dimer (99mTc-ECD) intravenously while the balloon inflated. Data acquisition with gamma camera was performed after the BOT.

RESULTS
Three patients presented clinical symptoms during BOT. As one patient presented drowsiness only, PCT and SPECT study were subsequently performed. There was no procedure-related morbidity. In total, 19 patients underwent PCT during BOT. In 9 patients, there was no significant laterality of CBF in PCT map. Seven patients presented severe decrease of CBF and three patients presented moderate decrease in the occluded side. Based on the results of PCT, four patients underwent ICA occlusion without bypass surgery. All of the four patients discharged without deficit. If the CBF laterality existed, the decrease of CBF was more prominent in PCT than SPECT. So PCT may be more sensitive to detect the CBF decrease.

CONCLUSION
Perfusion CT using intraarterial contrast injection during BTO was performed successfully and safely. This technique seems promising; however, further studies are necessary as the number of patients was limited and quantitative results should be validated against those of other modalities.

KEY WORDS: Balloon occlusion test, perfusion CT, intraarterial contrast injection

Scientific Exhibit 73

Flow Velocities and Wall Shear Stress in a Neuroform-Treo Stent

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PURPOSE
The use of small metallic stents for treatment of stenosed vessels has significantly increased in recent years but restenosis caused by neointimal hyperplasia continues to be an important problem after stent implantation. Evidence suggesting that alterations in wall shear stress due to stent implantation are responsible for restenosis has motivated the use of computational hemodynamics to study the blood flow. Unlike previous studies that simulated blood flow through idealized, artificially generated models of stented vessels, our study modeled the blood flow using a real stent geometry acquired by DynaCT imaging.

MATERIALS & METHODS
The 3D image of the Neuroform stent (Boston Scientific, Freemont, CA) was obtained using a single C-arm angiographic system with flat detector (Axiom Artis dBA, Siemens Medical Solution, Germany) with the following parameters: 20sec, 0.4o increment, and 543 projections (DynaCT, Siemens Medical Solutions). The DICOM image data obtained as described above were loaded into an image processing and visualization software package. The data set was subjected to an image intensity threshold to identify the stent struts and the segmentation editor was used to select the voxels representing the stent struts and create a 3D region representing the stent. Also, during image segmentation, a circular contour tangential to the struts was constructed to approximate the vascular wall in each slice. The region then was used to construct a computational mesh consisting of 950,000 tetrahedral cells. Steady, 3D computational hemodynamics simulations were performed for three different flow regimes and assuming wall overexpansion and no wall overexpansion.
RESULTS
The results indicated that stagnation zones develop adjacent to the struts and strut junctions and secondary flow is present inside the intrastrut cells as revealed by near-wall velocity vectors. This secondary flow was due to the converging and diverging patterns of the flow as it enters and exits the cells. The distribution of shear stress on the struts was uniform, however higher shear stress values occurred on the proximal struts that oppose the incoming flow and on the struts that protruded into the lumen. Difference in magnitude of wall shear stress in proximal, middle, and distal parts of the stented segment was observed. Regions of stagnation in the vicinity of the stent struts and inside cells were subject to low wall shear stress values of less than five dyn/cm². The low shear stress values were found to persist in these regions even for higher flow rate simulations.

CONCLUSION
The current study, to the best of our knowledge, represents the first computational hemodynamics simulation using realistic stent geometry. The current results show that the wall shear stress distribution varies along the stented segment and that nonuniform stent geometry, as is the case for real deployed stents, can locally alter the shear stress distribution. Also, a region of high wall shear stress was noticed distal to the stented segment for the wall overexpansion simulation.

KEY WORDS: Stent, CFD

Scientific Exhibit 74
Interventional Neuroradiology of the Head and Neck
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PURPOSE
Interventional neuroradiology techniques can prove to be a valuable asset and adjunct in the surgical management of various vascular disorders affecting the extracranial head and neck. Recent advances have included improvements in microcatheter technology for distal access and new embolic agents. Together these techniques have open up several avenues to treating often complex vascular disorders of the head and neck.

MATERIALS & METHODS
For this exhibit, we have collected representative cases from the interventional neuroradiology prospective database maintained at our institution as well as the author’s teaching files.

RESULTS
Using these cases, we describe the management of vascular lesions in the head and neck (arteriovenous fistulae/malformations, carotid-cavernous fistulae, cavernous hemangiomas, and venous/venous-lymphatic malformations). Additionally, we will present the role of interventional neuroradiology in preoperative or palliative embolization in head and neck (epistaxis, glomus tumors, juvenile nasopharyngeal angiofibromas, and vascular lymph node metastasis). We also will discuss the role of intravascular ultrasound in difficult cases of carotid blow-out and focus on the methods of treatment in cervical dissections/pseudoaneurysms and carotid blow-out.

CONCLUSION
We demonstrate the expanding role of interventional neuroradiology techniques as attractive treatment alternatives or valuable adjuncts in the surgical management of the aforementioned vascular lesions. The vast majority of these techniques are becoming the standard of care as safe alternatives with low complication rates. These techniques are invaluable in hypervascular tumors of the head and neck and significantly reduce intraoperative time and bleeding. We hope to increase the awareness of interventional neuroradiology practices in extracranial head and neck disorders.

KEY WORDS: Interventional neuroradiology, head and neck

Scientific Exhibit 75
Utility of the Amplatzer Vascular Plug in Parental Artery Occlusion
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PURPOSE
The Amplatzer Vascular Plug is a simple, effective, and economical device that has been used successfully in the treatment of peripheral arteriovenous fistulae, pseudoaneurysms, and arterial laceration/perforation. To our knowledge, reports of the use of the Amplatzer Vascular Plug in parent artery occlusion have been scarce. We report herein a case series of parent artery occlusions using the Amplatzer Vascular Plug device.

MATERIALS & METHODS
Eight (n = 8) patients underwent parent artery occlusion of the carotid or vertebral arteries from June 2005-September 2006 at two separate institutions. Patient ages ranged from 16-72 years. Six females and two males were treated. All patients underwent balloon test occlusion or were tested angiographically prior to permanent occlusion. Clinical and/or angiographic follow up ranging from 2 to ten months has been achieved to date.

RESULTS
Eight patients underwent successful parent artery occlusion utilizing the Amplatzer Vascular Plug device (6-8 mm) in combination with primary occlusion of a fistula or aneurysm using detachable bare platinum or hydrocoils (Table 1). All patients underwent evaluation by conventional angiography and (where indicated) balloon test occlusion prior to the treatment. The device was placed through a 6 Fr guiding catheter in most cases. Time of deployment to angiographic proved occlusion of the vessel was no more than 10 minutes. No permanent neurologic deficit secondary to the procedure or device occurred in any of the patients. To date, there has been no evidence of failure to occlude the artery using the Amplatzer device.
a minority of patients with functional impairment, anatomical atrophy may occur (2). In these cases, the MR imaging features include atrophy of the contralateral cerebellar hemisphere. This is thought to be secondary to disruption of corticopontocerebellar connections. Of note, functional CCD, as defined by PET findings are seen in patients of all age groups, while actual anatomical crossed cerebellar atrophy generally is seen in younger patients.

CONCLUSION

Functional impairment and anatomical atrophy of the contralateral cerebellum can occur following a cerebral insult. It is important for radiologists to recognize that in the pediatric population, anatomical crossed cerebellar atrophy can occur, likely from alterations of the corticocerebellar circuit, and does not represent a second site of injury.

REFERENCES


KEY WORDS: Cerebellar, diachisis, MR imaging

Scientific Exhibit 77

Fetal MR Imaging of Brain, Head and Neck, and Spinal Abnormalities: A Pictorial Essay

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PURPOSE

To familiarize radiologists with utility of fetal MR imaging and to depict MR imaging appearance of fetal anomalies within the neuroradiology spectrum.

MATERIALS & METHODS

A pictorial essay will systematically introduce a reader to the wide spectrum of fetal anomalies. The cases will be divided into three sections: brain, head and neck, and spine. Fetal MR imaging indications, technique, as well as safety issues will be discussed.

RESULTS

Evaluation of fetal anomalies by MR imaging is gaining popularity in medical centers throughout the world. Currently the primary modality for imaging of the fetus remains to be an ultrasound (US). However, US provides only limited evaluation, while MR imaging offers multiplanar imaging with superb soft tissue resolution that can more clearly demonstrate anatomical and pathologic conditions. MR imaging has been shown to change clinical decision making regarding diagnosis and management. As fetal MR imaging becomes widely available, its use is being expanded beyond purely clarifying or confirming abnormalities present on US. Its role in detecting associated or multiple

Scientific Exhibit 76

Crossed Cerebellar Diaschisis: MR Findings and a Pictorial Review

Mazumdar, A.1 · Konda, S.1 · Bardo, D.1 · McKinstry, R.1
1University of Chicago, Chicago, IL, 2Washington University in St. Louis, St. Louis, MO

PURPOSE

To review the phenomenon of crossed cerebellar diaschisis (CCD) and its imaging appearance.

MATERIALS & METHODS

We retrospectively reviewed the imaging appearance of cases of crossed cerebellar diaschisis seen at our institutions.

RESULTS

The term diachisis, as originally described, refers to damage to one brain area causing a disturbance at a distant but anatomically linked site. Originally visualized by positron emission tomography (PET) studies, crossed cerebellar diachisis was found to have cerebellar oxygen hypometabolism and reduced cerebral blood flow from an insult to the contralateral cerebral hemisphere (1). This finding can be seen in ischemic infarctions, as well as secondary to other lesions such as tumors and arteriovenous malformations. In

<table>
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<tr>
<th>Age</th>
<th>Gender</th>
<th>Indication</th>
<th>Location</th>
<th>Device Size</th>
<th>Complication Follow up</th>
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<tr>
<td>63</td>
<td>Female</td>
<td>cavernous carotid aneurysm/CNV palsy</td>
<td>Left ICA</td>
<td>8mm X 2</td>
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(CROSS 1)

CONCLUSION

The Amplatzer Vascular Plug provides a viable economical option for performing parent artery occlusion in the treatment of cerebrovascular disease. It is a user friendly system that allows precise placement, deployment, and permanent occlusion. The device provides an overall cost reduction, negating the need for additional coils normally required to obtain occlusion. As an off-label use it fills an application void, providing a durable alternative to detachable balloons, which are no longer available in the United States.

KEY WORDS: Amplatzer, cerebral, artery

Scientific Exhibit 76

Crossed Cerebellar Diaschisis: MR Findings and a Pictorial Review

Mazumdar, A.1 · Konda, S.1 · Bardo, D.1 · McKinstry, R.1
1University of Chicago, Chicago, IL, 2Washington University in St. Louis, St. Louis, MO

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anomalies is invaluable in guiding appropriate management. The relatively high sensitivity and specificity for fetal anomalies demonstrated with MR imaging provides for a major role in evaluating cases with genetic or maternal risk factors where US examination may be unremarkable. Our routine fetal MR imaging protocol includes single-shot fast spin-echo sequences in three planes which are fast and allow for breath hold. Large field of view (FOV) is used to image an entire fetus to evaluate body structures as well as to assess for spinal canal and vertebral column structures. A smaller FOV is used to image the brain and neck which provides for a higher spatial resolution without significant decrease in signal-to-noise ratio. Maternal and fetal safety issues must be addressed in each case. We do not utilize gadolinium-based contrast agents, and do not routinely scan patients in their first trimester. Patients usually are placed in supine or decubitus position. Feet are placed first into a bore to reduce a feeling of claustrophobia. The examination is scheduled during the time when the fetus is less active. We present variety of different anomalies of brain, head and neck, and spine that range from common etiologies such as ventriculomegaly, lymphatic malformation, and sacrococcygeal teratoma, to relatively uncommon cases that include neck teratoma, sacral agenesis and diastematomyelia, to rare entities such as kleeblattschadel, enophthalmos, and CNS anomalies of conjoined twins.

**CONCLUSION**

It is important for a radiologist to understand the role of fetal MR imaging and be familiar with appearance of neurologic fetal anomalies. Fetal MR imaging plays an integral role in patient care and will become an irreplaceable tool in a near future with further improvement of imaging techniques and ease of availability.

**KEY WORDS:** Fetal MR imaging, developmental abnormality, pregnancy

**Scientific Exhibit 78**

**Neuroimaging Presentations of Two Cases of Pediatric Influenza A Encephalitis**

Young, S. J. · Maya, M. M. · Moser, F. G. · Georganos, S. A.  
Cedars-Sinai Medical Center  
Los Angeles, CA

**PURPOSE**

Present imaging findings of influenza A encephalitis.

**MATERIALS & METHODS**

Retrospective review of clinical case histories performed by neuroradiologist and correlated with neuroimaging.

**RESULTS**

Case 1: 5-year-old male with congenital hydrocephalus presented with new onset lethargy after less than a day of fever, cough, diarrhea, and vomiting. In ER, rectal temperature was 107.1 F. Noncontrast head CT revealed stable baseline hydrocephalus. Eighteen hours later noncontrast head CT revealed increasing hydrocephalus with acute bilateral basal ganglia infarctions. Follow-up MR imaging (Fig 1: Axial T2) revealed infarctions involving bilateral thalami, basal ganglia, and pons suggestive of acute necrotizing influenza A encephalitis. Influenza A virus was cultured from nasopharyngeal washings and confirmed by fluorescent monoclonal antibody staining. Patient survived with extensive neurologic deficits. Case 2: 10-year-old male with no significant past medical history presented with new onset lethargy after three days of fever and cough. In ER, rectal temperature was 106.1 F. Noncontrast head CT was normal. Three hours later patient rapidly deteriorated into a coma. Postintubation noncontrast head CT demonstrated mild hydrocephalus with pontine edema and hemorrhage. Subsequent MR imaging (Fig 2: Axial T2) revealed diffuse signal abnormality involving the pons, mesencephalon, bilateral thalami, and the upper medulla oblongata with a hemorrhagic component in the dorsal aspect of the pons extending into the fourth ventricle. The symmetry and distribution were suggestive of influenza A encephalitis. Twelve hours later the patient was brain dead. Influenza A virus was cultured from nasopharyngeal washings and confirmed by fluorescent monoclonal antibody staining.
CONCLUSION
Influenza A encephalitis can be devastating with a rapidly progressive course. Neuroimaging is invaluable in diagnostic and clinical management.

KEY WORDS: Influenza A, encephalitis, MR imaging

Scientific Exhibit 79
Imaging of the Corpus Callosum in Pediatrics: A Pictorial Review

Yoo, J.¹ · Hunter, J. V.¹
¹Texas Children’s Hospital, Houston, TX, ²EWHA Womans University Tongdaemun Hospital, Seoul, REPUBLIC OF KOREA

PURPOSE
To illustrate the spectrum of disease processes seen in the corpus callosum (CC) of children and to understand the underlying embryology and pathophysiology of these disorders.

MATERIALS & METHODS
A retrospective review of the CC lesions diagnosed on MR imaging during the last five years was performed, using a word engine search in our PACS, at the largest tertiary referral pediatric hospital in the USA. Diffusion-tensor imaging (DTI) and fiber tractography (FT) also were reviewed in a restricted number of cases. Imaging patterns were divided into congenital and acquired lesions that can affect the CC in children. We will illustrate examples of both congenital and acquired CC lesions and also review and discuss the embryology and pathophysiology underlying some of these disease processes.

RESULTS
The disorders include various congenital lesions of the CC, (agenesis, hypogenesis, dysgenesis, lipoma, associated anomalies and syndromes), vascular malformation, infarction, hemorrhage, axonal injury, multiple sclerosis, acute disseminated encephalitis, various neoplasms (medulloblastoma, glioblastoma multiforme, juvenile astrocytoma, germinoma, lymphoma, metastasis), bacterial and viral infection, HIV-related lesions, adenoleukodystrophy, vanishing white matter disease, miscellaneous conditions (e.g., secondary change after VP shunt and colosotomy, transient lesion of splenium), etc. Many congenital lesions of the CC show very unique findings supporting our understanding of its embryologic development. Although the CC is not a common primary site for disease, it is a large white matter fiber tract that often reflects systemic disorders. Multiplanar MR imaging is very useful not only for the detection and diagnosis of the CC lesions but also for understanding the underlying pathophysiology of lesions made easier by the characteristic appearance and shape of the CC. Diffusion tensor imaging and fiber tractography also demonstrate abnormal fiber tract and disconnection in callosal agenesis as well as acquired diseases of the CC.

CONCLUSION
Corpus callosal lesions are both congenital and acquired in children. Understanding the embryologic developmental sequence of the CC is important in assessing many congenital CC disorders. Multiplanar MR imaging is the most useful imaging modality for the detection and diagnosis of the CC lesions. Diffusion tensor imaging and fiber tractography can demonstrate orientation and integrity of the CC fibers to determine normal fiber tract connection or aberrant connection correlating with clinical disorders.

KEY WORDS: Pediatrics, corpus callosum, MR imaging

Scientific Exhibit 80
Uncommon Causes of Thoracic Myelopathy: More than Just Disks and Demyelinating Disease

Meszaros, M. D. · Eskey, C. · Mamourian, A. · Pekala, J. S.
Dartmouth-Hitchcock Medical Center
Lebanon, NH

PURPOSE
Myelopathy is a term used to describe any neurologic deficit related to the spinal cord itself. Myelopathy has many causes, though it is caused frequently by demyelinating disease and cord injury caused by disks and osteophytes. We review some of the more unexpected and subtle causes of thoracic myelopathy. We also discuss the utility of the different imaging modalities in their evaluation.
The cases presented in this review include: spontaneous transdural spinal cord herniations, catheter tip granulomata, thoracic Spetzler type I perimedullary AVF (Please see the 3D MIP obtained during DSA below) and a neurtereric cyst. To present these cases, we will display multimodal images, intraoperative images and illustrative diagrams. The salient clinical features, imaging characteristics and the most appropriate imaging modalities will be evaluated.

RESULTS
Spontaneous transdural spinal cord herniation is a rare but treatable cause of thoracic myelopathy. To adequately evaluate this abnormality, MR imaging is required to assess the location and degree of cord herniation and CT is required to assess associated osseous abnormalities. Similarly, a multimodal approach was found to be effective for each of the additional unusual cases which we present. This strategy allowed complete characterization of the abnormalities and provided the confidence required to proceed to surgery. The imaging findings were confirmed surgically in each case.

CONCLUSION
Thoracic myelopathy has a very broad differential diagnosis. Our exhibit illustrates unexpected and subtle causes of thoracic myelopathy, such as spontaneous transdural spinal cord herniation. It is important for the neuroradiologist to review the pertinent clinical and imaging characteristics of these diseases, and to consider how the various imaging modalities may be used to diagnosis these uncommon causes of thoracic myelopathy.

KEY WORDS: Myelopathy

Scientific Exhibit 82
Spinal Cord Tumors: Current Classification and MR Imaging Features

Petrou, M. · Elias, A. E. · Foerster, B. R. · McKeever, P. E. · Sundgren, P. C.
University of Michigan
Ann Arbor, MI

PURPOSE
Spinal cord tumors are uncommon lesions but can result in significant morbidity. Differential diagnosis for spinal cord tumors is based primarily on location and imaging characteristics, but also the clinical presentation, age, and gender of the patient. This scientific exhibit will focus on the current classification and MR imaging features of the more common intradural extramedullary and intradural intramedullary spine lesions.

MATERIALS & METHODS
In this exhibit we will review the current World Health Organization (WHO) classification and grading system for spinal cord tumors. This classification system is based on the
assumption that tumor type results from the abnormal growth of a specific cell type. We also will provide an approach to differential diagnosis of spinal cord tumors based on age and gender of the patient as well as tumor location. We will discuss MR imaging protocols for the evaluation of spinal cord neoplasms as well as imaging findings in individual tumor types.

RESULTS
A pictorial review of the more common intradural extramedullary and intradural intramedullary spine lesions in both the adult and pediatric populations will be presented. Characteristic imaging findings for each tumor type will be discussed; nonspecific imaging features that can be seen in a number of tumor types also will be pointed out. A differential diagnosis approach using imaging features, patient age and gender as well as tumor location will be provided. The 2000 WHO grading and classification system for spinal cord neoplasms also will be discussed.

CONCLUSION
The viewer of this scientific exhibit will be provided with a pictorial review of imaging findings and an approach to differential diagnosis for the most common spinal cord neoplasms in both the pediatric and adult populations. In addition the appropriate MR imaging protocols and current classifications will be discussed.

KEY WORDS: Spine neoplasms

Scientific Exhibit 83
MR Imaging of Solitary Tumors and Tumor-like Conditions of the Spine
Cerniglia, C. A. · Satti, S. R. · Meyers, S. P.
'University of Rochester Medical Center, Rochester, NY, 2Drexel University College of Medicine, Philadelphia, PA

PURPOSE
To provide an instructional review of the MR imaging features of solitary benign and malignant tumors of the spine.

MATERIALS & METHODS
A variety of benign tumors and lesions can present as a solitary vertebral lesion and include: enostosis, hemangioma, osteoid osteoma, aneurysmal bone cyst, osteoblastoma, giant cell tumor, osteochondroma, and eosinophilic granuloma. Solitary primary and secondary malignant tumors of the spine include: solitary metastasis, plasmacytoma, lymphoma, chordoma, chondrosarcoma, osteosarcoma, and primitive neuroectodermal tumor or Ewing’s sarcoma. A review of the MR features of these common and uncommon solitary spine tumors is presented in correlation with radiographic findings.

RESULTS
Solitary tumors of the spine can be detected as incidental findings on routine MR imaging. Solitary vertebral lesions can occur as secondary tumors (e.g., metastasis, myeloma, and lymphoma) or as less common primary bone tumors. MR imaging often can provide additional useful information in further characterization of these lesions in concert with findings on conventional radiography and CT. MR imaging can demonstrate the extent of the lesions within marrow as well as subtle findings of cortical destruction and extraosseous extension that may not be apparent on conventional radiography. In addition to accurately depicting the extent of extraosseous extension of the vertebral lesions, MR imaging can evaluate the degree of compression of the spinal cord and/or nerve roots when present. Evaluation of the specific MR signal characteristics, gadolinium contrast enhancement features, and locations of these lesions combined with patients’ demographic data might enable the narrowing of differential diagnostic possibilities as well as distinguishing between benign and malignant solitary lesions. A systematic approach to evaluating these lesions can be useful in differential diagnosis, and to direct appropriate clinical management.

CONCLUSION
A review of the MR imaging of solitary tumors of the spine is presented in correlation with radiographic findings. Familiarity with these features can facilitate diagnosis and management of these tumors.

KEY WORDS: MR imaging, tumor, spine

Scientific Exhibit 84
Evaluation of MR Imaging Marrow Abnormalities of the Spine
Menchaca, M. · Meyers, S.
University of Rochester
Rochester, NY

PURPOSE
To review pathologic changes that may alter normal marrow signal on MR imaging.

MATERIALS & METHODS
The MR features of diffuse and focal marrow signal abnormalities involving the spine will be presented. Correlation with patients’ clinical history and treatment will be reviewed.

RESULTS
A myriad of pathologic conditions and medical treatments can abnormally alter marrow signal in a diffuse or multifocal pattern. Because marrow is involved in the production of red blood cells, virtually any hematologic disorder will cause a marrow abnormality. Hematologic disorders can be inherited (sickle cell anemia, thalassemia, and sideroblastic anemia) or secondary to disease. In adults, there may be reconstitution, the change of yellow marrow back to red marrow, due to secondary causes like obesity, smoking, long distance running or living at high altitudes. In addition, treatment for anemia, such as pharmacologic agents (exogenous erythropoietin and macrophage colony stimulating factor) or iron deposition secondary to multiple transfusions for anemia also can produce abnormal marrow. Overproduction of red blood cells seen in polycythemia vera, a myeloproliferative disease also causes abnormal marrow. Inflammatory and infectious conditions also may cause marrow changes. Sarcoid, an inflammatory disease, related to abnormal cellular immune response to antigens affects many organs include bone marrow. In osteomyelitis, depending on the chronicity of dis-
ease, abnormal marrow signal may vary. Paget’s disease changes marrow over its course of marrow infiltration. Initially, fibrovascular tissue replaces normal marrow and later focal areas of fat or regions of sclerosis predominate. Metabolic disorders which can abnormally alter marrow signal can be inherited (primary hemochromatosis, Gaucher disease, Glycogen Storage disease, osteopetrosis). Renal osteodystrophy results in hyperparathyroidism or osteomalacia. Other metabolic disorder such as osteoporosis and malnutrition also produce abnormal marrow. Preneoplastic and neoplastic disorders (myelodysplastic syndromes, multiple myeloma, leukemia, lymphoma, Waldenstrom’s macroglobulinemia, and metastases) invade and infiltrate marrow readily. In addition, radiation treatment in response to neoplasm may cause diffuse marrow abnormalities as well as focal areas of infarct.

**CONCLUSION**
When evaluating MR imaging signal marrow abnormalities of the spine, familiarization with the many causes of marrow signal alteration and their appearance will be useful for the reviewing radiologist and alert the clinician to underlying occult pathologies.

**KEY WORDS:** Marrow

**Scientific Exhibit 85**

**MR Neurography at 3T: Efficacy and Illustration of Imaging Parameters for Peripheral Nerve Imaging**

Stien, E. M. · Maravilla, K. R.

University of Washington Medical Center Seattle, WA

**PURPOSE**
To illustrate protocols and imaging parameters of peripheral nerve evaluation at 3T MR imaging.

**MATERIALS & METHODS**
We assembled a cohort of MR neurograms performed on a Philips 3T MR unit. MR neurograms of the ulnar nerve, peroneal nerve, median nerve, brachial plexus, and sciatic nerve were included. Sequences included fat suppression T2, short tau inversion recovery, and T1 imaging in multiple planes. Intravenous contrast was given in selected cases. The sequence parameters and coil type were recorded for each examination. The images then were evaluated by the authors. Attention was made to imaging parameters, imaging time, image quality, effectiveness of fat saturation, and types of artifacts. Reference was made to established common imaging parameters at 1.5T MR imaging.

**RESULTS**
Imaging parameters at 3T compared to 1.5T are explained and illustrated. Imaging parameter modifications for 3T are suggested. Evaluation of peripheral nerves can be obtained in a timely fashion on 3T, similar to or shorter than needed for imaging at 1.5T. Improved signal-to-noise ratio allows higher SENSE factors and shorter imaging times. Potential pitfalls include increased susceptibility, flow, and motion artifacts. Examples of images and examples of artifacts will be given.

**CONCLUSION**
MR neurogram imaging at 3T can be performed effectively and timely. Knowing image parameters and potential limitations will aid the radiologist in proper peripheral nerve imaging.

**KEY WORDS:** Neurogram, peripheral, nerve

**Scientific Exhibit 86**

**Median Nerve MR Imaging Findings in Carpal Tunnel Syndrome**

Stien, E. M. · Kliot, M. · Comstock, B. · Maravilla, K. R. · Shibata, D. K. · Jarvik, J. G.

University of Washington Medical Center Seattle, WA

**PURPOSE**
To illustrate characteristic MR findings of the median nerve and adjacent structures in patients with carpal tunnel syndrome and correlate these findings with electrodiagnostic studies (EDS) and clinical findings.

**MATERIALS & METHODS**
We prospectively assembled a cohort of 217 patients with a clinical diagnosis of carpal tunnel syndrome confirmed with EDS. Subjects also completed well validated measures of symptoms and functional status including the Carpal Tunnel Syndrome Assessment Questionnaire (CTSAQ). All subjects underwent T1 and either STIR or fat-suppressed T2 axial imaging through the wrist and proximal hand. Assessment categories included: median nerve size, fascicle size, nerve signal, length of abnormal signal, nerve shape, nerve position, and flexor tendon interspace thickening. We used normal muscle signal to determine relative nerve signal. The subjects all underwent median motor conduction velocity testing and we will correlate the imaging findings in the presented cases with the EDS results as well as clinical findings.

**RESULTS**
There is a wide range of median nerve abnormalities observed in patients with carpal tunnel syndrome. Common findings include increased signal within the nerve and abnormal nerve size. We observed both nerve flattening within the carpal tunnel and swelling proximal and distal to the tunnel. We also commonly identified interposition of the nerve between the flexor tendons. Each case will include EDS and clinical findings so that different imaging patterns can be contrasted with clinical variables.

**CONCLUSION**
Abnormal nerve signal, nerve flattening within the carpal tunnel, and nerve swelling outside of the tunnel are all found commonly in patients with carpal tunnel syndrome. In patients with equivocal EDS or clinical examination, these MR findings could be useful for supporting the diagnosis and directing patients to surgical therapy when appropriate.

**KEY WORDS:** Neuropathy, carpal, median

*The study is funded by the National Institute of Arthritis and Musculoskeletal Skin Disease (NIAMS) (P60 AR48093). Institutional IRB approval was obtained.*
Scientific Exhibit 87

Technique and Clinical Applications of Pudendal Nerve Block

Kathuria, S. · Westesson, P. · Edward, L. · Malhotra, A.
University of Rochester Medical Center
Rochester, NY

PURPOSE
To know the technique and clinical application of pudendal nerve block using illustrations from cases done at our institute.

MATERIALS & METHODS
Pudendal nerve entrapment is a pain condition for no apparent reason in the lower central pelvic areas. This usually is precipitated by prolonged sitting or trauma to the sitting area, combined with a genetic and developmental susceptibility. Pudendal nerve entrapment frequently can be misdiagnosed as prostatodynia, nonbacterial prostatitis, idiopathic vulvodynia, idiopathic orchialgia, idiopathic proctalgia, and idiopathic penile pain syndrome. Image-guided pudendal nerve block is the most important diagnostic test following history and physical examination for patients with suspected pudendal neuralgia. We present the proper technique of pudendal nerve block and its clinical application based on our experience of various cases done at our institute that were referred to us with clinical suspicion of pudendal neuralgia from wide geographic areas. We followed the protocol of three sequential CT image-guided nerve blocks, first with local anesthetics at ischial spine, followed by local anesthetic at the level of alcock's canal and later possibly combined with corticosteroids.

RESULTS
Pudendal nerve can be identified easily in all cases using cross-sectional CT image and pudendal nerve block can be obtained successfully under CT guidance. Pudendal nerve block is a relatively quick and useful procedure that can be done safely under CT guidance. The nerve anatomy and procedure steps will be illustrated in the final presentation.

CONCLUSION
Pudendal nerve block, along with clinical and physical examination, is an important and effective tool in the diagnosis of pudendal nerve entrapment. The procedure requires the knowledge of cross-sectional nerve anatomy and can be performed safely under CT guidance.

KEY WORDS: Pudendal nerve block
Electronic Scientific Exhibits (eSE) 1–45
Riverside Center East

Monday, June 11
12:00 PM – 9:00 PM

Tuesday, June 12 – Wednesday, June 13
6:30 AM – 9:00 PM

Thursday, June 14
6:30 AM – 6:00 PM

Note: A missing Electronic Scientific Exhibit number indicates an abstract has been withdrawn.

Electronic Scientific Exhibit 1
Pitfalls of CT Angiography in the Evaluation of Neurovascular Disease
Ansari, S. A. · Parmar, H. · Ibrahim, M. · Mukherji, S. K. · Gandhi, D.
University of Michigan Health System
Ann Arbor, MI

Purpose
CT angiography has evolved continuously in the last two decades, especially after the advent of multidetector CT, as a first line screening modality for many neurovascular disorders. The potential uses include detection and characterization of unruptured/ruptured aneurysms, arterial venous malformations/fistulas (AVM/AVF), carotid atherosclerotic disease, and traumatic/spontaneous carotid dissections. Several series have demonstrated the diagnostic sensitivity and specificity of CTA approaching nearly 90-95%. While CTA is useful as an initial screening modality, it is also important to understand its limitations. We demonstrate several pitfalls of CTA technique where adjunct use of cerebral angiography helped change the clinical management.

Materials & Methods
Our exhibit serves as a case-based teaching tool to demonstrate the potential pitfalls of CTA in diagnosing subtle neurovascular disease processes. The representative cases are obtained from a prospective neurovascular database and author’s teaching files. CT angiography findings are correlated with subsequent digital subtraction angiography (DSA) findings and, where available, operative findings.

Results
CT angiography may be suboptimal in detecting small aneurysms (< 3 mm), micro-AVMs, pial AVFs, web-like vessel stenosis, and dissection flaps, especially if intimal flaps project into the axial plane. Among the examples shown in this exhibit, we demonstrate missed cases of small ruptured/unruptured aneurysms, dural/pial AVF, small AVM, dissections and dissecting aneurysms. Correlative planar and 3D rotational DSA and in some cases operative findings more accurately diagnose these subtle vascular lesions.

Conclusion
We describe several pitfalls of CTA in diagnosing subtle neurovascular disease. In our opinion, CTA findings must be interpreted in the overall clinical context. Negative CTA findings in a setting of subarachnoid hemorrhage or intraparenchymal hemorrhage, that is not clearly attributed to hypertension, can not be relied upon to exclude underlying vascular lesions. In such settings, strong consideration should be given to further evaluation with cerebral angiography.

Key Words: CTA

Electronic Scientific Exhibit 2
Dynamic Susceptibility-weighted Contrast-enhanced Perfusion MR Imaging in Neurooncologic Imaging
Malhotra, A. · Mangla, R. · Ekholm, S. · Westesson, P.
University of Rochester Medical Center
Rochester, NY

Purpose
Dynamic susceptibility-weighted contrast-enhanced (DSC) MR imaging is a robust and most widely used technique among various methods of perfusion imaging. It plays a pivotal role in the transition from a purely morphology-based discipline to one that combines anatomy with physiology. When used in the study of mass lesions of the brain, it helps to distinguish between tumor and tumor mimicking lesions. It helps in the differentiation and categorization of tumor grade. The DSC MR imaging depicts regional variations in microvasculature, thus distinguishing between normal and diseased brain tissue without obvious abnormality on routine MR sequences. This exhibit briefly describes the physical basics of DSC MR imaging and summarizes its present clinical use in the evaluation of brain tumors.
Electronic Scientific Exhibit 3

Dynamic Contrast-enhanced MR Angiography for Intracranial, Neck and Intraspinal Vascular Abnormalities Using 4D-TRAK

Parmar, H. · Gandhi, D. · Dudek, N. · Ivancevic, M. · Chenevert, T. · Mukherji, S.

University of Michigan
Ann Arbor, MI

PURPOSE
MR angiography (MRA) has widely gained clinical acceptance for evaluation of arterial and venous anatomy in the head, neck, and spine. Flow sensitive sequences predominantly used in the past (2D/3D MRA and phase contrast) are being replaced widely with gadolinium contrast-enhanced technique (CE-MRA). Until recently, MRA was performed as a static 3D scan. Limitations of this method include lack of dynamic information and occasionally mistimed bolus with resultant suboptimal vessel signal or venous contamination. In this pilot project, we present the use of 3D CEN-TRA, keyhole and SENSE (4D-TRAK) for time-resolved MRA for evaluation of various vascular abnormalities in the head, neck, and spine region.

MATERIALS & METHODS
Organizational structure - Description of technique, pictorial imaging findings with illustration in application of DSC in brain tumors and other neuropathologic conditions which mimic tumors with pathologic correlation. A) Imaging technique - The first-pass of a contrast bolus in brain tissue is monitored by a series of T2*-weighted MR acquisitions. The susceptibility effect of the paramagnetic contrast agent leads to a signal loss that can be converted, using the principles of the indicator dilution theory, into a contrast agent concentration curve. The area under the curve for each voxel is mathematically integrated, similar to standard tracer experiments used to calculate CBV. Creating CBF maps involves an additional arterial input function and MTT maps are then created by dividing CBV/CBF. The blood-brain barrier permeability maps also are created using the initial data. B) Imaging findings - This exhibit will discuss the role of perfusion in 1) Grading of gliomas, 2) Differentiation between tumor and tumor mimicking brain lesions, 3) Distinguishing between tumor recurrence, radiation necrosis, and peritumoral edema.

CONCLUSION
Dynamic susceptibility-weighted contrast-enhanced MR imaging is 1) Useful in the preoperative workup of various neoplasms, as well as in the differentiation of neoplastic lesions from infections and other tumor-like conditions, 2) A tool to measure tumor angiogenesis and capillary permeability, which are important biological markers of malignancy grade and prognosis, particularly in gliomas, 3) Helpful in determining regions of active tumor growth, used as the target of stereotactic biopsy, 4) Useful tool to detect residual tumor, treatment response, and therapy-related complications such as radiation necrosis.

KEY WORDS: Perfusion MR imaging, brain neoplasm

Electronic Scientific Exhibit 4

Neuroradiologic Findings of Histiocytic Disorders: Imaging Features of Langerhans Cell Histiocytosis and Non-Langerhans Cell Histiocytosis

Ozturk, A. · Uzuner, O. · Aygun, N.

Johns Hopkins Hospital
Baltimore, MD

PURPOSE
Histiocytoses are systemic proliferative disorders that encompass a wide variety of clinical, radiologic, and histopathologic entities. On the basis of the lineage of proliferating cells, they are divided into three main groups: 1) Langerhans cell histiocytosis (LCH) 2) non-Langerhans cell
histiocytosis (non-LCH), and 3) malignant histiocytosis. The purpose of this exhibit is to present the spectrum of neuroradiologic manifestations of LCH and non-LCH.

**Materials & Methods**
We retrospectively reviewed MR images of 13 patients who had a pathologic diagnosis of a form of histiocytic disorder. All the patients had neurologic manifestations. Pathologic diagnoses consisted of LCH in six and non-LCH including Erdheim-Chester disease in two, and Rosai-Dorfman disease in three patients. Hemophagocytic lymphohistiocytosis and dendritic cell histiocytoma were the other entities encountered.

**Results**
The study group consisted of five female and eight male patients. The median age at the presentation was 22 years ranging from 3 months to 52 years. Osseous lesions in the craniofacial bones or spine in 4 (67%), intraaxial white matter lesions in 3 (50%), pituitary involvement in 1 (17%), cerebellar signal changes in 1 (17%) patient were noted in the LCH group. Multiple meningeal masses, parotid gland involvement, and dural thickening were observed in Rosai-Dorfman patients. One of the Erdheim-Chester patients had spine and neck masses and the other had brain stem and cerebellar lesions with abnormal bone marrow signal. The patient with hemophagocytic lymphohistiocytosis had innumerable enhancing lesions throughout the brain, a few of which demonstrated restricted diffusion.

**Conclusion**
The histiocytic disorders are rare and diverse. Their diagnosis presents many challenges to clinicians and radiologists alike. Familiarity with the neuroradiologic manifestations of these entities is important in reaching a prompt diagnosis.

**Key Words:** Langerhans cell histiocytosis, non-Langerhans cell histiocytosis, MR imaging

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**Electronic Scientific Exhibit 5**

**White Matter Navigator: An Interactive Tutorial of Acquired White Matter Disease Based on Pattern of Lesion Distribution**

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**Purpose**
To create an interactive computer exhibit to aid in the diagnosis of acquired white matter disease based on pattern of lesion distribution.

**Materials & Methods**
We will build a FLASH-based computer desktop reference and teaching tool which allows the user to navigate quickly and easily between menus, disease entities, and unknown quiz cases and answers.

**Results**
White matter disease encompasses a large and disparate group of pathologies. The conditions that involve white matter traditionally have been categorized using two basic classifications: a) primary versus secondary and b) based on etiology. We will categorize these lesions based on five common imaging patterns encountered in clinical practice: 1) multiple punctuate lesions or unidentified bright objects (UBOs), 2) patchy lesions, 3) global or diffuse lesions, 4) white matter with basal ganglia abnormality, and 5) other region specific. Clinical scenarios, imaging appearances, differential diagnoses and examples of diffusion-weighted imaging, MR spectroscopy, and PET imaging are presented in a computer interactive format. The exhibit is designed to allow navigation between pattern-type menus, representative disease entities, and several “unknown cases”. This format also helps to illustrate the fact that many of these disease entities have more than one imaging appearance. We devised this interactive exhibit to aid in the diagnosis of these lesions in daily practice and for teaching purposes.

**Conclusion**
Computer exhibits done in an interactive format allow the user to quickly learn and review acquired white matter diseases of the brain. The exhibit can serve as a desktop reference for daily practice or as a desktop tutorial.

**Key Words:** White matter, FLASH, patterns

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**Electronic Scientific Exhibit 6**

**Abnormal Signal Intensity Seen in the Cerebrospinal Fluid Space on Fluid-Attenuated Inversion Recovery MR Images: Differential Diagnosis**

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**Purpose**
To review cases with hyperintense T2 signal in the cerebrospinal fluid (CSF) space on fluid-attenuated inversion recovery (FLAIR) and to provide a comprehensive differential diagnosis.

**Materials & Methods**
A retrospective review of cases with abnormal high signal intensity in CSF spaces on FLAIR images at our institution was performed. Selected cases are presented to demonstrate the spectrum of different causes of abnormal high signal in the CSF spaces on the FLAIR.

**Results**
There are different causes of CSF signal abnormality on FLAIR. These can be divided into three major categories: physiologic, pathologic, and artifact. Physiologic causes of FLAIR signal abnormality includes increased forced inspiratory oxygen concentration (FiO2). Pathologic causes can be subdivided further into: subarachnoid hemorrhage, neoplastic process such as leptomeningeal carcinomatosis, infectious/inflammatory process, and vascular causes like angi-
Radiologic Spectrum of Intraventricular Lesions: Age and Location-based Approach

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Purpose
1) This exhibit classifies, describes, and illustrates the CT, MR imaging (MRI) appearance of various intraventricular lesions. 2) Diagnostic pitfalls and aids to differential diagnosis are highlighted.

Materials & Methods
We retrospectively reviewed the imaging studies (CT and MRI) on 153 patients with intraventricular lesions. The diagnostic images (CT, 3DCT, MRI, MRA, CT A, and DSA) of these patients with intraventricular lesions serve the basis of this exhibit.

Results
Intraventricular lesions frequently are identified on cross-sectional imaging in day to day practice. Tumors were the most common lesions identified and their closest diagnosis was reached using the two major criteria — location and age. Less common lesions such as intraventricular cysticercosis, arachnoid cyst, vascular lesions like vascular malformations, and aneurysms also were identified which causes the diagnostic challenge to a neuroradiologist.

Conclusion
In this exhibit we give an algorithmic approach to the various intraventricular lesions at different locations within the ventricular system with respect to age of the patient. We also illustrate the typical and atypical imaging features of tumoral and nontumoral lesions along with diagnostic “pearls” to their diagnosis.

Key Words: Intraventricular lesions, MR imaging, CT

Electronic Scientific Exhibit 8

Brain Hyperperfusion: A Distinct Dynamic Perfusion Imaging Finding Noted in Various Clinical Conditions

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Purpose
Dynamic perfusion CT and MR imaging play an increasingly common role in the evaluation of central nervous system (CNS) ischemia. The most common clinically relevant finding in this setting is reduced (hypo-) perfusion of ischemic tissue and most literature thus far has focused on this application (1). Increased (hyper-) perfusion is a less common finding, but has been described in various case reports including hemiplegic migraine, status epilepticus, hypertensive encephalopathy, postthrombolysis, postcarotid endarterectomy hyperperfusion syndrome and eclampsia (2-4). Central nervous system hyperperfusion observed on dynamic perfusion series should prompt review of specific differential diagnostic considerations.

Materials & Methods
Over the past 3 years, we encountered 15 clinical cases demonstrating CNS hyperperfusion (colocalized increase in cerebral blood volume or flow and shortened mean transit time). This exhibit reviews key hyperperfusion imaging findings related to various etiologies including: posthemiplegic migraine, mitochondrial encephalopathy, herpes simplex encephalitis, postictal state, subacute ischemia, posthypertensive diet, cocaine-induced stroke and postischemic hyperperfusion.

Results
The finding of CNS hyperperfusion represents a common link between the otherwise distinct cases reviewed in this exhibit. The common mechanism underlying CNS hyperperfusion in these cases is not clear but likely relates to neurovascular uncoupling of diverse causes. “Pseudo” hyper-(or hypo-) perfusion also may be seen in the setting of variant vascular anatomy, such as fetal origin of posterior cerebral artery.

Conclusion
Perfusion imaging is being used to triage and follow patients beyond traditional applications in acute ischemia. Complex new patterns of abnormal perfusion are being identified and need to be better understood. Observation of hyperperfusion should prompt consideration of various infectious, metabolic, and ischemic entities leading to loss of autoregulation.

References


**KEY WORDS:** Perfusion imaging, hyperperfusion

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**Electronic Scientific Exhibit 9**

**Cystic Lesions of the Posterior Fossa: A Pictorial Review**

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**PURPOSE**
1) Describe the main clinical and cross-sectional imaging features of the posterior fossa cystic lesions. 2) List the differential diagnosis of the posterior fossa cystic lesions. 3) Discuss the features that allow differentiation between the various posterior fossa cystic lesions.

**MATERIALS & METHODS**
We retrospectively analyzed 240 cases of cystic lesions of the posterior fossa (PF) from our institution, which formed the basis of this exhibit. Relevant images were identified to illustrate the wide variety of the spectrum of cystic lesions in the posterior fossa. Benefits of the MR and CT scans will be emphasized in classifying and diagnosing congenital and various acquired lesions.

**RESULTS**
Cystic lesions in the posterior fossa frequently are encountered in both pediatric and adult age group. They could be either congenital or acquired. For the purpose of this exhibit and better understanding of these lesions we classified these lesions into 5 categories: 1) Cystic congenital malformations: Dandy Walker cyst/variants, mega cisterna magna, arachnoid cyst, 2) Infective: cysticercosis, abscess and hydatid cyst. 3) Cystic neoplasm: intraaxial (hemangioblastoma, pilocytic astrocytoma, cystic metastasis) or extraaxial (cystic neurofibroma, meningioma), 4) Intraventricular: arachnoid cyst, cysticercosis, and 5) Msc: posttraumatic/hemorrhagic cyst.

**CONCLUSION**
This pictorial review illustrates the common and uncommon cystic lesions of the posterior fossa and highlights the salient differentiating points from one another. It also lends a clear understanding of the various congenital cystic lesions.

**KEY WORDS:** Congenital cystic lesions, noncongenital cystic lesions

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**Electronic Scientific Exhibit 10**

**Radiology of the Fifth Nerve**

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**PURPOSE**
1) To learn the normal anatomy of the fifth nerve, its branches on the cross-sectional imaging. 2) Illustrate the imaging appearance of wide spectrum of pathologies primarily or secondarily involving the nerve and its branches. 3) Discuss the differential diagnosis based on the segmental involvement of the nerve.

**MATERIALS & METHODS**
CT and MR scans performed for the patients with signs and symptoms of fifth nerve in our institution were reviewed retrospectively. Various cases and selective images were selected which demonstrates the common and uncommon pathologies involving the five segments of the fifth nerve namely: a) nucleus, b) cisternal segment, c) ganglionic, d) cavernous segment, and e) peripheral divisions.

**RESULTS**
Fifth nerve is the largest cranial nerve and is best imaged with MR. Imaging is further enhanced by newer sequences and gadolinium enhanced scans. In this exhibit we review the normal anatomy and pathology of the fifth nerve and its branches. Pathologies are classified as per the segmental involvement: a) Nucleus: infarct, demyelination, tumors, cord pathologies, b) Cisternal segment: vascular compression, meningitis, sarcoidosis, local tumors, c) Ganglionic: meningioma, metastasis, d) Cavernous segment: tumors, aneurysm, Tolosa Hunt syndrome, and e) Peripheral divisions.

**CONCLUSION**
This exhibit will be a core learning tool for the fifth nerve anatomy and pathology. It also highlights the importance of newer 3D sequences in imaging of fifth nerve. We illustrate the pattern of perineural spread and the various pathologies involving the base of the skull and the apertures of ophthalmic (V1), maxillary (V2), and mandibular (V3) divisions of the fifth nerve.

**KEY WORDS:** Fifth nerve, MR imaging, CT
Electronic Scientific Exhibit 11

Semiautomated Quantitative Software Tool for Atlas-based Volumetric Lobar Brain Analysis Made Easy for Neuroradiologists

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PURPOSE
Quantitative lobar volumetric analysis may be useful in many disease processes with focal brain involvement such as Mesial temporal sclerosis, Alzheimer disease, Rasmussen’s encephalitis, Sturge-Weber syndrome (SWS) or global changes (normal aging) for early detection and quantification of preferential anatomical alteration. In SWS, identification of focal involvement may provide an objective correlate for severity of disease in a particular neuropsychological domain and assist decision of surgical intervention such as hemispherectomy or lobectomy. There are many efficient ways to subsegment regions of the brain. We present a simplified version of semiautomated and interactive software tool for a Talairach atlas-based brain lobar volumetric analysis and its application in SWS.

MATERIALS & METHODS
Lobar volumetric segmentation was performed using an example of a SWS patient. High-resolution (0.9 mm) 3D MPRAGE images were used. We describe the steps in a simplified manner. The complete process is integrated as a set of plug-ins for medical image processing, analysis, and visualization (MIPAV), a user-friendly and powerful medical image analysis software package. The software can be used in an automated fashion/interactive mode/manual method. 1) First, the skull and extracerebral tissues are removed with a fast semiautomated technique. 2) The image of the extracted brain is further segmented into gray matter (GM), white matter (WM), and cerebrospinal fluid using an automated fuzzy segmentation technique. 3) The brain image is transformed into Talairach coordinate system using computed software (AC-PC and boundaries of cerebrum). 4) Load the labels for the volume of interest (VOI) on the Talairach image (our labels are generated from the Talairach Daemon database). 5) Transform the labels from Talairach to original space. 6) The transformed labels are copied onto the segmented image obtained in step 2. 7) Finally the volume of GM/WM inside the labels of interest are computed.

RESULTS
There was good interrater reliability in using this software protocol using a combination of the semiautomated and interactive method. The semiautomated method was less reliable when the source images were not acquired in the perfect axial plane. In these cases it became necessary to have greater interactive modification by the user. The whole process for one patient took about 35 minutes after some experience with the program.

CONCLUSION
We describe a flexible set of tools that employs well studied techniques based on the Talairach atlas for performing volumetric analysis on anatomical brain MR imaging using a combination of semiautomated and manual techniques.

KEY WORDS: Quantitative lobar volume analysis, Talairach atlas, MIPAV

Electronic Scientific Exhibit 12

Beyond Black and White: Assessment of Noncontrast CT Imaging in Hyperacute Stroke with a Color Overlay

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PURPOSE
1) To assess the use of a nonlinear color overlay to improve detection of hyperacute stroke using noncontrast CT. 2) To provide an interactive exhibit whereby viewers can test themselves in early stroke detection using grayscale and color CT displays.

MATERIALS & METHODS
Noncontrast CT was performed in 18 patients with hyperacute (< 6 hours) stroke and eight control patients. All patients were imaged for suspicion of ischemia and had either diffusion-weighted imaging (DWI) or follow-up CT to confirm diagnosis and stroke location. All positive cases had subtle findings and only 40% of these strokes were recognized in the initial report. A neuroradiologist and radiology resident blinded to the clinical presentation independently assessed scans for presence and location of parenchymal changes of acute stroke, as well as for presence of a dense vessel sign. A crossover design was used; half of the studies were viewed in grayscale and the other half with a preselected color overlay during each viewing session. All images were reviewed with software designed to apply a custom color lookup table to grayscale images with variable overlay brightness and
adjustable window/level settings. Images were reviewed with either grayscale only (including standard window/level of 80/40 and stroke window of 8/32) or with combination of grayscale and color.

RESULTS
The radiology resident spent an average time of 3.4 and 2.5 minutes reviewing cases with grayscale and with color, respectively. The neuroradiologist spent average 4.1 and 4.2 minutes per case. The resident had accuracy (percent true positives plus true negatives) of 38% with grayscale and 54% with addition of color. The attending was accurate in diagnosis of 62% of cases with no difference between grayscale and color. Since tPA can be used to treat ischemic stroke within a limited time after symptom onset, detection of subtle, early parenchymal changes is critical. Although neuroradiologists are cognizant of the markers of early infarcts on noncontrast CT, often, the physicians initially reviewing studies and making decisions regarding patient management include less experienced radiology residents and nonradiologists. Perception of low contrast targets can be improved with color and therefore application of a color overlay in addition to use of narrow grayscale stroke windows may improve lesion detection.

CONCLUSION
Application of a color algorithm may improve detection of acute stroke with noncontrast CT. This interactive exhibit both demonstrates the use of this color algorithm and provides training in signs of acute stroke using both grayscale and color display.

KEY WORDS: Color, acute stroke, nonenhanced CT

Electronic Scientific Exhibit 13
Dynamic Susceptibility Contrast MR Analysis Software for Evaluation of Perfusion Parameters in Patients with Brain Tumors

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PURPOSE
One barrier to the validation of dynamic susceptibility (DSC) MR imaging (MRI) techniques is the lack of widely available reference methods to analyze the images. In the absence of comparable acquisition and analysis methods, it is difficult to directly compare quantitative results obtained in different laboratories. As a first step toward providing a reference analysis method, particularly for the application of DSC MRI to brain tumors, we developed the DSCoMAN software package.

MATERIALS & METHODS
DSCoMAN software was developed as Java-language plugins to ImageJ (http://rsb.info.nih.gov/ij/, Wayne Rasband, NIMH), an open source image processing tool. The plugins are available for free download at http://dblab.duhs.duke.edu. The Boxerman-Weisskoff (1) analysis technique was implemented to produce cerebral blood volume maps corrected for gadolinium permeability, and K2 maps to measure leakage rate. Other parameter maps such as time to peak and estimates of relative mean transit time and cerebral blood flow can be produced from raw delta R2 images. The reproducibility of parameter maps was tested on Windows, Mac, and Linux platforms using DSC MRI data from patients with brain tumors obtained on either GE (Milwaukee, WI) or Siemens (Iselin, NJ) MR scanners.

RESULTS
DSCoMAN software produced identical parameter maps on Windows, Mac, and Linux platforms. The processing time varied depending on the analysis scheme and the hardware used for testing, but was acceptable. Parameter maps could be generated through a graphic user interface or via macro scripts.

CONCLUSION
DSCoMAN software creates parameter maps with acceptable speed that were reproducible across all major operating systems. This represents an early effort toward providing standardized analysis techniques for DSC MRI.

REFERENCES

KEY WORDS: Brain tumors, dynamic susceptibility contrast imaging, software
Correlation between Perfusion-weighted MR Imaging, Gadolinium Enhancement, and MR Spectroscopy in the Study of Brain Tumors: A Preliminary Study

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PURPOSE
In the MR study of brain tumors gadolinium (Gd) enhancement is used to detect blood-brain barrier breakdown and perfusion-weighted imaging (PWI) is implemented to study the tumor vascular properties. In addition, MR spectroscopy (MRS) enables to estimate cellular proliferation and neuronal tissue destruction by quantifying choline (Cho) and N-acetylaspartate (NAA) signals, respectively. The aim of this study was to determine how blood-brain barrier and vascular properties are related to metabolite changes found in brain tumors.

MATERIALS & METHODS
A total of 12 patients with untreated brain tumors were examined with a 1.5T magnet. After the MR examination all patients underwent brain surgery and the tumor type was confirmed by histopathology to be: 7 glioblastomas, 2 metastases, 1 astrocytoma, 1 ependymoma, 1 adult primitive neuroectodermal tumor. MR examination included axial T1-weighted spin-echo (SE) images (echo time (TE)/repetition time (TR) = 9 ms/500 ms) acquired before and after Gd injection. Before Gd injection a 2D MRS imaging acquisition also was performed, placed on an axial slice including a representative area of the solid part of the tumor. A 2D PRESS sequence was used with TE/TR = 135/1500 ms and the slice thickness was 10 mm, leading to an individual voxel size of 2.25 mm³. During Gd injection perfusion-weighted axial gradient-echo echo-planar images (GRE-EPI) were acquired (TE/TR = 34.7/2000 ms; flip angle=30°).

RESULTS
After off-line processing and quantification of the spectra the metabolic ratios Naa/Cr and Cho/Cr were calculated for each patient for a number of voxels placed on different tumor locations. Subsequently, relative negative enhancement integral and T1 enhancement maps were elaborated. On these maps we tried to reproduce the locations studied by MRS in order to determine a value of relative cerebral blood volume and T1 enhancement for each voxel. A Pearson correlation was applied in order to detect statistical significant correlations between both perfusion and Gd enhancement parameters with metabolic ratios.

CONCLUSION
In our preliminary study we found a significant correlation between Gd enhancement and Cho/Cr ratio (r = 0.81), but no correlation with the Naa/Cr ratio or between rCBV and metabolic ratios was found.

KEY WORDS: Perfusion-weighted MR imaging, MR spectroscopy, brain tumor
appearances of evolving cysts, their distribution in the central nervous system and muscles and their appearances on ultrasound, CT, and MR imaging. We also review the diagnostic criteria and differential diagnosis.

RESULTS
The cyst evolves through various stages during its life cycle viz; the vesicular stage, colloid vesicular stage, the granular nodular stage, and the nodular calcified stage, all of which have different appearances on imaging. Calcified cysts often exhibit edema and may show a faint rim of enhancement when associated with seizures. The parasites most frequently lodge in the brain parenchyma but also may be seen in the ventricles, subarachnoid space, skeletal muscles, eye, spinal cord, parotid glands, and subcutaneous fat. Miliary cysticercosis refers to numerous lesions scattered in the nervous system and muscles which can surprisingly go unrecognized.

CONCLUSION
Neurocysticercosis infection can manifest in several different ways and could be a trap for the unwary. It can often mimic sinister pathology and an understanding of the imaging features is crucial to avoid invasive biopsies. This exhibit reinforces our understanding of the imaging appearances of various stages of neurocysticercosis. We describe the distribution, natural history, and imaging evolution of the lesions with respect to the life cycle of the parasite.

KEY WORDS: Neurocysticercosis, MR imaging, cysticercus

Electronic Scientific Exhibit 17
Evolution of Imaging Findings in the Response to Treatment of Central Nervous System Tuberculosis in HIV/AIDS, Including Paradoxical Worsening: A Pictorial Review
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PURPOSE
To demonstrate the broad range of intracranial and spinal findings in response to treatment of tuberculosis (TB) in HIV/AIDS patients. The short-term, paradoxical, worsening of the radiologic appearances which may occur during therapy will be illustrated in order to emphasize that paradoxical worsening should be expected and should not be taken to mean that the diagnosis is wrong or the treatment inappropriate.

MATERIALS & METHODS
Cases were selected from a database of 1400 HIV/AIDS patients with a presentation diagnosis of central nervous system (CNS) tuberculosis. Examples of paradoxical worsening, subsequent stabilization and resolution (particularly in response to steroids) are given. The role of the immune reconstitution inflammatory syndrome (IRIS) in modifying the imaging response to treatment will be discussed.

RESULTS
A period of radiologic deterioration may occur following antituberculosis treatment in spite of clinical improvement. This usually is followed by a period of radiologic stabilization and ultimate healing. These findings should be seen as part of the normal progression of CNS TB and its response to treatment. Physicians should understand that they are witnessing a recognized neuroradiologic phenomenon. Otherwise, clinicians may attribute these findings to a failure of therapy and believe that an alternative pathology or drug-resistance is responsible. Clinical response, including laboratory and biochemical markers, is more reliable than imaging in the early posttreatment phase. The phenomenon is more prevalent in patients with low CD4 counts who are on highly active antiretroviral therapy (HAART). It is believed to be due to the IRIS which is an adverse consequence of the restoration of pathogen-specific immune responses during the initial months of HAART and usually responds to steroids.

CONCLUSION
There is an interesting spectrum of radiologic findings in response to the treatment of CNS TB including paradoxical worsening.

KEY WORDS: Tuberculosis, HIV/AIDS, treatment

Electronic Scientific Exhibit 18
Radiology of Dementia
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PURPOSE
Dementia is truly a devastating disease that robs patients of their personalities and their ability to interact. It could be either progressive irreversible or reversible (treatable) types. This exhibit will review various causes and imaging appearances of both types of dementia and highlight the salient differentiating points between the various causes of dementia.

MATERIALS & METHODS
We retrospectively reviewed the imaging studies (CT and MR) of 510 patients with clinically suspected cases of dementia. For the purpose of this exhibit we classified them into irreversible and reversible types. Irreversible types were further classified depending on primary site of involvement: 1) Cerebral cortex - Alzheimer and Pick’s disease, frontal lobe degeneration. 2) White matter - multiinfarct dementia, subcortical vascular dementia, cerebral amyloid angiopathy. 3) Gray matter - Huntington’s disease, Wilson’s disease, Hallervorden-Sparcht, CJD. 4) Substantia nigra - Parkinson’s disease, striatonigral degeneration, cerebellar cortical degeneration, progressive supranuclear palsy. 5) Cerebellum and brain stem - olivopontocerebellar degeneration, cerebellar cortical degeneration. Reversible were classified depending on the cause: 1) Cerebrovascular disease, 2) Psychiatric disorder, 3) NPH, 4) Infection, 5) Metabolic/endocrinal, 6) Tumors, 7) Trauma, 8) Alcohol related, 9) Toxic causes.
RESULTS
Radiology plays a very important role in differentiating the two types and also helps in classifying the irreversible type, so that the specific pharmacotherapy can be administered for better management.

CONCLUSION
1) Learn radiologic appearances of reversible and irreversible causes of dementia. 2) To highlight the salient differentiating points between the various causes of dementia. 3) Algorithmic approach for the diagnosis of dementia is presented.

KEY WORDS: Dementia, MR imaging

Electronic Scientific Exhibit 19
Reducing the Gray Zone: Imaging Spectrum of Hypoperfusion and Hypoxic Brain Injury in Adults
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PURPOSE
1) To illustrate the multimodality imaging manifestations of hypoperfusion and hypoxic brain injury in adults. 2) Provide imaging-pathologic correlation in cases of hypoperfusion and hypoxic brain injury. 3) To discuss the differential diagnosis of the focal and generalized patterns of brain hypoperfusion and hypoxic brain injury.

MATERIALS & METHODS

RESULTS
Imaging findings can be subtle or marked depending on type of injury and time from injury to imaging. Recognition of the pattern of brain injury can be helpful in differentiating etiologies in some cases. Differential diagnosis includes encephalitis, ischemia, prion disease, metabolic/toxic disorders, and excitotoxic brain injury.

CONCLUSION
Accurate recognition of the imaging findings in hypoperfusion and hypoxic injury in adults is important for accurate therapy and family-patient counseling.

KEY WORDS: Brain, hypoperfusion, hypoxia

Electronic Scientific Exhibit 20
Multimodality Imaging of Stroke and Stroke Mimics: A Teaching File Approach
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PURPOSE
Imaging of the patient with acute stroke-like symptoms is becoming increasingly important, not only to rule out hemorrhage or other causes of the patients' symptoms, but also to potentially guide treatment. The purpose of this exhibit is to review the imaging of patients with stroke or its mimics using multiple case examples with a variety of imaging techniques. This exhibit will cover the following aspects of stroke imaging: 1) Imaging findings of acute stroke on CT and MR exams. 2) The use and interpretation of CTA and MRA in the acute stroke setting. 3) The use and interpretation of CT perfusion and MR perfusion in the acute stroke setting. 4) Abnormalities and imaging findings that can mimic acute stroke, clinically and radiologically, and how to differentiate them.

MATERIALS & METHODS
Using a case-based, interactive, teaching file approach, the imaging findings of stroke and its mimics will be reviewed. This will include, where appropriate, a discussion of pathophysiology and imaging techniques.

RESULTS
This computer-based exhibit provides an ideal means for the review of stroke imaging and its mimics using an interactive format that will allow active participation of the learner.

CONCLUSION
The viewer of this exhibit will be provided with an interactive overview of imaging in patients presenting with acute stroke-like symptoms.

KEY WORDS: Stroke, cerebral ischemia, cerebrovascular accident

Electronic Scientific Exhibit 21
Controversies of the MR-based Diffusion-perfusion Mismatch Concept for Selecting Acute Stroke Patients for Thrombolytic Therapy
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PURPOSE
Thrombolytic therapy in acute ischemic stroke patients requires an adequate selection strategy. This selection can be based on the MR-based diffusion-perfusion mismatch (DPM) concept, which indicates the presence or absence of potentially salvageable ischemic brain tissue. The purpose of this exhibit is to present a critical overview of the use of
DPM for selecting patients for thrombolytic therapy and to suggest novel approaches to identify salvageable ischemic tissue in these patients.

**Materials & Methods**

The advantages and drawbacks of the DPM concept are analyzed on the basis of a literature review and on our experience with multimodal MR imaging in more than 250 patients who were candidates for thrombolytic therapy.

**Results**

Diffusion-weighted imaging (DWI) is a sensitive and accurate technique for showing the presence and extension of ischemic tissue. Thus, it is useful for selecting patients for thrombolytic therapy and assessing the effect of recanalization on progression of the infarcted tissue. Not infrequently, however, the initial diffusion-weighted signal abnormality partially or almost completely reverses when recanalization is achieved rapidly, indicating that this diffusion-weighted signal change contains, but is not equivalent to, the ischemic core. Moreover, not all diffusion-weighted signal abnormalities in the setting of an acute neurologic event correspond to an ischemic stroke. Similar changes have been identified in patients with seizures, hypoglycemia, and encephalitis. In clinical decision-making and clinical trial enrollment, PWI sequences are considered mandatory for proper selection of ischemic stroke patients who may benefit from thrombolytic therapy. However, PWI is a complex, time-consuming, and not well standardized technique, which limits the use of MR imaging for this purpose. In fact, the most common hemodynamic map used in these patients, the time-to-peak map, usually overestimates the area of ischemic penumbra, as it also includes areas of ischemic oligemia, which has a very low risk of infarction even in the absence of reperfusion. This overestimation is even greater when there is proximal internal carotid artery stenosis, a fact that usually is not contemplated when evaluating the extension of the DPM. Moreover, the visual estimate of DPM is not reliable among observers and should be used with caution as the deciding factor in treatment. Mainly because of the drawbacks of PWI, it seems necessary to seek alternative methods for identifying ischemic penumbra in acute stroke patients, such as patient selection based on the presence of a DWI clinical mismatch or DWI MR angiography mismatch. In our experience, this last option has shown very high sensitivity for detecting patients with a DPM, simply by combined analysis of the extension of the diffusion-weighted signal abnormality and the presence and location of the relevant arterial occlusion by MR angiography.

**Conclusion**

Prior to the use of multimodal MR imaging for selecting acute stroke patients for thrombolytic therapy, the drawbacks of the DPM concept must be known. Efforts should be made to design a simplified, well standardized method to select patients for this purpose with MR imaging, as this will probably lead to an increase in the number of patients treated.

**Key Words:** Stroke, MR imaging, thrombolysis

**Electronic Scientific Exhibit 22**

**Current Eponyms in Neuroanatomy**

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Recife, BRAZIL

**Purpose**

Eponyms are labels that provide two kinds of information: the pattern of a complex injury or pathologic problem and the name of an individual who has been closely identified with that problem, reminding us that the medicine of today is not entirely the work of our contemporaries. The word eponym is derived from the Greek word *eponymos*, which means named after. An eponym may be defined as the name(s) of one or more individuals who presumably have devised or described an anatomical structure, a classification system, a disease, an injury, a principle, a physical sign, or an operative technique. The purpose of this pictorial essay was to present some of the eponyms still in use in neuroanatomy.

**Materials & Methods**

The authors describe and illustrate each anatomical structure using different imaging modalities as well as photographic illustrations or drawings when pertinent. They also describe a brief biography of each individual whose name has been closely attached to the structure (anatomist, pathologist, surgeon) and whose contributions were so important to neuroanatomy.

**Results**

Included in this exhibit are Francoise Sylvius, a French anatomist, Antonio Pacchioni, an Italian neuroanatomist, Claudius Galeno, the doctor of the gladiators, François Magendie, from France, Hubert von Luschka, a German anatomist, Johann L. Gasser, from Vienna, Paul Pierre Broca, a French surgeon, Thomas Willis, an English anatomist, Luigi Rolando, from Italy, Ludwig Edinger, a German professor of anatomy, Karl Friedrich Otto Westphal, a German neurologist, Alexander Monro, from Scotland, Friedrich Theodor Schwann, a German anatomist and citologist and Constanzo Varolio an Italian anatomist.

**Conclusion**

The multiplicity of the names attributed by scientists and researchers to some organs and anatomical structures has made difficult reading and elaborating scientific papers. Although nowadays frowned on by the authorities, eponyms were once widespread, and many still persist and may be a source of confusion but we believe that the contributions of these great men justify our knowledge of their lives.

**Key Words:** Anatomy, eponyms, brain
**Electronic Scientific Exhibit 25**

**Diffusion-weighted Imaging and Apparent Diffusion Coefficient: Utility in Extracerebral and Extracranial Lesions on Brain MR Imaging: A Review**

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**PURPOSE**
To discuss and illustrate the utility of diffusion-weighted images and the apparent diffusion coefficient (ADC) maps of MR imaging of the brain in evaluating subdural, extradural, cranial, and extracranial pathology.

**MATERIALS & METHODS**
1) Principles behind diffusion-weighted imaging (DWI) and ADC maps. 2) Short summary of the established use of DWI and ADC in cerebral parenchymal lesions. 3) Review of imaging findings and illustrations for subdural lesions, extradural lesions, cranial/calvarial lesions, extracranial lesions - orbital, parotid, scalp. 4) Discussion of the pathophysiology and DWI/ADC correlation of these lesions. 5) Summary.

**RESULTS**
Diffusion-weighted imaging sequence should be performed as a part of routine brain MR imaging. Evaluation of DWI and ADC maps in all cases, even where there is no cerebral parenchymal abnormality, facilitates detection of subtle lesions outside the brain, some of which could be consequential and significant. Pathologic processes can alter the structural organization of tissues by altering membranous permeability or by a change in cellularity (scarring, inflammatory, or neoplastic infiltration). These changes alter proton mobility, or diffusivity, which can be evaluated by DWI. The appearance of the lesions is not pathognomonic or characteristic on DWI and ADC map. Many of the illustrated pathologies appear similar to one another. Some lesions such as lymphoma, neuroblastoma, empyema, dermoid/epidermoid have a more characteristic appearance similar to their corresponding cerebral pathology. Diffusion-weighted imaging and ADC maps have inherent appearance similar to that of fat suppression. Lesions in the orbit, scalp, and calvarium hence are more conspicuously visualized due to this effect, since fat suppression is not used in a routine brain MR imaging. Asymmetrical lesions are appreciated more easily. Lesions are visualized due to the differences in ADC and DWI characteristics of pathologic lesions from the adjacent normal tissues; however, no significant systematic research has been made with regard to lesions in these compartments. Whereas the utility of DWI and ADC maps in cerebral pathology is firmly established, their role in evaluating orbital, parotid, and other head and neck pathology is only now being investigated. Some of the current areas under investigation include: posterior ischemic optic neuropathy, distinguishing benign from malignant parotid tumors, early detection of parotid involvement in connective tissue disorders, grading and prediction of tumor response in malignant tumors of head and neck.

**CONCLUSION**
The review of DWI images and ADC maps should not be limited to ischemic or neoplastic cerebral lesions. Diffusion-weighted imaging can be useful in detecting subtle pathology in subdural, extradural, calvarial, and peripheral pathology in the orbits, parotids, and other visualized portions of the maxillofacial region.

**KEY WORDS:** Diffusion-weighted imaging

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**Electronic Scientific Exhibit 27**

**Hydrocephalus: Understanding Evolving Concepts and Treatments**

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**PURPOSE**
Recent research has challenged the long standing and widely held tenets in CSF circulation, which in turn has led to radical rethinking of the pathophyslogic basis of hydrocephalus. Our objectives, therefore, are focused on the following: 1) To provide a topographic analysis of the anatomy of the ventricular system and CSF pathways. 2) Describe the pathophysiologic processes underlying the imaging findings in hydrocephalus and related spectrum, according to both prevailing models and emerging theories. 3) Identify and correct critical gaps in our knowledge as radiologists of the diagnosis and management of these conditions. 4) Discuss the imaging appearance of treatment-related changes and complications. 5) Describe the potential role of Aquaporin proteins (cellular plumbers) in the nonsurgical treatment of hydrocephalus.

**MATERIALS & METHODS**
We present cross-sectional images of the brain demonstrating the anatomy and function of the ventricular system and the CSF reabsorption apparatus. Case materials from our institution are used to illustrate the imaging characteristics of the different types of hydrocephalus and related spectrum of conditions including their complications. Emphasis on post-treatment findings are made including those in: a) endoscopic third ventriculostomy; b) overshunting; c) slit ventricle syndrome; d) shunt malfunction; e) “trapped ventricle”; f) normal pressure hydrocephalus; and g) benign intracranial hypertension. Evolving management concepts also are portrayed, specifically the potential role of Aquaporin proteins as “cellular plumbers.”

**RESULTS**
As neuroradiologists, we are often presented with images and a clinical history of “hydrocephalus.” A rigorous definition of “hydrocephalus,” however, can be surprisingly slippery and consistently connecting the imaging findings to clinical outcome is often complex. We increasingly recognize that these conditions are more than “plumbing problems.” Dilatation of the ventricles with increased CSF pressure represents only one presentation in a spectrum of conditions ranging from pseudotumor cerebri to low-pressure hydrocephalus. The treatment of these conditions with shunts and other mechanical measures presents further com-
plexities. Long term shunt failure remains the rule rather than exception; a mechanical solution, in Davidoff’s words, “often wrecked with purely mechanical obstacles.” In the future, alternative nonmechanical treatments may become important. If we are to help patients and their doctors, we must understand the evolving literature on the pathophysiology of hydrocephalus and how treatments either successfully or unsuccessfully alter it.

**CONCLUSION**
Understanding the pathophysiologic basis of imaging findings, recognizing posttreatment diagnostic issues, and management options are the key to a better understanding of hydrocephalus. Synthesis of both old and new concepts promotes advancement of our ability to successfully treat these challenging problems.

**KEY WORDS:** Hydrocephalus, ventricular shunts, aquaporins

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**Electronic Scientific Exhibit 28**

**Diffusion Tensor Imaging Atlas of White Matter Anatomy in the Adult Human Brain**

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**PURPOSE**
The purpose of this exhibit is to create a detailed computerized teaching atlas of the white matter tracts of the brain using diffusion tensor imaging (DTI) in conjunction with the corresponding slices in the Dejerine atlas (1). Knowledge of this anatomy can be useful in exploring the connectivity between different functional regions of the brain as well as in evaluating changes in a variety of disease states (such as stroke, multiple sclerosis, neoplasm, and certain neuropsychiatric disorders).

**MATERIALS & METHODS**
Fourteen healthy adult volunteers (7 women and 7 men) were imaged with a 1.5T MR unit (Siemens, Sonata), with b values of 600 and 1200 and diffusion gradients in 12 directions. Axial slices parallel to the AC-PC plane were obtained with isotropic voxels of 2 mm. DTI color maps and 3D fiber tracking images were generated with DTI processing software (DTI Studio version 2.02). Diffusion tensor imaging data were compared to the Dejerine atlas.

**RESULTS**
Seven major and six minor white matter tracts were identified. Among the major tracts we noted; corpus callosum, corticospinal tract, optic radiations, uncinate fasciculus, superior and inferior longitudinal fasciculus, and arcuate fasciculus. Among the minor tracts we identified; cingulate fibers, tapetum, temporo-thalamic tract and thalamic fasciculus (field H1).

**CONCLUSION**
Diffusion tensor imaging of the brain in conjunction with the Dejerine atlas, provide a useful teaching tool for learning the anatomy of the white matter tracts. This can be useful for both research and clinical purposes.

**REFERENCES**

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**Electronic Scientific Exhibit 29**

**Pictorial Review of Basal Ganglia: Anatomy, Pathology, and Imaging Characteristics**

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**PURPOSE**
There are a variety of disease entities that present as symmetrical basal ganglia abnormalities. Although these findings may not indicate a specific diagnosis, knowledge of the characteristics of diseases that affect this area can limit the differential considerations. The purpose of this exhibit is to review the anatomy of the basal ganglia, the pathologies causing symmetric signal abnormalities of both basal ganglia and discuss differential diagnosis.

**MATERIALS & METHODS**
Clinical information is often essential for narrowing the possible pathology that can be found here. A simplified approach to the differential diagnosis of these entities is based on acute versus chronic conditions and radiologic manifestations. Acute processes include hypoxia, hypoglycemia, carbon monoxide poisoning, hemolytic-uremic syndrome, osmotic myelinolysis, and encephalitis. Chronic conditions include inherited (inborn errors of metabolism, Huntington disease, and demyelinating diseases) or acquired conditions (sequelae of acute disorders) that represent abnormal biochemical or structures processed within the basal ganglia. Calcifications, T1 signal intensity, and concomitant involvement of the cortex could be a key for differential diagnosis of these lesions.

**RESULTS**
The main categories of diseases causing symmetric MR abnormalities of bilateral basal ganglia are as follows: 1) Aging process; progressive deposition of iron, enlargement of Virchow-Robin spaces, physiologic calcifications, 2) Toxic and metabolic abnormalities; hepatic encephalopathy, extrapontine myelinolysis, methanol toxicity, carbon monoxide toxicity, hypoxic-anoxic brain injury, hypoglycemic encephalopathy, Fahr’s disease, 3) Vascular disorders; lacunar infarction, venous infarction, posterior reversible leukoencephalopathy syndrome, 4) Mitochondrial disease; Leigh’s syndrome, and 5) Degenerative and inherited disorders; Creutzfeldt-Jakob disease, neurofibromatosis, and Hallehorden-Spatz syndrome.

**CONCLUSION**
Even though a wide variety of diseases may cause symmetric lesions of the bilateral basal ganglia, clinical and imaging features may be helpful for differential diagnosis.

**KEY WORDS:** Basal ganglia, pathology, imaging
Electronic Scientific Exhibit 30

Cerebellar White Matter Atlas of Normal and Different Subtypes of Ataxia Using Diffusion Tensor Imaging

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PURPOSE
Diffusion tensor imaging (DTI) plays an important role in analyzing white matter anatomy. The purpose of this exhibit is to present a cerebellar white matter atlas to better understand the cerebellar pathways and to be familiar with anatomical structures related to them. The exhibit also will demonstrate abnormalities of different cerebellar pathways in different subtypes of ataxia.

MATERIALS & METHODS
This exhibit is divided into two parts: Part 1: Normal anatomy of the cerebellar white matter pathways and related structures demonstrated with conventional MR imaging and DTI. Part 2: Patient cases of different subtypes of ataxia will be presented with diffusion tensor imaging to define the specific pathway affected. Twenty-four normal subjects (13 males, 11 females: from 22 to 56 years old: mean age of 36 years) and 10 ataxia patients (25 to 60 years old: mean age of 40 years) were analyzed. Ataxia cases include multisystem atrophy (MSA), spinocerebellar ataxia (SCA) type 1 and type 2, progressive supranuclear palsy (PSP), dentate-rubral-pallidoluysian atrophy (DRPLA), episodic ataxia, and ataxia caused by alcoholism. MR images of the brain were obtained with a 1.5T Siemens Sonata scanner. Diffusion tensor imaging was obtained with two b values of 600 and 1200, and 12 gradient directions. 5 mm and 2 mm slice thickness were used.

RESULTS
Superior cerebellar peduncles, middle cerebellar peduncles, and inferior cerebellar peduncles were identified by DTI. Using the atlas, the viewer can discuss the pathologic cases with the help of anatomical details. MSA patients exhibited afferent pathway abnormalities and SCA patients exhibited efferent pathway abnormalities. Progressive supranuclear palsy patients demonstrate significant loss of superior cerebellar peduncle fibers.

CONCLUSION
Precise knowledge of the cerebellar pathways aids in the understanding of different disease processes of the cerebellum. This atlas will be a useful tool for researchers and in daily clinical practice.

KEY WORDS: Diffusion tensor imaging, white matter atlas, ataxia

Electronic Scientific Exhibit 31

Neuroradiology Email Case Conference versus 1.2

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PURPOSE
This new and continuously updated version of the project for 2007 is designed to demonstrate the usefulness of collaboration with colleagues via email and the internet for sharing opinions regarding difficult or interesting cases.

MATERIALS & METHODS
Neuroradiologists typically encounter complex, difficult, or interesting cases in their clinical practices. It enhances quality of patient care for the neuroradiologist to consult with colleagues regarding these cases in order to arrive at a correct diagnosis, or plan an interventional procedure. We describe an internet and email-based method for alerting fellow neuroradiologists to such cases and for sharing opinions anonymously if needed.

RESULTS
Cases are taken from our PACS system, stripped of patient identification and converted to JPG format. Where applicable, MPG movie files and 3D user controlled VRML files also are included. Cases then are converted into HTML galleries using Photoshop 6.0 and uploaded to a server using FTP protocol. The URL of the individual case then is emailed to a list of recipients whose replies are posted anonymously in the discussion section of the case. When all replies have been received, the recipients are notified and then can view not only their opinion regarding a case, but the opinions of all the others. Group members also may submit their own images to be posted in the discussion section if they have a similar case to share.

CONCLUSION
We have found email and web-based collaboration with colleagues regarding difficult or interesting cases to be a very effective method for enhancing procedural safety and accuracy of imaging diagnosis. Furthermore, sharing of interesting cases in this manner enhances resident and staff education and fund of knowledge.

KEY WORDS: Internet, neuroradiology, conference
Multimodality Diagnostic Imaging in Fetal, Newborn, and Child Spine and Spinal Cord Malformations

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PURPOSE
Spine and spinal cord malformations range from nonsymptomatic features to highly impaired sensorimotor function with other organs dysfunction. The diagnosis, well established in the literature, receives new interest with the introduction of multidetector computed tomography (MDCT), with MPR and 3D rendering, with high matrix digital ultrasound equipment and new MR scanners at high field (1.5 and 3T) which allow reliable morphologic and functional studies: quantitative CSF flow, diffusion imaging. We present a review of the complexity of spine and spinal cord malformation from fetus to child, with evaluation of the role of each single modality in diagnosis of specific aspects of single or group of anomalies.

MATERIALS & METHODS
Two hundred forty-seven total malformations were studied: Isolated spine (83), spinal cord (65), and combined (99) malformations. Forty multidetector CT studies were performed in isolated spine and in 12 combined spinal cord malformations with volumetric isotropic acquisition and multiplanar reformatted and volumetric 3D rendering, 512 x 512 digital ultrasound studies were performed in newborn (43) with 12 MHz linear transducers, and 1.5T (184) and 3T (14) MR studies were performed. The patients were evaluated morphologically with SE-T1 sagittal, coronal, and axial sequences, FSE-T2 sagittal and axial sequences, SE-T1 FAT SAT in sagittal and axial plane. Quantitative flow studies with phase contrast acquisition, phase, magnitude visualization, were performed on sagittal and selected axial plane and diffusion imaging with ADC Trace, b value: 600 mm²/s on coronal and axial planes. Fetal images were obtained with FSE T2 single-shot echo-planar imaging on three orthogonal fetal planes, with T1 FFE breath hold on axial and coronal planes, EPI-FLAIR in sagittal and coronal planes and MR fetoscopy acquisition with thick slices (50-70 mm). All range of spinal malformation at low axial anomalies, vertebral fusion, hemispindula, butterfly vertebra, open and close dysraphism isolated or in combination with spinal cord malformations, Chiari I and II, closed with and without mass, open dysraphism, primary and secondary neurulation failure were presented. Quantitative CSF flow (QF) evaluation is requested in Chiari I with or without associated hydrosyringomyelia, Chiari II, tethered cord. Diffusion imaging in selected patients markedly in tethering and in hydrosyringomyelia cases.

RESULTS
Bony anomalies are visualized in fetal period with GE and EPI-FLAIR imaging, and newborn with ultrasound and MDCT (with low or very low exposure), with relative poor visualization in MR studies. Spinal cord and related anomalies were visualized in newborn with US and, in all ages from fetus to child, with MR studies. In difficult cases all the diagnostic modalities are complementary, particularly in follow up of surgery repaired cases, and in cases with progressive neurologic impairment (diffusion, QF evaluation).

CONCLUSION
Early diagnosis of spinal and spinal cord is essential to proceed to reparative or reconstructive surgery, in evaluation of progressive clinical failure. All the modalities play a specific role in different aspects on the morfofunctional entities. Their integration and the evaluation of consequent advantages is the purpose of this presentation.

KEY WORDS: Spine, developmental, malformations

Use of Gd-BOPTA for Contrast-enhanced Imaging of the Central Nervous System in Children

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PURPOSE
Gadobenate dimeglumine (Gd-BOPTA) has been shown to be safe and effective for use in MR imaging of the central nervous system (CNS) in adults in many clinical trials but its safety and efficacy in the pediatric population is less well characterized. We report the results from an open labeled multicenter phase-III study designed to demonstrate the safety profile of Gd-BOPTA in children. The purpose of this presentation is to evaluate safety and efficacy of Gd-BOPTA for MR imaging of the CNS in children.

MATERIALS & METHODS
We screened subjects between the ages of 2 to 17 years with known or highly suspected CNS disease who were referred for cranial or spinal MR examination requiring an injection of MR contrast agent. Thirteen such children met the inclusion criteria and were enrolled for this study. After patient history and physical examination were obtained each subject underwent MR imaging of their brain with contrast (Gd-BOPTA). In conjunction with the MR exam, vital signs were monitored and serial electrocardiograms (ECG) were performed. Urinalysis was performed and blood was drawn for basic metabolic panel and complete blood count within 24 hours prior to the MR scan and at 24 hours postcontrast. Adverse event monitoring was performed for 72 hours and all study subjects were followed up at 30 days to determine final diagnosis.

RESULTS
Gd-BOPTA was tolerated well by all of the children and there were no significant or serious adverse events reported. No clinically meaningful changes in laboratory parameters and ECGs were observed during the study. In patients with enhancing lesions, assessment of lesion border delineation,
definition of disease extent, visualization of lesion internal
morphology and lesion contrast enhancement were consid-
ered good to excellent in all subjects.

**CONCLUSION**

Gd-BOPTA is a safe and effective MR contrast agent for use
in the evaluation of CNS lesions in the pediatric population.

**KEY WORDS:** Pediatrics, neoplasm, contrast media

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**Electronic Scientific Exhibit 34**

**Recent Advances in the Cytogenetics and Molecular
Biology of Pediatric Nervous System “Blastomas”: Implications for Diagnosis and Management**

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**PURPOSE**

1) To review recent advances in the pathogenesis and molec-
ular biology of childhood solid tumors (CSTs) of the nervous
system: retinoblastoma, medulloblastoma, and neuroblas-
toma. 2) To describe the intimate link between oncogenesis
and organogenesis in the pathogenesis of these tumors. 3) To
correlate the histopathology and tumor biology of hereditary
and sporadic “blastomas” with their imaging spectrum.

**MATERIALS & METHODS**

Pediatric nervous system blastomas exhibit characteristic
histopathology, tumor biology, and imaging findings. Recent
advances have offered new insights into the ontogeny, biol-
ogy, and pathogenesis of these tumors.

**RESULTS**

Retinoblastoma, medulloblastoma, and neuroblastoma
belong to a heterogeneous group of childhood solid tumors
(CSTs). The pathogenesis of these tumors is related closely
to organogenesis, tissue growth, and maturation. The histol-
ogy and gene expression profile of these tumors closely
resemble the tissues in which they arise. Peak tumor inci-
dence closely parallels the periods of maximum growth of
the tissue of origin.

**CONCLUSION**

Recent clarification of cytogenetic and oncologic pathways
has led to better understanding of the pathogenesis, behavior,
and prognosis of these tumors. Select tumors may benefit
from molecular targeted therapy. In this exhibit, the cytoge-
netics of selected CSTs are discussed and correlated with
phenotypic characteristics and tumor biology.

**KEY WORDS:** Childhood solid tumors, genetics, blastomas

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**Electronic Scientific Exhibit 35**

**Cytogenetics and Molecular Pathogenesis of
Neurofibromatosis 1 and 2: Is There a Common
Pathway?**

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San Antonio, TX, 2University of Arkansas for Medical
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York, NY

**PURPOSE**

1) To review recent advances in the pathogenesis and molec-
ular biology of neurofibromatosis (NF)1 and NF2. 2) To
describe the cytogenetic changes leading to initiation, prolif-
eration, and malignant transformation in neurofibromatosis.
3) To correlate the histopathology and tumor biology of NF1
and NF2 with their imaging spectrum.

**MATERIALS & METHODS**

Recent advances in genetics and pathology have thrown
fresh light on the oncologic pathways, tumor biology, and
pathogenesis of neurofibromatoses. The causative genes,
their locations and functions have been clarified. Some spo-
radic neoplasms also show mutations similar to NF.

**RESULTS**

Genotype-phenotype studies show that the NF1 and NF2
genesis function as tumor suppressor genes. Their gene prod-
ucts - neurofibromin and merlin - regulate cell growth and
proliferation. These two proteins are structurally different
and have different mechanisms of action, but both probably
act through modulation of the RAS/RAC oncogenic path-
ways. Several drugs that act at the molecular level are being
developed to treat the conditions. This exhibit examines the
role of these proteins in the oncogenic pathways, discusses
the resulting cytogenetic changes, and correlates these with
the characteristic phenotypes and tumor biology of these
entities.

**CONCLUSION**

NF1 and NF2 are characterized by inactivating mutations of
tumor suppressor genes. Knowledge of the oncologic path-
ways permits better understanding of the imaging spectrum
and may help in developing molecular targeted therapy for
NF1, NF2, and other NF-related sporadic neoplasms.

**KEY WORDS:** Neurofibromatosis, genetics, oncogenesis
A review of the pathophysiology, clinical features, treatment, and neuroradiologic features of mucopolysaccharidosis type I (MPS I) is presented with an explanation of the utility of CT and MR imaging in the assessment and follow up of MPS I. Turnbull, I. W.

Deib, G.

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1. Long Island College Hospital, Brooklyn, NY, 2. University of Iowa Hospitals and Clinics, Iowa City, IA

PURPOSE
The purpose of this exhibit is to increase familiarity with the imaging appearance of the normal brain and common congenital brain malformations on prenatal ultrasound (US). This will facilitate an early and more confident diagnosis of these malformations, the presence of which may have a significant impact on the outcome of pregnancy.

MATERIALS & METHODS
This exhibit will commence with a review of the appearance of normal brain on prenatal sonography in early pregnancy (first trimester) and late pregnancy (second and third trimester). The AIUM/ACOG/ACR guidelines for evaluation of the developing brain on routine prenatal sonography and the pertinent measurements obtained during routine prenatal sonography will be described. Different stages of brain development will be reviewed along with a list of malformations that occur from abnormalities during these different stages.

RESULTS
The core of the exhibit is an image-based quiz. The quiz cases include anencephaly, encephalocele, Chiari malformations, Dandy Walker malformation and variant, holoprosencephaly, septo-optic dysplasia and agenesis of the corpus callosum. The quiz answers will review the pertinent imaging features of these entities on prenatal sonography with postnatal CT or MR correlation.

CONCLUSION
A description of relevant clinical aspects of these entities also will be provided. The role of 3-dimensional ultrasonography and prenatal MR imaging will be discussed briefly.

KEY WORDS: Congenital, prenatal, sonography

Material & Methods
The history, epidemiology, and genetic basis of MPS I are discussed. Case examples are used to demonstrate the characteristic neuroradiologic findings in the spectrum of MPS I (Hurler syndrome, Scheie syndrome, and Hurler-Scheie syndrome) with clinical and biochemical correlation including response to treatment. Pathologies which mimic MPS I are presented and contrasted.

RESULTS
In the neuroradiologic assessment of MPS I there is a broad spectrum of features. CT and MR imaging may reveal cortical atrophy, white matter abnormalities, a delay in myelination and hydrocephalus which (in combination with mucopolysaccharide deposition) may result in macrocephaly. Atrophy and white matter changes tend to occur early in MPS type I. Many patients develop multiple, small, spot-like cystic lesions dispersed in the white matter radiating towards the cortex with a predilection for the parietal and occipital regions. Punched out cystic lesions also may present in the corpus callosum. In exceptional cases, the thalamus and the basal ganglia have a honey-comb like appearance. Multiple high signal areas which may represent gliosis are seen on T2-weighted imaging. White matter abnormalities can be progressive on follow-up MR imaging. Spinal cord compression occurs most commonly at the atlanto-axial joint and MR imaging of the cranio-cervical junction shows a shortened odontoid, with a soft tissue mass of variable size. MR spectroscopy demonstrates decreased NAA/choline and large peaks in the inositol and glutamate/glutamine regions.

CONCLUSION
A broad spectrum of MR and CT findings are seen in mucopolysaccharidosis type I. When correlated with clinical and biochemical features, the neuroradiologic findings provide an integral clinical tool in patient assessment.

KEY WORDS: Mucopolysaccharidosis, MR, CT

Electronic Scientific Exhibit 38
Radiology of Lysosomal Storage Disorder
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PURPOSE
1) We present a thorough illustrated review and classification of the lysosomal enzyme disorders. 2) Illustrate the imaging appearance of the wide spectrum of abnormalities found in different lysosomal storage disorders (LSD).

MATERIALS & METHODS
Lysosomes are subcellular organelles responsible for the physiologic turnover of cell constituents, containing catabolic enzymes. Lysosomal storage disorder is a group of genetic disorders that results from defective lysosomal metabolism resulting in cellular dysfunction. To date, as many as 41 disorders have been described. We present the experiences of two major institutions, one is Salmania Medical Centre, Bahrain, which is a tertiary referral hospital for the Gulf region and second is Penn State Milton Hershey Medical
Center, Hershey, PA. We present here common and uncommon lysosomal disorders along with clinical and imaging findings.

**RESULTS**

For the purpose of this exhibit and for easy understanding of these complex pathologies we have used the standard biochemical classification which depends on the enzyme deficiency and accumulation and/or excretion of toxic substrate. 1) Lipidosis: a) Sphingolipidosis- Fabry’s, Gaucher, GM1 and GM2 gangliosidoses diseases and leukodystrophies like Krabbe’s and metachromatich b) Nonosphingolipidosis: Wolman’s disease, 2) Mucopolysaccharidoses 3) Glycogenosis - Pompes, 4) Glycoproteinoses - Fucosidosis, Mannosidosis, 5) Neuronal ceroid lipofuscinosis, and 6) Mucolipidosis.

**CONCLUSION**

Due to nonspecific clinical findings various radiologic images may help in providing either a diagnosis or aid in limiting the differential diagnosis of LSD. This in turn will guide the selection of appropriate enzyme assay for definitive diagnosis. We illustrate the characteristic imaging features of these various lysosomal enzymatic defects. After study of this exhibit the participant will be able to list and identify the radiographic findings of the various LSD.

**Key Words:** Lysosomal storage disorder, MR imaging

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**Electronic Scientific Exhibit 39**

*Imaging of Sensorineural Hearing Loss*

Kanekar, S. G. · Moshiri, S. · Singh, T. · Patil, S.

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Hershey, PA

**Purpose**

1) To describe and illustrate the anatomy of the sensorineural hearing pathway. 2) To illustrate the common and uncommon lesions involving the cochlear and retrocochlear pathway.

**Materials & Methods**

Hearing loss does not respect the age. Forty percent of people over the age of 75 years have hearing loss and 1 in 1000 babies born in the USA is completely deaf. Imaging studies of 753 patients with clinically suspected sensorineural hearing loss (SNHL) were analyzed retrospectively from our institutional archive system, which formed the basis of this exhibit.

**Results**

For the purpose of this exhibit we have classified SNHL into 1) Developmental/congenital: a) nongenetic, b) genetic, and c) inner ear anomalies. 2) Cochlear lesions: a) otodystrophies - otosclerosis/Paget’s, b) Infective (mainly in children) - labyrinthitis (toxic/suppurative) various viral infections, c) Tumors primary within the membranous labyrinth/secondarily involving the bony labyrinth, d) Trauma: head/temporal bone trauma, barotrauma. 3) Retrocochlear lesions: a) IAC/CPA cistern pathologies: congenital lesions, tumors, infection/inflammatory, vascular, b) Neurologic disorders: multiple sclerosis, vascular and hematologic disease, SCD, leukemia. In our study we also came across multiple other causes where radiology has little role to play but are clinically seen as frequent causes of SNHL (e.g., endocrine/metabolic, immune disorders: Wegner’s granulomatosis, PAN, Cogan’s syndrome, pharmacologic toxicity - aminoglycosides, loop diuretics, antimalarial, salicylate. Unknown etiology - presbycusis, endolympathic hydrops.

**Conclusion**

1) We demonstrate and discuss the cross-sectional imaging appearances of common and uncommon lesions involving the cochlear and retrocochlear pathway. 2) We give the algorithmic approach for evaluation of SNHL according to the anatomical locations, type of hearing loss, and the patient’s age.

**Key Words:** Sensorineural hearing loss, MR imaging, HRCT

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**Electronic Scientific Exhibit 40**

*Laryngeal Cancer: What a Radiologist Needs to Know*

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**Purpose**

Malignant lesions of the larynx far outweigh benign neoplasms. We review the diverse patterns of local spread of squamous cell carcinoma affecting the larynx on CTand MR imaging and provide key imaging features.

**Materials & Methods**

The accurate staging of laryngeal cancer is extremely crucial in treatment planning. As a large referral centre for head and neck cancers we regularly image laryngeal malignancies. We describe the patterns of local spread according to each anatomical region and provide key imaging features for local staging.

**Results**

Whilst the mucosal extent of tumour and cord mobility is best assessed with endoscopy, cross sectional imaging is required to determine the submucosal extent and invasion of adjacent structures. The combined information allows the tumour to be classified according to the relevant T staging. Moreover, imaging also provides information on nodal spread, systemic metastasis, synchronous tumours and recurrent disease.

**Conclusion**

Accurate staging of head and neck squamous cell carcinomas plays vital role in planning treatment options. We present a comprehensive imaging review of cancers affecting the larynx.

**Key Words:** Larynx, cancer, carcinoma
**Electronic Scientific Exhibit 41**

**Buccal Space Is “In Your Face”**

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**PURPOSE**

1) Review the anatomy of the buccal space. 2) Review location and appearance of buccal space lesions. 3) Learn clinical findings associated with buccal space lesions and relevant information for surgical planning.

**MATERIALS & METHODS**

The imaging studies of 62 patients with buccal space lesions who presented to four major teaching institutions over a 2-year period were reviewed. The lesions were analyzed with regards to location and imaging characteristics.

**RESULTS**

The buccal space is often overlooked in the discussion of head and neck pathology. Because of its connection with adjacent spaces (masticator, parotid, and submandibular) and areas such as the retromolar trigone, an understanding of the anatomy and patterns of disease spread is essential when interpreting cross-sectional imaging in the head and neck. The major component of the buccal space is fat, which consists of four projections of adipose tissue extending from a central hub. There is no standard nomenclature for these subdivisions; however we define them as an anterior division (central hub of fat) and superior, inferior, lateral, and medial divisions (the four projections). Each division will be discussed individually with regard to site specific and nonspecific lesions. Points of communication with adjacent spaces also will be discussed. Buccal space lesions that can occur in all locations will be presented such as infection, vascular lesions, and primary buccal space tumors. Pathology which is site specific also will be presented: anterior division - cheek implants and gingival lesions; lateral division - parotid duct pathology, accessory parotid gland, and parotid lesions in the portion of the gland superficial to the masseter muscle; medial division - tumors extending from the retromolar trigone onto the pterygomandibular raphe with extension into the buccal space, gingival lesions and masticator space infection. The clinical findings associated with buccal space lesions and patterns of disease spread to and from adjacent spaces will be reviewed. The ability to reliably localize pathology in the buccal space will aid in diagnosis when considered in conjunction with a lesion’s imaging characteristics and clinical findings. Many of these lesions require surgical intervention and imaging provides crucial information for surgical planning; therefore key points for surgical planning will be included.

**CONCLUSION**

Upon the completion of this exhibit, one will be familiar with normal anatomy, appearance and location of buccal space lesions, relevant clinical information that may aid in the diagnosis and pertinent findings for surgical planning.

**KEY WORDS:** Buccal

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**Electronic Scientific Exhibit 42**

**Comprehensive Diagnostic Evaluation of Traumatic Cerebrovascular Injury**

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**PURPOSE**

This scientific exhibit reviews the current state of the arts for diagnostic evaluation of traumatic arterial and venous cerebrovascular injury (CVI). The goals of this investigation were to identify risk factors for CVI in patients presenting to a busy Level I trauma center following blunt and penetrating craniocervical trauma and to develop an effective protocol to manage these patients. Several presenting clinical and radiographic factors were used to identify patients needing urgent diagnostic vascular evaluation. These included mechanism of injury, high-risk radiologic predictors of injury identified on initial CT imaging, significant spinal fracture/dislocation, massive hemorrhage, and ischemic clinical symptoms. Traumatic CVI were categorized into five grades according to the Denver Grading Scale. The imaging features of traumatic CVI and diagnostic imaging pitfalls encountered are presented. Clinical features and management issues of the most common traumatic complications are discussed.

**MATERIALS & METHODS**

The diagnostic images of 4345 consecutive patients presenting with blunt craniocervical trauma to a Level I Trauma Center over a 5-year time frame were reviewed retrospectively and the diagnostic studies analyzed. All patients who had vascular imaging studies (MRA, CTA, ultrasonography, conventional angiography) (n = 450) for workup of suspected CVI were specifically analyzed. The results of this study are presented in an interactive hypertext-based multimedia format (audio, video).

**RESULTS**

Arterial CVI were classified according to location (cervical, intracranial), vessel involved, and grade (1-5) of injury (1 representing intimal irregularity < 25% and 5 representing transaction with active extravasation). Dural venous sinus injuries also were classified according to grade and location of injury. We identified a significantly higher incidence of CVI (5%) than previously reported in the literature (0.05-1%). The higher incidence of CVI in this series of patients is likely due to a lower threshold used for obtaining vascular imaging studies, greater severity of injury in our patient group, and interval improvements in imaging studies over the last decade. The major complications of vascular injuries included hemorrhagic events, pseudoaneurysm formation, increased intracranial pressure, ischemic and neurologic events, and death.

**CONCLUSION**

Multiple imaging modalities often are required to identify, classify, and evaluate CVI in patients with blunt and penetrating craniocervical trauma and to evaluate the often devastating clinical sequelae of these injuries. Diagnostic CTA, duplex ultrasonography, MRA, and conventional angiography are of paramount importance for expedient diagnosis.
and initiation of treatment in certain head trauma patients with a high relative risk for CVI. A high index of suspicion for CVI and specific radiographic risk factors suggestive of occult CVI are emphasized in this exhibit.

**Key Words:** Trauma, vascular, venous

**Electronic Scientific Exhibit 43**

**Imaging Facial Pain: Facing the Challenge**

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**Purpose**

We describe CT and MR imaging findings in patients presenting with facial pain. We highlight key imaging features and provide an algorithmic approach to the differential diagnosis.

**Materials & Methods**

Facial pain is frequently nonspecific and the etiologies are highly diverse. As a tertiary referral center, we are regularly faced with the problem of diagnosing the culprit process. Intracranial, dental, pharyngeal, sinonasal, orbital, and otoplogic processes often are incriminated as causative factors. We provide a structural approach to imaging by classifying facial pain as neuralgic pain, pain with cranial nerve findings and pure facial pain and describe the imaging abnormalities encountered in each subgroup.

**Results**

As a radiologist it is extremely difficult to pinpoint a cause for facial pain and a focussed imaging examination usually is dependent on a good clinical examination. We attempt to summarize the role of imaging in facial pain and describe CT and MR findings in some of the commonly encountered pathologic processes using an algorithmic approach.

**Conclusion**

Facial pain is a troublesome and common problem encountered in clinical practice. With the ever increasing role of imaging in head and neck pathologies, the radiologist is called in increasingly to aid the clinician in determining the underlying pathologic processes.

**Key Words:** Facial pain, face, neuralgia

**Electronic Scientific Exhibit 44**

**Maxillofacial Trauma: Patterns, Pearls, and Pitfalls**

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**Purpose**

The anatomy of the facial skeleton is highly complex with numerous sutures and bones. In describing facial fractures, the radiologist may find it difficult to decide which fractures are clinically relevant to the surgeon. There are issues relating to functional units of the face and cosmetic deformities. Using an algorithmic approach we describe the various patterns of maxillofacial trauma on CT imaging.

**Materials & Methods**

Traditionally, fractures are described according to the anatomical sites. However, the various bones of the face function together supporting the different functional units of the face. We describe in detail the different patterns of maxillofacial trauma from a surgical perspective.

**Results**

The fracture sites can be classified as mandibular, central midface (LeFort, nasoethmoidal, isolated maxillary or palatal), lateral midface (zygomatic, zygomatico-maxillary and zygomatico-calvareal) orbital, or craniofacial. We describe appearances of fractures in each subgroup. We also describe the associated soft tissue abnormalities and the role of multiplanar imaging.

**Conclusion**

We present a comprehensive review of imaging in maxillofacial trauma and describe fractures and injuries from a clinically relevant standpoint.

**Key Words:** Trauma, maxillofacial fractures, facial trauma

**Electronic Scientific Exhibit 45**

**Keck University School of Medicine Spine Radiology Course Chapter 4: The Intraspinal Spaces**

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Los Angeles, CA

**Purpose**

We live in a period of super specialization in radiology. Radiology residents and fellows migrate from section to section learning MR imaging, CT, and invasive neuroradiology.
It is unusual for there to be an opportunity for the trainee to be in the position of seeing the entire picture of spine disease. Furthermore, the radiologist tends to be isolated from the clinicians who care for the patients. During the last 4 years a comprehensive 10-hour, interactive, course in diagnostic imaging of the spine has been created including plain X-ray, videofluoroscopy, CT and MR imaging. The course is designed to present the spine in its totality, as an entity with three functions, supporting the head and body, allowing mobility, and protecting the spinal cord. The purpose of this computer exhibit is to demonstrate several segments of the interactive CD-based course in spine radiology. It is intended to weave a total picture of spinal anatomy, biomechanics, and physiology. It is designed to teach basic concepts rather than the details of rare entities. Symptom correlation with observed abnormalities is stressed. Chapters 1-3 were shown consecutively at previous meetings of this society.

**Materials & Methods**

Chapter 4 of the course dealing with the anatomy and pathology of the intraspinal space will be read from CDs. Imbedded in these presentations is a combination of text, voice, and video used to challenge the trainee’s powers of observation and deduction. There are many quiz questions about the images pervading the lectures.

**Results**

Chapter 4 of the University of Southern California radiology course will teach the radiographic anatomy and physiology in a most unusual way.

**Conclusion**

The course in its entirety provides a novel approach for learning spinal imaging.

**Key Words:** Tumors, infections
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Index Key: C = Computer Assisted Exhibit; I = Invited Speaker; O = Oral Paper; P = Poster; S = Scientific Exhibit

Numbers refer to session and presentation numbers, not to page numbers.
Dear Colleagues,

Welcome to the ASNR 45th Annual Meeting and NER Foundation Symposium 2007. David M. Yousem, MD, MBA, President-Elect/Program Chair, has assembled a program with thought-provoking and significant educational and scientific sessions for this year’s program.

The NER Foundation Symposium 2007: The Aging Brain will bring us all up to speed on an important area of neuroradiology research and clinical care. Discussions will focus on brain volume and intracranial atherosclerosis as well as on important trends and opportunities for the future.

The Annual Meeting features more than 40 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 Interventional and Therapeutic Neuroradiology (ASITN) and the American Society of Spine Radiology (ASSR), covering a wide range of topics for both the sub-specialist in neuroradiology and the general neuroradiologist.

In addition to the focus sessions, the meeting will offer Advanced Imaging Seminars, expanded ELC Workshops and Lectures, the ASNR Business Center, How-To Sessions, and daily Maintenance of Certification (MOC) review sessions.

Again this year, we are pleased to provide Audience Response Plus (AR+) throughout the entire program.

Our Annual Meeting provides a unique opportunity to better understand how the ASNR assists its members in the practice of neuroradiology during a time of rapid change. We can all look forward to renewing old friendships and making new ones as we exchange ideas and expand our knowledge. Please join us at the “All That Jazz” Reception with the technical exhibitors on Tuesday evening. The Scientific Exhibition will be open for viewing during the evening. Be sure to spend some free time during your stay by participating in our optional tour program offered throughout the week.

I wish to extend a special thanks to Dr. David Yousem and to the following Co-Chairs for their efforts in organizing the program:

American Society of Functional Neuroradiology (ASFNR) ............................................Jeffrey R. Petrella, MD
American Society of Head and Neck Radiology (ASHNR) .............................................Timothy L. Larson, MD
American Society of Interventional and Therapeutic Neuroradiology (ASITN)..............Mary E. Jensen, MD
American Society of Pediatric Neuroradiology (ASPNR)................................................Nancy K. Rollins, MD, FAAP
American Society of Spine Radiology (ASSR).................................................................Alyssa T. Watanabe, MD

On behalf of the entire Executive Committee, welcome to Chicago, Illinois for the ASNR 45th Annual Meeting and NER Foundation Symposium 2007 — where advanced technology, clinical imaging and interventional neuroradiological excellence come together.

Sincerely,

Robert I. Grossman, MD
ASNR President